Comments on CC's annotated issues statement: The CC's approach to measuring concentration

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(NON-CONFIDENTIAL)

Section 1

Introduction and summary

Introduction

1.1 The Competition Commission published an annotated issues statement (AIS) in the context of its Private healthcare market investigation.[1] In the context of the CC's Theory of Harm 1 (Market power of hospital operators in certain local areas) and with possible relevance to the CC's Theory of Harm 3 (Leverage of Local Market Power in National Bargaining), the AIS outlines the methodology the CC has used to 'understand the degree of market power that is enjoyed by hospitals.' (paragraph 2, Annex 2.) The CC then goes on to argue that 'Market Concentration is commonly used as a proxy or indicator of market power.' And in Annex 2, the CC argues that it has 'adopted two methodologies for quantifying market concentration – fascia counts and a measure based on market shares. The market share measure is closely related to the 'Logit Competition Index,' herein referred to as "LOCI". LOCI is also described to be equivalent to 1 minus a 'weighted average market share'.

1.2 Using these approaches, the CC identifies 147 hospitals of potential concern, of which 122 had a weighted average market share of 40% or higher and a further 25 hospitals faced no more than one relevant competitor within their catchment area.[2]

1 Competition Commission, "Annotated issues statement", dated 28 February 2013, available at: http://www.competition-commission.org.uk/our-work/private-healthcare-market-investigation/annotated-issues-statement.

2 Annotated IS, paragraph 62. I note the CC adjusted the total number of hospitals of concern down to 144 on 5 April 2013. No BMI hospitals were affected by this change.

1.3 The CC has then investigated the relationship between local prices for self-pay patients and local competition using an econometric model.[3] Based on the price concentration analysis ("PCA"), the CC states that "initial analysis shows a statistically significant relationship between price and concentration, indicating that prices are expected to be, on average, higher in more concentrated local markets"[4] and concludes that "[CC's] current thinking is that some private hospital operators have market power in local areas".[5]

1.4 In this document, I provide my comments on the CC's assessment of local concentration and competition in local areas as set out in the AIS. Considering that the CC is planning to set up a data room to enable parties to review and test robustness of the CC's economic analyses, at this stage I do not comment on the PCA.

Summary

1.5 My comments on the CC's assessment of local concentration and competition in local areas (as set out in the AIS) are at this stage focused on: (i) the conventional economic analysis of the link between concentration and market power; (ii) CC's fascia counts analysis as a measure of concentration; and (iii) CC's LOCI measure of concentration. I summarise my comments below.

The conventional economic analysis of the link between concentration and market power

1.6 In this section I consider the most famous analysis of the relationship between concentration and market power – built from on the foundations of the Cournot model. In essence the lessons from that analysis are: (i) that concentration and margins may be correlated for a number of reasons – in particular differences in firm efficiency; and (ii) that concentration alone is not enough to generate high margins. In the Cournot model for example, concentration must be high and also consumer demand at the market level must also be relatively price insensitive.

3 Annotated IS, paragraphs 68-69, and Appendix B, Annex 3.

4 Annotated IS, paragraph 68.

5 Annotated IS, paragraph 69.

1.7 The current context is complicated by at least two factors relative to the baseline Cournot model. The first is the presence of fixed costs, which must be recovered and will therefore require some degree of market power to be exercised for any services to be provided. Thus concentration need not be an indicator of a problematic degree of market power. And second is the role of product differentiation - in terms of hospital quality but also in particular geography. Neither of these two factors detract from the two important lessons from the classic analysis of the Cournot model. But they do introduce a number of other issues that must also be considered. For example, investments in product quality may result in high quality services being charged at prices which are above those available in markets with lower concentration.

1.8 Overall the key point to consider is that economics shows that market concentration doesn't of itself imply problematic market power. Thus, while concentration may be used as a proxy for market power – any such proxy must be developed and then applied with a significant degree of care.

1.9 When attempting to measure concentration as a proxy for market power, the CC develops two indicators - fascia counts and LOCI. I next discuss each in turn.

CC's fascia counts approach

1.10 The first approach which the CC uses to assess local concentration is 'catchment areas and fascia counts' approach. I note and largely agree with the CC's caveats around this measure of concentration and in addition I consider:

(a) The treatment of the NHS (other than NHS managed PPUs);

(b) The size of the catchment area;

(c) The use of road-distance versus drive-time;

(d) The use of regional or GB catchment areas in the analysis;

(e) The extent to which it would be appropriate to use catchment areas around hospitals versus population areas; and

(f) The treatment of specialties and in particular oncology.

CC's LOCI approach

1.11 The second approach the CC uses for measuring concentration is the Logit Competition Index (LOCI) approach, which the CC also describes as the 'weighted average market share' approach.

1.12 I make a number of points about this methodology. First, I note that it is not a methodology which is widely accepted by the scientific economics community. The paper the CC cites is unpublished and LOCI is not well known or widely used among industrial economists. The CC must therefore actively work to satisfy itself that such an approach forms an appropriate basis for its analysis. A position that LOCI is discussed in the newly published market investigation guidance would obviously in this instance be insufficient, since the inclusion of LOCI to the draft guidance was not consulted upon[6] and was apparently made after the CC's decision to use a LOCI approach in this case. Simple reference to use by other competition agencies[7] without far more detail on exactly the role LOCI played in the cases considered by these agencies is also clearly an insufficient basis to rely on LOCI as a methodology.

1.13 Second, the CC currently appears to conflate: (i) LOCI as a particular measure of weighted average market share and (ii) LOCI as a correlate of market power in a particular economic model. I believe that it is very important to keep these two aspects of the measure as conceptually distinct when thinking about what LOCI is, and is not, likely to tell us.

1.14 The fact that LOCI can be 'interpreted' as a particular weighted average measure of various sub-market shares cannot of course be disputed - it is mathematically a fact. But it is certainly not, for example, the measure of market share more commonly associated with the economic model which the CC uses to motivate LOCI. Fundamentally, LOCI is a correlate of market power predicted by a particular economic model - it is not in my view fundamentally a measure of market concentration that is well motivated by economic theory.

1.15 Indeed, the fact that the LOCI can also be interpreted as a particular weighted market share turns out to have a lot to do with the widely accepted undesirable properties of the Logit model.

[6] A search for 'LOCI' and 'Logit' return no responses in the June 2012 consultation document available on the CC's website: http://www.competition-commission.org.uk/assets/competitioncommission/docs/2012/consultations/market_guidlines_main_text.pdf . There is also no reference to LOCI in the earlier April 2011 consultation document available: http://webarchive.nationalarchives.gov.uk/20111108202701/http:/www.competition-commission.org.uk/rep_pub/consultations/current/pdf/110427_mi_guidelines_text_v8_black_line.pdf

[7] AIS Annex 2 paragraph 41.

LOCI has no connection with market power in the benchmark Hotelling(1929) model

1.16 To consider whether LOCI is likely to be a useful measure of market power, I have considered how LOCI performs in the canonical model of a geographically differentiated market due to Hotelling(1929). This model is clearly a benchmark model for analysis of retail markets. **I find that in this class of models the LOCI index has, strikingly, absolutely no connection with market power**. Instead, LOCI always takes on the value zero implying that every firm has a monopoly no matter how low transport costs are. Such a prediction is clearly nonsense.

1.17 I conclude that (i) the LOCI's deep connection with the Logit model (which is definitely not a reliable basis for measurement of market power) and (ii) the fact that the LOCI index completely fails to detect market power in the benchmark economic model that has been used by economists for almost a century to understand competition in retail markets, suggests that LOCI is unlikely to be a useful measure of market concentration. **This in turn suggests that using LOCI as a filter to identify hospitals of potential concern isn't likely to provide the CC with useful results**.

1.18 In addition to my consideration of the principles of the LOCI analysis, I also consider a number of more detailed aspects of the CC's analysis. I outline those in turn below.

The LOCI measure is likely to understate the competitive constraint from other hospitals

1.19 LOCI involves calculating a particular weighted average market share of a hospital in the area from which the hospital drew its patients during the period of study. In that sense it is very different from a standard market share measure which indicates a given hospital's share of a defined actual or potential market (i.e. not just the parts of the market from which the hospital actually draws its patients). Clearly hospitals (like any other local retail business) are likely to have fairly high market shares among their nearby customers and we are therefore likely to find that LOCI measures tend to indicate relatively high market shares. It is therefore not surprising that on the basis of the LOCI filter the CC are currently finding a very high fraction of potentially problematic hospitals. The filter is not filtering much out and appears instead to be more of a catch-all.

The impact of the omitted data (hospitals) on the analysis

1.20 The CC states that LOCI was calculated for 173 hospitals and it did not have invoice records for the remaining 50 hospitals. I understand that the CC stated at the roundtable that in its view this is unlikely to be significant because 41 of the 50 excluded competitors were PPUs and were "small". It is not appropriate to simply dismiss these competitors in this way. The CC has accepted that PPUs are competitors to private hospitals, PPUs are geographically diffuse and in some instances are significant local competitors to BMI's hospitals. Omitting the data for these hospitals, as the CC correctly says, will understate actual competition since hospitals for which the CC has data will have higher calculated market shares than their actual market shares. This accepted overstatement is important in the treatment and interpretation applied to the LOCI results and should not be so lightly dismissed as likely to be insignificant.

Impact of postcode definition on the LOCI calculation

1.21 The LOCI calculation will be heavily dependent on the definition of “sub-markets”. The CC uses postcodes to define sub-markets, but the LOCI analysis will be determined to a significant degree by the level of aggregation (grouping) of postcodes used to calculate the weighted average market share measure.

1.22 The particular weighting approach used by the CC is assigning larger weights and thus emphasising the areas close to the hospitals from which the hospital draws a lot of patients. However, the relevant customers in terms of competitive constraint (and assessment of market power) are those who would be likely to switch if, for instance, prices change.

1.23 In a more traditional market share approach, the shares are linked to the market definition. In the weighted average market share approach, the CC defines sub-markets as postcodes, and all postcodes from which the hospital draws patients together form the total market. This is clearly a choice of a geographic market. Furthermore, the weighting approach assigns higher importance to the postcodes from which the hospital draws more patients, which is again a choice that leads implicitly to a narrower market on which the market share is based.

LOCI threshold

1.24 The CC does not provide the reason why, under this particular LOCI measure, the threshold of 40% is used to identify the hospitals of potential concern. Since the LOCI measure is a non-conventional measure of a weighted market share, leaving aside the question of the extent to which 40% is a useful threshold on a conventional market share test, it is far from clear that any such conventional market share threshold would be appropriate for its application – given the weighting being used.

Consistency of the CC's network LOCI adjustment with the underlying economic model

1.25 The CC has noted that the LOCI analysis is motivated by reference to a particular economic model built on the foundations of the Logit model. However, when undertaking the analysis of the impact of owning nearby hospitals (network LOCI), the CC appears to have adopted an ad-hoc approach rather than using the adjustment implied by the underlying economic model. It is not clear why the CC chose to follow an ad-hoc adjustment approach to calculate the CC's network LOCI. The result is that the CC's network LOCI does not correspond to a measure of either concentration or market power in any known underlying economic model.

Restrictive implicit assumptions in the underlying economic model for LOCI

1.26 My examination of the LOCI model has led me to believe that the model underlying LOCI assumes that consumers cannot substitute to a choice which involves not purchasing. Ordinarily models such as the Logit model or other richer variants will allow consumers to substitute away from the market being studied if (for example) all prices in a market rise. In the LOCI model this is not the case. As a result, a monopolist is, wholly unrealistically, predicted to have an arbitrarily large amount of pricing power in this model. Similarly, in less concentrated markets, consumers are presumed to face an unrealistically constrained choice of options and so LOCI appears likely to overstate the degree of market power available to market participants. In the terminology of the academic literature building such consumer choice models, the LOCI model unrealistically presumes consumers have no 'outside option'. The reasonableness (or otherwise) of this assumption is not discussed in the CC's AIS and yet it forms one of several very significant differences to the 'well known Berry, Levinsohn and Pakes (1995) model' which the CC argues is 'closely related' to the LOCI model.[8]

[8] Footnote 5 of Annex 2 to Appendix B of the AIS.

Section 2

Conventional economic analysis of the link between concentration and market power

2.1 In Annex 1 to Appendix B of the AIS, the CC outlines its measurements of local concentration, stating (on slide 2) that: “The objective of the analysis […] is to create filters for use in identifying the hospitals that are located in the more concentrated areas (referred to as ‘hospitals of potential concern’)”. In Annex 2 (paragraph 2), the motivation for measuring concentration is relatedly (but not identically) that ”[m]arket concentration is commonly used as a proxy or indicator of market power”.

2.2 Conceptually the distinction between measuring market concentration and measuring market power is a potentially significant one. A measure of market concentration is just that. It may or may not ultimately be a correlate for market power. Moreover, the causes and consequences of such a correlation must be clearly understood.

2.3 To illustrate this distinction between measures of market power and concentration further, consider the classic motivation for the HHI as a measure of concentration and potential correlate of market power. As is well known, the motivation for HHI arises from the analysis of a particular economic model, the Cournot model. In that model, a firm's optimal mark-up (sometimes known as the Lerner index, (price (minus marginal cost)/price) is shown to be related to the market share of an individual firm divided by the market elasticity of demand.[9] When aggregated across firms by share-weighting the Lerner index, I find that this measure of industry-wide mark-ups is proportional to the HHI, with a coefficient of proportionality of the elasticity of demand. Thus in the Cournot model, the HHI is predicted to be a correlate of industry average mark-ups. In that sense mark-ups can in the Cournot model be proxied by concentration.

2.4 Of course it is important to realize the limitations of such a construction. In particular, as is well known, in the Cournot model the key drivers of firm measured market power (i.e. gross margins) are actually the mix of (i) firm's market share and (ii) the own-price elasticity of market demand. Moreover, in the Cournot model the only driver of a firm's market share is actually its cost-efficiency - since firms do not differ on the demand side at all. Thus a finding of correlation between market share and margins is according to the classic critique of such activities potentially only an indicator of which firms are efficient.

2.5 Two important lessons from that classic construction are traditionally drawn by competition economists. Firstly, that concentration is a correlate of margins but need not be the cause of them; in the Cournot model the cause of concentration is heterogeneity in firms' efficiencies. And second, that concentration is not the same as market power; in the Cournot model the two are linked at both the firm and industry level by the elasticity of market demand. Thus sufficient numbers of price-sensitive consumers may mean that firm and industry measured margins may be 'low' even in highly concentrated markets.

9 Recall, in the Cournot model, $\frac{p-c}{p} = \frac{s_i}{\eta^{PED}}$ where η^{PED} is the market price elasticity of demand and s_i is a volume market share. Multiplying by s_i and adding across firms gives the prediction that industry average mark-ups are related to the HHI: $\sum_{i=1}^{N} s_i \frac{p-c}{p} = \frac{HHI}{\eta^{PED}}$ since $HHI = \sum_{i=1}^{N} s_i^2$. For further description and references to the literature see Davis and Garces (2010), pages 286 to 289. Davis and Garces (2010) "Quantitative Techniques for Competition and Antitrust Analysis" Princeton University Press.

2.6 The current context is complicated by at least two factors relative to the baseline Cournot model. The first is the presence of fixed costs, which must be recovered and will therefore require some degree of market power to be exercised for any services to be provided. And second is the role of product differentiation – in terms of hospital quality but also in particular geography. Neither of these two factors change the two important lessons made available from the classic analysis of the Cournot model.

2.7 The first, the presence of fixed costs (importantly - at both hospital and at the hospital chain level) is clearly important for the economic analysis in this case because it suggests that: (i) margins must clearly be positive (indeed significant) for any given hospital to be viable, and (ii) group wide fixed costs - incurred in the provision of centralized services for hospitals in the chain - will be efficiently recovered at potentially differential rates from different hospitals across the estate. Each of these facts of economic analysis will clearly have important implications for what can and cannot be properly inferred from any finding of a link between concentration and prices or margins. I will defer further discussion of this topic to subsequent submissions, since it clearly most directly relates to the inferences that can and cannot properly be drawn from any PCA analysis on the basis of economic analysis.

2.8 The second, where the CC has focussed its efforts, when attempting to measure concentration as a proxy for market power – is the situation where firms are offering differentiated products. The CC's analysis attempts to focus on geography and I agree that attempting to take geographic differentiation seriously in the analysis of hospital competition is clearly an important task for a proper and convincing analysis. More specifically, the CC develops two indicators - Fascia counts and LOCI - which I now discuss in turn.

Section 3

Fascia counts

3.1 The first approach which the CC uses to assess local concentration is 'catchment areas and fascia counts' approach. The CC has noted a number of limitations and concerns with this approach (slide 16, Annex 1 to Appendix B and paragraph 8, Annex 2 to Appendix B) which I do not repeat. I set out my comments on the detail of this analysis below.

Treatment of the NHS

3.2 At paragraph 7 of Appendix B, the CC notes that: "Based on our survey evidence, we have not included NHS hospitals in our facia count. 68 per cent of self-pay patients considered having their treatment on the NHS, 31 per cent did not". The CC's conclusion to 'not include NHS hospitals' in its facia count follows from the proposition that: "When asked which other hospital they would have used if the hospital they did use was not available, 67 per cent of self-pay patients said they would have used another private hospital or PPU (85% when unallocated answers are allocated) […]".

3.3 The question is whether the CC is acting reasonably when relying on this proposition. In that regard I make four observations:

(1) First, as I understand it the 85% relates to the situation when 'unallocated answers are allocated' when analysing the sample. Allocation of 'don't know' responses is inherently speculative – since for such an allocation not to bias our estimates of sample proportions we must know that the 'don't know' responses are a random selection of survey respondents. Yet intuitively, it seems likely that those who knew of a good alternative private hospital would be likely to say they would use the other private hospitals while those who did not – and so responded 'don't know' - would be more likely to use the NHS than an individual drawn at random if, for example, there was a reason they didn't know about another local private hospital – for example if there wasn't one.

(2) Putting the 'don't know' responses to one side, I do know that the CC survey says that 67% of patients say they would have used another private hospital or PPU facility if their current hospital choice were unavailable and 12% would have switched to an NHS facility. It is well known that a competitive constraint can arise when only a fraction of customers switch and so the diversion of even 12% of customers - particularly if they were high acuity customers – could potentially mean that self-pay prices faced at least a degree of competitive constraint. In terms of revenue lost a 12% switch of higher acuity patients would account for a higher proportion of a PHP's revenue. The CC has undertaken no analysis of whether that is the case before discarding the NHS as a competitor which seems a wholly unnecessary presumption (see also point (4) below).

(3) Third, and perhaps most significantly, I note that the situation with respect to individual hospitals may differ considerably. In particular, market areas with relatively less private provision, may be exactly where the NHS is the primary alternative and exerts the most significant competitive constraint on private providers. Evidence is before the CC demonstrating this point, particularly in the context of investment decisions such as BMI's proposed entry into Edinburgh.

(4) Fourth, as a practical matter, since the locations of the NHS hospitals are known and could be easily integrated into the analysis, there seems little reason not to test whether or not self-pay prices are lower where private hospitals compete with the NHS. There is no reason why only one fascia count needs to be constructed for the empirical analysis and constructing more than one would help address the concern acknowledged by the CC (see slide 16, Annex 1 to Appendix B) that the CC's facia count measure 'Treats all fascia as equal competitors, regardless of size or range of specialities offered'. Indeed, in fact, in the PCA the CC includes three measures of fascia counts.

Size of the catchment area

3.4 The size of the catchment area is a key assumption under this approach, since it determines which competitors are considered and which are not considered to be within a hospital's catchment area. The CC determined the size of the catchment area by the distance travelled by 80% of the hospital's patients.[10]

[10] Annotated IS, Appendix B, paragraph 4.

3.5 First I note that building hospitals means incurring significant fixed costs, so that the 20% of a hospital's patients coming from outside the catchment area can make the difference between operating profitably and not. For example, those 20% of patients not considered in the catchment area could be the difference between a hospital operating at 40% capacity utilization and 50% capacity utilization – with significant consequences for profitability.

3.6 Second I note that patients outside the 80% catchment area - who may have choices not captured in the CC's fascia count - may be very significant to the extent that they may be an important source of customers whose business is directly and most immediately contestable – since they may be the patients who are closest to other nearby hospitals.

Road-distance versus drive-time

3.7 The CC uses road-distance (in miles) as the metric to measure patient journeys to determine the catchment areas covering the distance from the hospital postcode to the home postcode of at least 80% of patients (i.e. the distance which covers at least 80% of patients living closest to the hospital). The CC characterised road-distance as being more conservative and less subjective than using drive-time.[11]

3.8 I note that in previous investigations, for instance retail/supermarket mergers (Somerfield/Morrison,[12] CGL/Somerfield,[13] Asda/Netto[14]) and the Grocery sector inquiry,[15] the OFT and the CC preferred drive-time as the relevant metric for measuring distance. I note that the CC argues in the case of private healthcare that road distance is 'more conservative and less subjective (e.g., to assumptions on road speed or public transport) than using drive-time. However, it is not clear such a statement is in fact true – rather using road distance makes 'all miles equal' – which may or may not be true in reality - and so is not, in particular, obviously universally better than estimating the average annual speed in a particular region for example. A better approach would be to check the robustness of the results.

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11 Annotated IS, Appendix B, Annex 1, slide 9.

12 Competition Commission. 2005. "Somerfield plc and Wm Morrison Supermarkets plc.A report on the acquisition by Somerfield plc of 115 stores from Wm Morrison Supermarkets plc."

13 Office of Fair Trading. 2008. "Anticipated acquisition by Co-operative Group Limited of Somerfield Limited."

14 Office of Fair Trading. 2010. "Anticipated acquisition by Asda Stores Limited of Netto Foodstores Limited."

15 Competition Commission. 2008. "The supply of groceries in the UK market investigation." The CC also imposed remedies using drive-time to determine the circumstances where the 'Competition Test' is to be applied; see Appendix 11, op. cite.

Use of regional or GB catchment areas

3.9 I understand that the CC has used regional median catchment area (or GB median catchment) in areas with insufficient patient journey information.[16] I cannot tell how many areas are affected by this averaging and the extent to which this could have a material impact on the number of competitors counted within particular catchment areas. I note that from the summary statistics presented by the CC,[17] it is clear that there are very significant differences between the sizes of catchment areas even within regions. For example, in the West Midlands, the distance used for catchment areas ranges from 8 to 51 miles with a median of 15 miles. Clearly using the regional or GB median catchment areas could be significantly understating or overstating the size of the catchment area for a specific hospital.

Catchment areas around hospitals versus population areas

3.10 Competition in a local area cannot be effectively analysed by taking into account just the number of rivals present in an area (isochrone) around the hospital itself. Patients naturally consider how far the hospitals are from them (their home, family, etc.), rather than how far the hospitals are from each other. This point is related to the "caveats to the fascia count method" acknowledged by the CC in the appendix of the AIS.[18]

3.11 The OFT and the CC have attempted to address this issue in other investigations (in particular, in the retail sector) by considering "re-centred" isochrones on population areas rather than just the hospitals. For instance, if two hospitals are on opposite sides of the centre of a bigger town, they may be quite *far away from each other*, but they could both be *close to the population* (population centres) in and around the town centre. As a result, hospitals in a particular local area may not be in each other's catchment area based on distance/drive-time from each other, but many or even most patients in the local area could have a choice between both of them (i.e. choice of two competitors rather than just one) when considering the distance/drive-time to the local hospitals from their home.

The treatment of specialty groups

3.12 The CC develops two sets of fascia counts based on 80% catchment areas. The first involves the fascia count for 16 specialties. The second relates to Oncology only – with a restricted competitor set involving just those hospitals active in the provision of Oncology services.

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16 Annotated IS, Appendix B, Annex 1, slide 9.

17 Annotated IS, Appendix B, Annex 1, slide 11.

18 Annotated IS, Appendix B, Annex 1, slide 16.

3.13 First I note that the rationale for using just the 16 specialties relies on the argument that supply substitution is limited to just those specialties. I understand from BMI that there are reasons to believe the supply substitution argument applies to a wider set of specialties. Second I note that whether the exclusion of the '8 specialty hospitals' is reasonable depends on the purpose to which the fascia count is subsequently used. In an analysis of the price-concentration relationship in a CCSD code covered by those specialty hospitals, it would not obviously be reasonable to exclude them.

3.14 Thirdly, I note that with regard to Oncology, the assumption of the general 80% catchment area is an appropriate basis for the analysis should be tested. To explain why, suppose that patients in this particular specialty are different from the generality of the patients visiting a hospital. For example, BMI has submitted evidence that patients visit BMI Thornbury in Sheffield for Gamma Knife surgery (a treatment usually, but not exclusively, used to treat cancer of the brain) from a very large part of the UK. It is unlikely that a fascia count within the 80% local catchment area for the hospital patient population as a whole will properly reflect the degree of competition for these patients. And so taking this approach could very significantly mislead the CC when defining concentration.

Section 4

The Logit Competition Index (LOCI) approach

4.1 The second approach the CC uses is the LOCI approach, which the CC also describes as the 'weighted average market share' approach.

4.2 First I note that the CC reports that the LOCI measure was introduced by Akosa Antwi, Gaynor and Vogt in 2006 in an unpublished manuscript referred to by the CC.[19] I note that at the top of the version of the paper I found on the internet (dated 1st May 2006)[20] the authors state in capital letters at the top of the first page of their paper that the paper is a "ROUGH DRAFT: NOT FOR CITATION OR QUOTATION." This is the version of the paper which comes out at the top of a Google search on its title so in the absence of a full citation I presume this is the version to which the CC refers in its AIS.[21] I note at the outset that it is very surprising that the CC is choosing to rely so heavily (including I note now having included reference to the methodology in the CC's published market investigation guidelines, CC3) on a methodology that appears: (i) not to be widely used or accepted and (ii) not to have been successfully through the peer review process (the CC's various citations are also to the paper as an 'unpublished manuscript'). In sum, it is not apparent that the methodology outlined in this paper has achieved a status anything like that of 'widely accepted' among the scientific community. The onus is on the CC therefore to satisfy itself that this methodology is a reasonable one for its purposes. It cannot simply assert that in the CC's view it is.

19 Y.O.D. Akosa Antwi, M. Gaynor and W.B. Vogt. 2006. "A competition index for differentiated products oligopoly with an application to hospital markets", unpublished manuscript.

20 The paper is available for download here: http://www.krannert.purdue.edu/faculty/smartin/ios/gaynor.pdf

21 This version of the paper was also the one handed to me inside the CC's dataroom as the relevant one.

4.3 Moving beyond the general status of the LOCI methodology, I begin by noting that the CC currently appears at times to conflate (i) LOCI as a measure of market share (perhaps indicator of concentration) and (ii) LOCI as a correlate of market power in a particular economic model. For reasons I now discuss, I believe that it is very important to keep these two aspects of the measure as conceptually distinct when thinking about what LOCI is, and is not, likely to tell us.

4.4 First, I agree that it is true, as a matter of mathematics, that the LOCI can be motivated as a particular 'weighed average market share.' However, that fact raises the central question of whether the weighting being used makes any economic sense or whether, alternatively, the weighting is being driven purely by unreasonable and overly restrictive assumptions embedded in the economic model underlying LOCI.

4.5 I believe the particular weighting adopted in LOCI comes directly from the economic model that underlies the LOCI approach. That weighting emerges because in that specific economic model, built on the foundations of the Logit model, LOCI is actually motivated as a correlate of market power – not because LOCI is a reasonable or reasoned measure of concentration. This can be seen for example in the Antwi et al paper and also in the CC's annex 2 at paragraph 48, where the CC notes that under the assumptions made in paragraph 46, the optimal price p_j^* charged by the owner of a single hospital (selling not a range of individual treatments but rather a single product) with marginal cost MC_j would be described according to the formula:

$$p_j^* = MC_j \ + \alpha \frac{1}{LOCI_j}$$

4.6 Thus, like the volume market share in the Cournot model, the key motivation for the LOCI index is that it appears as a correlate of individual firm (here a single hospital) mark-ups in a particular economic model.[22] Whether that is a useful construction in this context will of course be completely dependent on whether the underlying economic model is an appropriate one with which to frame the CC's analysis.

4.7 Somewhat more generally, the relationship determining mark-ups within the class of models including that considered by the CC (at paragraph 46 of Annex 2) can be written as:

[22] The parameter α is related to the CC's (representative) consumer's marginal utility of income – assumed identical for all consumers.

$$\frac{p_j^* - MC_j}{p_j^*} = \frac{1}{\frac{-\%\Delta D_j(p)}{\%\Delta \mathrm{p}}}$$

4.8 That is, the baseline economic theory suggests that a firm's mark-up $\frac{p_j^* - MC_j}{p_j^*}$ will be related inversely to the price sensitivity of demand; that is the percentage change in demand $\%\Delta D_j(p)$ that would result from a given percentage change in price, $\%\Delta \mathrm{p}$. The key part of this relationship is that margins (which I understand is what the CC is considering to mean market power) are predicted to be related to the **change** in demand that would occur if the focal hospital were to raise its price; that is the hospital's elasticity of demand.

4.9 The fact that LOCI can be 'interpreted' as a particular weighted average measure of market share cannot of course be disputed – it is mathematically a fact. But it is certainly not, for example, the measure of market share more commonly associated with the model which the CC (following Antwi et al (2006)) uses to motivate LOCI. Fundamentally, LOCI is a correlate of market power predicted by a particular economic model – it is not fundamentally a measure of market concentration motivated by theory.

4.10 Indeed, the fact that the LOCI can **also** be interpreted as a particular weighted market share turns out to have a lot to do with the widely accepted undesirable properties of the Logit model. The fact that this is so follows from the fact that (as the CC shows) in the LOCI model, the price sensitivity of demand is assumed to be simply proportionate to the **level** of the (weighted average) market share of the hospital. This is a very restrictive assumption as it presumes – without any basis grounded in data, economic theory or the reality of the situation - that a high (weighted average) market share (low LOCI) will mean a hospital faces a low price sensitivity of demand and so a high mark-up. Of course, that need not be the case if for example there are in reality lots of contestable consumers who can and would easily switch between hospitals in the event of a price rise. LOCI rules out such a situation by assumption.

4.11 For related reasons, I will show below that LOCI completely fails to be an informative measure of market power in the standard benchmark economic model of retail markets due to Hotelling (1929).[23] And it does so for very clear and understandable reasons. Since this particular weighting: (i) fails as a reasonable indicator of market power in the benchmark Hotelling model and (ii) to my knowledge only appears as an indicator of market power in a model built on foundations known to make unreasonable predictions about market power – it is not a reasonable basis for constructing a helpful index of either market power or market concentration.

4.12 On the basis of the economic theory developed by Antwi et al (2006) and presented by the CC, we only know that LOCI will provide a useful indicator of market power if the world is characterized by the model described in paragraph 46 of the CC's Annex 2 (Appendix B of the AIS). For the avoidance of doubt, while I can see the attraction of simplicity and commend the CC for properly attempting to ground its analysis firmly in economic theory, I do not consider that the CC's analysis in the AIS currently provides a considered view on whether that specific economic model is anything like a reasonable approximation for the economic analysis of hospital competition – either for self-pay or insured patients. And I definitely do not consider such an assumption (that it is a reasonable model) should properly be considered a 'safe' assumption for the CC to make without significant reasoning.

4.13 As a result, for the reasons given above and expanded upon further below, I believe that there are clear and unambiguous reasons to suggest that the CC's LOCI analysis is not likely to provide a reliable indicator of either market power or concentration for hospital markets – at least on the basis of the reasoning outlined by the CC in the AIS.

[23] Hotelling, H. (1929) "Stability in Competition" Economic Journal, Vol. 39, No. 153.

Assumptions underlying the LOCI measure of concentration

4.14 The CC describes that: "The authors motivate the LOCI measure by constructing it from an underlying Logit model of consumer demand for differentiated products." The CC argues (see paragraphs 46-50 of Annex 2 to Appendix B) that LOCI can in practice be motivated as 1 minus a weighted average market share of a hospital, $LOCI_j = 1 - \sum_t^T w_{tj} s_{tj}$ where j indicates 'hospital j' and t indexes 'consumer types' (consumer locations or sub-markets), the market share s_{tj} is the fraction of consumers from location t that go to hospital j, and where I describe the weights w_{tj} below.[24] Mathematically then, the index of market power for this particular model - LOCI - can be written as a particular weighted average market share.

4.15 The CC further states that it considers: "The [underlying economic] model is closely related to the well-known Berry, Levinsohn and Pakes (1995) model."[25] This is partly true, but this claim is not obviously correct in the relevant sense.

4.16 Specifically, the LOCI model is motivated by its inventors by reference to an underlying model known as the Logit model. Indeed the acronym 'LOCI' stands for 'Logit Competition Index.' The Berry, Levinsohn and Pakes (1995) [henceforth BLP] model provides a very significant generalization of the Logit model by introducing 'random coefficients' into the Logit model. The need for the BLP generalization was motivated by the poor substitution properties of the Logit model (i.e. the poor ability of the logit model to detect substitution patterns). The question then is the degree to which the LOCI model has more in common with the obviously unreasonable Logit model (due to unreasonable implied substitution patterns), or with the less unreasonable, and if carefully specified potentially reasonable, BLP model.

4.17 In this regard I note that there are no random coefficients in the LOCI model and so the resulting demand model is not very flexible – the model will heavily constrain substitution patterns between hospitals in a manner not driven by data at all. As the authors acknowledge, their model "is less flexible than those typically used in multinomial logit demand systems." (Antwi et al (2006), page 5.) The next few paragraphs spell out my current thoughts regarding the limitations of the LOCI model when determining substitution patterns.

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24 The CC also presents a modified LOCI measure which reflects network ownership, incorporating the market share of hospital groups (rather than individual hospitals) in each sub-market. See Annotated IS, Appendix B, Annex 2, paragraph 21.

25 Annotated IS, Appendix B, Annex 2, paragraph 46 footnote 5.

4.18 We wish to consider what happens in the LOCI model when consumers are induced to substitute between their choice of hospital in the model. As I have already stated, the Logit model is well known to suffer from undesirable substitution properties, the question is whether the LOCI model's properties are more reasonable.

4.19 Recall first that in response to a £1 price increase for self-pay prices at some hospital k, the Logit model would predict that the fraction of patients that would switch from one hospital to another would be proportional to the market share[26] of the hospital whose price had changed and would not, for example, depend on whether the rival hospital was a close substitute in terms of having similar product characteristics.[27] Mathematically we would write that the impact of a price change on the sales at hospital j would be:

$$\frac{1}{D_j(p,x)}\frac{\partial D_j(p,x)}{\partial p_k} = \frac{1}{Ns_j(p,x)}\frac{\partial Ns_j(p,x)}{\partial p_k} = \begin{cases} -\alpha(1-s_j) & if \quad j=k \\ -\alpha \ \ s_k & otherwise \end{cases}$$

where N is the total number of potential customers in the market so that demand for hospital j is related to the market share at hospital j according to the equation $D_j(p,x) = Ns_j(p,x)$.

4.20 Importantly, substitution patterns in the model underlying the LOCI index, like the Logit model, do not immediately depend on the characteristics of the (in this case) hospitals being studied. In the LOCI model if x denotes characteristics (of all hospitals) and p denotes prices (again of all hospitals) then demand for hospital j would be:

$$D_j(p,x) = \sum_{t=1}^{T} N_t \, s_{tj}(p,x)$$

And the predicted effect of a change in self-pay prices at hospital k in the LOCI model is:

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26 In the Logit and BLP models, market shares are measured as the volume of sales achieved as a proportion of the maximum potential achievable volume of sales across the market.

27 In mathematical terms, in the Logit model the cross- semi-elasticity of demand is given by: $\frac{\partial \ln s_j}{\partial p_k} = -\alpha s_k$ which is entirely independent of the product characteristics of product j and is proportional to the market share of hospital k. The analogous own-price semi-elasticity is given by $\frac{\partial ln s_j}{\partial p_j} = -\alpha(1-s_j)$ again it depends – by assumption - solely on the market share of hospital j.

$$\frac{1}{D_j(p,x)}\frac{\partial D_j(p,x)}{\partial p_j} = \frac{1}{\sum_{t=1}^{T} N_t\, s_{tj}(p,x)}\sum_{t=1}^{T} N_t \frac{\partial s_{tj}(p,x)}{\partial p_j} = -\alpha\left(1 - \sum_{t=1}^{T} w_{tj}\, s_{tj}\right)$$
$$= -\alpha LOCI_j$$

where following the CC's analysis the weights are given by the expressions $w_{tj} = \left(\frac{N_t s_{tj}}{\sum_{t=1}^{T} N_t s_{tj}}\right)$ where each N_t describes the exogenously given and fixed number of customers of type t and s_{tj} denotes the share of hospital j of patients of type t; i.e., the share of hospital j's customers in outward post-code area t.

4.21 Thus the CC argues that it is a desirable property of the model that the LOCI index $LOCI \equiv 1 - \sum_{t=1}^{T} w_{tj}\, s_{tj}$, which is proportional to the own-price term $\frac{1}{D_j(p,x)}\frac{\partial D_j(p,x)}{\partial p_k}$ with proportionality given by the price coefficient in the LOCI model α, can be interpreted as one minus a weighted average market share. However, this interpretation itself indicates that there is a very tight relationship in the LOCI model between the level of (weighted average) market share (the level of hospital demand) and the impact of a price change on the demand facing the hospital (the slope of hospital demand). This appears to be very close to the usual critique of the Logit model – that the market share of a hospital basically determines its price responsiveness.

4.22 In sum, the LOCI model appears to be effectively replacing the Logit model's market share determined mark-up term with a mark-up prediction that is wholly determined by a differently calculated estimate of the market share, the weighted average market share. This restriction is a considerable distance from the desirable properties of the random coefficient Logit model studied by BLP – which is known to be potentially capable of matching the observed substitution pattern in any dataset (Mcfadden and Train (2000)[28]). The cross-price elasticities in the LOCI model are analogously determined by weighted average market share calculations:

$$\frac{1}{D_j(p,x)}\frac{\partial D_j(p,x)}{\partial p_k} = \alpha\sum_{t=1}^{T} w_{tj} s_{tk}$$

28 Mcfadden, D. and Train, K. (2000) "Mixed MNL models for Discrete Response" *Journal of Applied Econometrics*, Vol. 15, pp. 447-470.

4.23 In summary, the analysis above indicates that the degree of substitution away from any given hospital j following a price rise in the LOCI model will simply be proportional to the (weighted average) market share achieved by hospital j in each sub-market s_{tj}. Neither the price-sensitivity of hospital demand nor the degree of substitution to rival hospitals will ultimately depend on how good a substitute those hospitals are – just on what their 'outward post-code area' market share levels are.

4.24 The importance of the detail of these various types of models can be seen for example in the decidedly scathing response of Berry and Pakes (2001) to Wojcik (2001)[29] who claimed that the Nested Logit model outperformed the BLP framework when used for merger simulation.[30,31]

4.25 More generally I have already noted that LOCI has not been generally endorsed by even the academic economics community. What there is in the economic literature is a clear consensus that the Logit model of consumer demand (which, appears to have properties similar to LOCI) will typically imply unreasonable substitution patterns. In this regard I refer for example to comments submitted by Elisabeth Bailey et al. to the US Department of Justice and the Federal Trade Commission in 2010 which laid out a variety of quotations from the academic economics literature supporting this view:[32]

> *"An implication of the [logit model] is that all cross elasticities are equal…This property is not plausible in some choice situations…models satisfying [IIA] yield implausible conclusions when there are strong contrasts in the similarity of the alternatives…"* Daniel McFadden, "Econometric Models of Probabilistic Choice," in *Structural Analysis of Discrete Data with Econometric Applications* (Charles F. Manski and Daniel McFadden, eds., 1981), pp. 222-223.
>
> *"[T]he logit model produces unreasonable substitution patterns."* Steven Berry, "Estimating Discrete-Choice Models of Product Differentiation," *RAND Journal of Economics*, 25 (1994), p. 250.

29 Wojcik, C. 2000. "Alternative models of demand for automobiles," *Economics Letters*, 68: 113-118.

30 Berry, S. and A. Pakes. 2001. "Comments on 'Alternative models of demand for automobiles' by Charlotte Wolcik", *Economic Letters*, 74(1): 43-51.

31 Berry, S. and A. Pakes. 2001. "Comments on 'Alternative models of demand for automobiles' by Charlotte Wolcik", *Economic Letters*, 74(1): 43-51.

32 Bailey, E.M., Leonard, G.K. and L. Wu. 2010. "Comments on the 2010 Proposed Horizontal Merger Guidelines," pages 3-4.

"[T]he logit demand model makes the [IIA] assumption, which implicitly restricts the demand structure by constraining the pattern of demand substitution between products…the logit demand system makes the assumption of identical cross-price elasticities for all products with respect to a given product." Jerry A. Hausman and Gregory K. Leonard, "Economic Analysis of Differentiated Products Mergers Using Real World Data," *George Mason Law Review*, 5 (1997), p. 322.

"As a result of [the IIA] property, [logit] models necessarily predict that a change in the attributes of one alternative [e.g., price]…changes the probabilities of the other alternatives proportionately, such that the ratios of probabilities remain the same. This substitution pattern can be unrealistic in many settings… [I]dentification of the correct substitution pattern is an empirical issue, and the IIA property of logit…imposes a particular substitution pattern rather than allowing the data analysis to find and reflect whatever substitution pattern actually occurs." David Brownstone and Kenneth Train, "Forecasting New Product Penetration with Flexible Substitution Patterns," *Journal of Econometrics*, 89 (1999), p. 110.

"[T]he logit model greatly restricts the own- and cross-price elasticities…" Aviv Nevo, "Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry," *RAND Journal of Economics*, 31 (2000), p. 402.

"The major analytical criticism of the logit model is that it embodies the restrictive assumption of the Independence of Irrelevant Alternatives...This is a highly restrictive assumption that clearly will not be valid in many instances" Daniel Hosken, Daniel O'Brian, David Scheffman, and Michael Vita, "Demand System Estimation and Its Application to Horizontal Merger Analysis", 2002 FTC Working Paper #246 (as published in *Econometrics: Legal, Practical, and Technical Issues*, American Bar Association Section of Antitrust Law (2004)).

"It is known that the pure logit model…imposes strong restrictions o[n] the pattern of substitutability." Marc Ivaldi, Bruno Jullien, Patrick Rey, Paul Seabright, and Jean Tirole, "The Economics of Unilateral Effects," Interim Report for DG Competition, European Commission, November 2003.

"[IIA] imposes significant restrictions on the substitution patterns between products" Gregory K. Leonard and J. Douglas Zona, "Simulation in Competitive Analysis," *Issues in Competition Law and Policy*, American Bar Association Section of Antitrust Law.

> *"…the [logit] model imposes severe limitations on own- and cross-price elasticities…we recommend strongly against using [logit] models in situations where we must learn something about substitution patterns (e.g., for merger simulation)"* Peter Davis and Eliana Garcés, Quantitative Techniques for Competition and Antitrust Analysis (2010), pp. 477-478.

4.26 The clear consensus in the literature is that the Logit model is deeply problematic as a framework for thinking about own- and cross-price elasticities and therefore about either substitution patterns or firm market power. For the LOCI model to be convincing as a framework for analysis, it is I hope entirely clear from the above quotations that the CC would need to be satisfied that its properties are significantly distinct from those of the Logit model. So far, the CC's analysis has suggested that that is not the case. I consider the issue further in the next section.

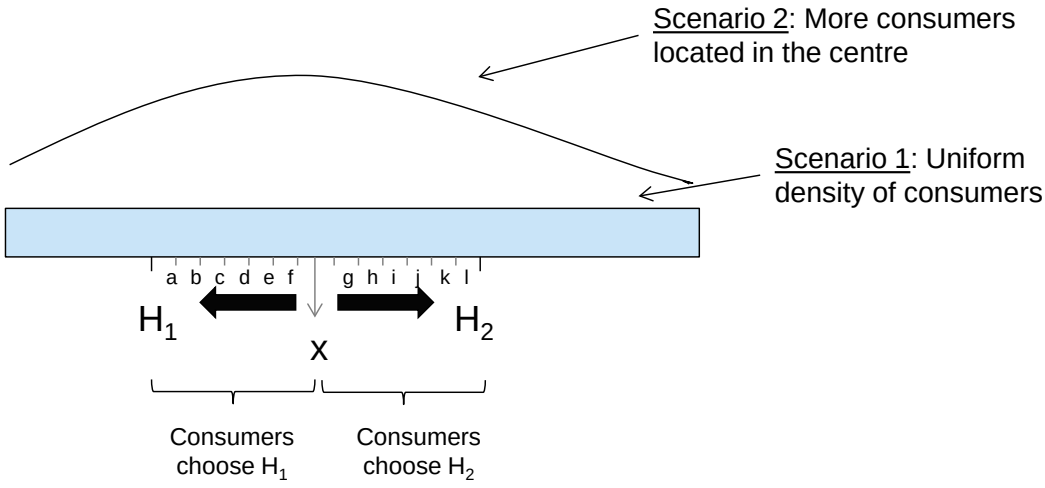
LOCI has no connection with market power in the benchmark Hotelling(1929) model

4.27 To consider this matter further, I have considered the canonical model of a retail market due to Hotelling(1929).[33] This model is clearly a benchmark model for analysis of retail markets. The model studies firm behaviour and outcomes when firms (in our case hospitals) interact while choosing location and prices. I consider next whether the degree of competition between two hospitals in this benchmark model would be successfully indicated using the LOCI measure of concentration. I find that, to the contrary, the LOCI index has absolutely no connection with market power in this class of models.

4.28 In the Hotelling(1929) model, demand for hospital services depends on the consumers' valuation of the services provided by the hospital, the locations of the hospitals and the prices charged by the hospitals. For simplicity I consider the simplest version of the model which supposes that consumers live in a stylized city which I model as a straight line of unit length as shown in Figure 1 and where the hospitals provide services of equal value. Such assumptions are easy to relax and do not drive the results I establish below.

[33] Hotelling, H. 1929. "Stability in Competition." *Economic Journal* 39: 41-57.

Figure 1: Hotelling model and choice of consumers based on location



4.29 The figure shows two hospitals (H_1 and H_2) and sub-areas (a to l) from which these two hospitals draw their patients. In the CC's empirical implementation of LOCI these would be the outward post-code areas (see paragraph 27(a) of Annex 2 to Appendix B). The Hotelling model supposes that all else equal patients will choose their most preferred hospital. In the figure above for example, we may find that patients from sub-areas a, b, c, d, e, f will choose H_1 and patients from sub-areas g, h, i, j, k, l will choose H_2. However, if hospital H_1 decreases its price, patients from an area which were previously patients for hospital H_2 – for instance those in sub-area g – would now prefer to go to hospital H_1, once both prices and transport costs are taken into account.[34]

4.30 The important property of the standard version of the Hotelling model for present purposes is that no sub-market area (except possibly the one that the indifferent consumer at x is located in) will send consumers to both hospitals. Patients in a particular submarket will typically either strictly prefer H_1 or strictly prefer H_2 by construction. However, depending on transport costs and the distribution of consumers, firms may have a lot or only very little market power in this model.

[34] A consumer located at x will be indifferent between choosing hospitals H_1 and H_2 when the utility from each service net of the monetary and transport costs incurred are equal. That is, if $d(x, H_1)$ and $d(x, H_2)$ denotes the distance travelled to each hospital for a consumer located at x and the utility from option 1 is given by the gross surplus s_1 minus quadratic transport costs $td(x, H_1)^2$ minus the price that must be paid for self-pay treatment p_1 then we could follow D'aspremont et al (1979) and find the indifferent consumer x's location by solving the equation $U_{x1} = s_1 - td(x, H_1)^2 - p_1 = s_2 - td(x, H_2)^2 - p_2 = U_{x2}$.

4.31 The property that consumers in a particular sub-market have relatively homogenous preferences for one hospital or the other has very important implications for the LOCI measure because it implies that **both** hospitals H_1 and H_2 will have LOCI equal to (or possibly very very close to)[35] zero. In the benchmark Hotelling model that will be true irrespective of the true degree of market power held by the hospitals. In contrast, the true degree of market power in the Hotelling model will depend on transport costs and the shape of the distribution of consumers across the market relative to the location of the hospitals.

4.32 This observation suggests that the CC's proposition derived from the Logit based model that LOCI=0 describes a monopoly is not correct.[36] The reason is simply that all (or most) patients in a particular sub-market area will choose a particular hospital but that does not imply they would continue to choose the same hospital if the prices or service levels at a particular hospital changed. Indeed in the Hotelling model all the customers in particular sub-markets may switch following a price cut or change in service offering. However, under any degree of competition between these two hospitals, the areas from which each hospital draws its patients will not overlap: patients would then choose the hospital which has the higher valuation based on prices and transport costs. The fact that LOCI will be zero can be easily seen using the CC's interpretation '1 *minus* weighted average market shares' since the market share of a given hospital for consumers in a given sub-market area will be always either 0 or 1 in this model. [37] This suggests that a LOCI of zero may simply be telling us that the customers in a particular location may make similar trade-offs.

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35 The possibility that the LOCI can be very slightly different from zero arises from the fact that the indifferent consumer may in general be in the middle of one of the sub-markets and so for that sole sub-market consumers will be divided between the two hospitals. As the sub-market structure gets richer such effects will become negligible and LOCI will converge on zero.

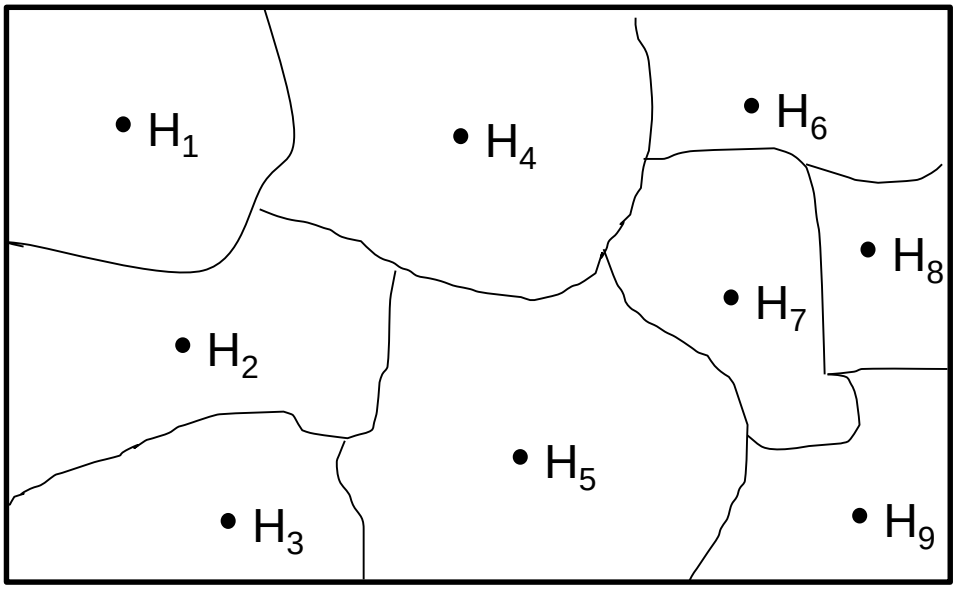
36 Annotated IS, Appendix B, Annex 3, slide 18.

37 To see why more formally recall that $LOCI_1 = (1 - \sum_{t=1}^{T} w_{t1}\, s_{t1})$ where $w_{t1} = \left(\frac{N_t s_{t1}}{\sum_{t=1}^{T} N_t s_{t1}}\right)$ and where $s_{t1} = 1$ for all sub-markets which buy from hospital 1 so that $w_{t1} = \left(\frac{N_t s_{t1}}{\sum_{t\ buy\ from\ H1} N_t s_{t1}}\right) = \left(\frac{N_t}{\sum_{t\ buy\ from\ H1} N_t}\right)$ and so $LOCI_1 = \left(1 - \sum_{t\ buy\ from\ H1} \frac{N_t}{\sum_{t\ buy\ from\ H1} N_t}\right) = 1 - 1 = 0$ and $LOCI_2 = 0$ follows analogously.

4.33 Figure 1 also shows two scenarios regarding the distribution of consumers (patients): Scenario 1 assumes uniform density of consumers; Scenario 2 assumes that there are more consumers located in the centre between the locations of the two hospitals H_1 and H_2. The distinction is helpful because in Scenario 2, more consumers (patients) are located close to the point of indifference "x" and this means that more consumers will wish to switch from H_2 to H_1 if the latter reduces its prices (which will change the consumer's valuation of going to that hospital). A greater proportion of switching customers following a price cut would ordinarily be associated with keener competition and less market power.

4.34 The figure below shows another example of hospital locations in a particular local area which would result in LOCI equal to zero for every hospital.

Figure 2: Example of a local area with LOCI equal to zero



4.35 In this example, all hospitals draw their patients from the sub-market areas around them. As before, since there is no overlap between these areas (i.e. hospitals draw their patients from separate sub-areas), LOCI as a measure of concentration would be equal to zero, indicating a monopoly under CC's interpretation but clearly there may be a far more significant degree of competition between these hospitals in reality, depending on the willingness of consumers in different sub-market areas to substitute towards other hospitals following a worsening of the terms of trade.

4.36 I conclude that the LOCI's deep connection with the Logit model (which is discredited for these purposes) and the fact that the LOCI index fails to detect market power in the benchmark economic model used by economists for almost a century to understand competition in retail markets, is not encouraging for the use of LOCI as a filter to identify hospitals of potential concern.

4.37 In short, isolating the outward postcodes where a local hospital has a particularly high share doesn't ultimately tell the CC about the choice that that a person living there has. That is true particularly in a world where self-pay patients travel up to 44 minutes according to the CC patient survey.

The LOCI measure is likely to understate the competitive constraint from other hospitals

4.38 LOCI indicates the weighted average market share of a hospital in the area from which the hospital drew its patients during the period of study. In that sense it is very different from a standard market share measure – even that calculated in a discrete choice model such as the Logit - which indicates a given hospital's share of a defined potential market (i.e. not just the parts of the market from which the hospital actually draws its patients).

4.39 Hospitals are likely to have fairly high market shares among their nearby customers. As such we are likely to find that LOCI measures tend to indicate relatively high market shares – and so the LOCI measures (defined as 'one minus the weighted average market share') will tend to be low. It is therefore not surprising that on the basis of the LOCI filter the CC is currently finding a very significant fraction of potentially problematic hospitals. LOCI appears in practice to be acting less as a filter and more as a catch-all.

The impact of the omitted data (hospitals) on the analysis

4.40 The CC indicated that "[c]alculating the appropriately weighted market shares requires data at a very granular level" and "[b]ecause of limitations in the data [the CC] could obtain, [the CC] had to omit certain private hospitals from [the analysis]".[38] The CC acknowledges that "[t]his concentration measure is therefore likely, in a limited number of instances, to understate the level of competition".[39]

4.41 The CC states that LOCI was calculated for 173 hospitals and it did not have invoice records for the remaining 50 hospitals.[40] I understand that the CC explained at the roundtable that this is unlikely to be significant because 41 of the 50 excluded competitors were PPUs and were "small". It is not appropriate to simply dismiss these competitors in this way. The CC has accepted that PPUs are competitors to private hospitals, PPUs are geographically diffuse and in some instances are significant local competitors to BMI's hospitals. By omitting the data for these hospitals, as the CC correctly says, will understate actual competition since hospitals for which the CC has data will have higher calculated market shares than their actual market shares. It cannot be appropriate, having rightly accepted there will be an understatement of actual competition, to simply dismiss it as likely to be insignificant without a proper analysis of whether that is genuinely so.

4.42 It seems that such a high number of omitted hospitals could be expected to have significant impact on the results of the CC's analysis. By omitting the data for these hospitals, the CC is correct to say that this will understate actual competition since hospitals for which the CC has data will have higher calculated market shares than their actual market shares. This is because the patients treated in hospitals for which the CC did not have data are not included in the analysis. However, it is not clear why the CC refers to a "limited number of instances" in which the results understate competition – the number of hospitals for which the data is missing (50 hospitals out of 223 or 22% of the sample) is potentially quite material and should not simply be dismissed without further investigation as insignificant.

38 Annotated IS, paragraph 58.

39 Annotated IS, paragraph 58.

40 Annotated IS, Appendix B, Annex 1, slide 21.

Impact of postcode definition on the LOCI calculation

4.43 The LOCI calculation will depend on the definition of "sub-markets". The CC uses outward postcodes to define sub-markets, but the LOCI analysis will be determined to a significant degree by the level of aggregation (grouping) of postcodes used to calculate the weighted average market share measure. This can for example be seen from the CC's example (Appendix B, Annex 1, slide 19), where a different (more or less granular) delineation of postcodes yields a different LOCI result.

4.44 Following my analysis of the Hotelling model for example, it is clear that a narrow enough delineation of sub-markets will always mean that measured sub-market shares will tend towards 1 (and LOCI will tend towards 0). This is because with a very narrow market definition, eventually every consumer will be in their own sub-market and, by definition, a hospital's market share would be 100 per cent for each sub-market (all individual customers), and also the defined market as a whole. That is because a hospital's market share for each of the sub-markets so defined, i.e., individuals, is 100 per cent). Thus, as the analysis (sub-markets) becomes more granular, we will tend to find that LOCI will move towards zero.

4.45 By its construction, the particular weighting approach used by the CC is assigning larger weights and thus emphasising the areas close to the hospitals from which the hospital draws a lot of patients. However, the relevant customers in terms of competitive constraint (and assessment of market power) are those who would be likely to switch if, for instance, prices change. If the size of this customer group is large, diversion away from the hospital (e.g. after a price rise) could be significant and the respective hospital would be unlikely to have much (or significant) market power. Those customers who are most likely to switch may not live close to the hospital and, depending on the location of rival hospitals, may often live further away.

4.46 It follows that it is deeply problematic to use a weighting approach which automatically assigns lower importance to customers living further away or living in areas from which a hospital draws fewer patients. The fact that a hospital draws a smaller proportion of customers from a particular sub-market may well be precisely due to strong competitive constraint from rival hospitals in that sub-market. It is then the choice and preferences of these customers that determine which hospital receives more customers from such sub-market (geographic area). If this customer group is sufficiently large (for instance, enough outlying customers in bordering areas), it would be problematic to automatically degrade its importance in a market share calculation and regard the hospital as having market power (based on a high share of customers in the nearby areas only). In reality, the hospital may actually be subject to significant competitive constraints and the likely significant patient diversion to rivals may be a strong disciplining factor. In such a situation, it may well be the case that the hospital's "traditional" market share (e.g. of a market defined as 30 minute drive-time around the hospital) would be low. Due to the chosen weighting approach, LOCI (based on the weighted average market shares used by the CC) may not reflect that reality.

4.47 In a more traditional market share approach, the shares are linked to the market definition. Market shares in such setting can be interpreted as the proportion of customers (or sales) the company has out of the defined market, while the remaining share of the defined market belongs to its competitors. In the weighted average market share approach, the CC defines sub-markets as postcodes, and all postcodes from which the hospital draws patients together form the total market. This is clearly a choice of a geographic market. Furthermore, as set out above, the weighting approach assigns higher importance to the postcodes from which the hospital draws more patients, which is again a choice that leads to effectively a narrower market on which the market share is based.

LOCI threshold

4.48 The CC states that it identifies hospitals of potential concern as those hospitals which "either have a weighted average market share of 40 per cent or higher, or face no more than one competitor hospital in their catchment area".[41]

[41] Annotated IS, paragraph 60.

4.49 The CC does not provide the reason why, under this particular LOCI measure, the threshold of 40% is used to identify the hospitals of potential concern and indeed the CC notes that it has not formed any firm view on the most appropriate levels for the thresholds.[42] Although LOCI is based on market shares in various postcodes of a local area, it is not a standard market share measure (due to, for instance, its weighting approach) and it is therefore not evident what is the level of LOCI which indicates high concentration or which should raise competition concerns – even assuming that 40% would be an appropriate threshold in a traditional market share approach in this market. As a filtering method, I note that it is capturing a very high proportion of the total number of hospitals.

Consistency of the CC's network LOCI adjustment with the underlying economic model

4.50 The CC has noted that the LOCI analysis is motivated by reference to a particular economic model built on the foundations of the Logit model. However, when undertaking the analysis of the impact of owning nearby hospitals (network LOCI), the CC appears to have adopted an ad-hoc approach rather than using the adjustment implied by the underlying economic model. Antwi et al (2006) do construct the analogous LOCI measure which depends for example on the likely diversion between the hospitals. If it believes in the model, it is not clear why the CC chose to follow an ad-hoc adjustment approach to calculate the CC's network LOCI.

Restrictive implicit assumptions in the underlying economic model for LOCI

4.51 Finally I note that my examination of the LOCI model has led me to believe that the model underlying LOCI assumes that consumers cannot substitute to a choice which involves not purchasing. Ordinarily models such as the Logit model or other richer variants will allow consumers to substitute away from the market being studied if (for example) all prices in a market rise. In the LOCI model this is not the case. As a result, a monopolist is, wholly unrealistically, predicted to have an arbitrarily large amount of pricing power in this model. This can be seen for example directly in the CC's mark-up formula I previously noted and described in paragraph 4.5 above and, more particularly, in the CC's annex 2 at paragraph 48. As the CC notes, under the assumptions made in paragraph 46 to Annex 2 of Appendix B of the AIS, the optimal price p_j^* charged by the owner of a single hospital (selling not a range of individual treatments but rather a single product) with marginal cost MC_j would be described according to the formula:

[42] Annotated IS, Appendix B, paragraph 8.

$$p_j^* = MC_j \ + \alpha \frac{1}{LOCI_j}$$

4.52 And for a monopoly, LOCI is zero – so that the model clearly predicts that monopolists can charge infinite prices! The reason for this prediction is because the model does not allow consumers to choose not to purchase – so that a monopolist is presumed to be able to increase prices to consumers without limit.

4.53 Similarly, in less concentrated markets, consumers are presumed to face an unrealistically constrained choice of options and so LOCI appears likely to overstate the degree of market power available to market participants. In the terminology of the academic literature building such consumer choice models, the LOCI model unrealistically presumes consumers have no 'outside option'. The reasonableness (or otherwise) of this assumption is not discussed in the CC's AIS and yet it forms another of the very significant differences to the 'well known Berry, Levinsohn and Pakes (1995) model' which the CC argues is 'closely related' to the LOCI model.[43]

[43] Footnote 5 of Annex 2 to Appendix B of the AIS.