

Annex 2: Measuring local concentration using a market-share-based measure

Introduction

1. This annex provides a detailed explanation of a measure of market concentration used in the Private Healthcare market inquiry. The concentration measure has been constructed for our assessment of Theory of Harm 1 (the effects of local market power), but may also have relevance for Theory of Harm 3 (national bargaining). The emphasis of this annex is in relation to Theory of Harm 1.
2. In assessing the local markets for private healthcare, we wish to understand the degree of market power that is enjoyed by hospitals. Market concentration is commonly used as a proxy or indicator of market power. We have 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’,¹ herein referred to as LOCI, and this is the subject of this annex.
3. Measures of local concentration have two main roles in this inquiry. First, they can help us focus attention on the more concentrated local areas where competition problems may be more prevalent or more likely to arise. We can therefore use the concentration measures to help filter and prioritize between local areas where we will conduct more in-depth analysis.
4. The second use of concentration measures is in the direct assessment of Theory of Harm 1. We are conducting a regression analysis of the relationship between prices paid by self-pay patients for hospital services and local market concentration (a price-concentration analysis, or PCA), and this requires a concentration measure as an explanatory variable in the regression. LOCI is a concentration measure that we consider well-suited to these two purposes and, more generally, to the characteristics of the market for the provision of healthcare services.
5. This annex is structured as follows. First, the motivation and intuition behind LOCI are provided, as well as analogies to traditional measures of concentration. Second, the LOCI methodology is explained through a worked example. Third, our results are summarized. Finally, some potential issues that arise with the use of LOCI are highlighted. The final section of this annex provides details of the economic model that has been used to motivate the LOCI measure.

Motivation

6. The use of market shares as a measure of local concentration is well-established and widely employed technique. Closely related measures are the fascia count (the number of rivals in a local area) and the HHI (the summation of market shares squared); the former can be thought of as a market share measure that treats all competitors as equally sized, while the latter as a market share measure that assigns more weight to firms that have high market shares (compared with those that have low market shares). In principle, LOCI is closely related to these traditional

¹ See Y O D Akosa Antwi, M Gaynor & W B Vogt, ‘A competition index for differentiated products oligopoly with an application to hospital markets’, unpublished manuscript, 2006.

concentration measures, and can be interpreted as (one minus) a weighted average market share.

7. The key difference between LOCI and traditional concentration measures is that LOCI does not rely on a fixed geographic market definition, calculated, for example, with a catchment area or isochrone methodology. Traditional concentration measures often rely on a two-step process of first defining catchment areas and then measuring concentration within each catchment area. The underlying assumption is that the catchment area is a proxy for the geographic market; as a result, the concentration measures are only as accurate as the catchment areas. LOCI does not rely on catchment areas—it avoids the two-step process by exploiting more granular geographic data on purchases.
8. Before discussing LOCI in more detail, it is worth highlighting certain issues that can arise when dealing with traditional concentration measures, such as fascia counts and simple market share measures based on catchment areas (especially when these are calculated around firms):²
 - (a) concentration measures based on catchment areas may not identify pockets of local market power that are located within subareas of the catchment areas;
 - (b) catchment areas for nearby firms can overlap, which can lead to measures of concentration that are counterintuitive or misleading;
 - (c) catchment areas are often based on a fixed and symmetric radius of distance or time travelled by the 80th percentile of customers, and this can misstate the true catchment area if the surrounding geography is not uniform (eg if large cities are located on one side of the catchment area);
 - (d) catchment areas may be sensitive to the chosen threshold—this is typically based on 80 per cent of patients, but can vary; and
 - (e) catchment areas may be sensitive to the chosen measure of distance—this is typically based on straight-line distance or time travelled, but can vary, particularly with regard to assumptions about travel time.
9. While these issues are well known and can be kept in mind when employing traditional concentration measures, the benefits of LOCI, in avoiding a catchment area approach, are expected to be greatest when these issues are more acute. The current inquiry has highlighted such issues, on account of the following characteristics of the market: the wide geographic scale, the number and location of private hospitals, the distance travelled by patients to private hospitals, and the fact that catchment areas can be quite large and vary substantially between hospitals. A concentration measure that does not rely on catchment areas is therefore seen as being particularly beneficial in this instance.
10. Rather than computing catchment areas around firms, the LOCI method involves computing market shares for all geographic submarkets (ie areas that are typically much smaller than the catchment areas), and then combining these shares into a single measure by averaging. This requires data on firms' purchases for each submarket—a much greater amount of information than is required for computing the traditional concentration measures.

² Some of these issues are addressed in the Oxera report on market definition that was commissioned by the OFT. See *Techniques for defining markets for private healthcare in the UK*, Oxera, November 2011.

11. Two issues arise when calculating LOCI. The first is common to all concentration measures: on what basis to compute the market shares? The second is specific to LOCI and does not arise with other concentration measures: how to average the market shares for each submarket? It can be shown that computing LOCI with volume shares (ie patient numbers) and using an average market share, weighted according to the importance to the firm of each submarket, corresponds to an underlying economic model of differentiated products and logit demand—see the final section of this annex for more details. It is therefore this formulation (patient shares, and an average weighted according to importance) that is favoured in the following discussion. However, the same basic methodology can be applied with revenue (or any other metric) shares, and other weighting schemes.
12. In summary, it is the more detailed data, and the procedure of averaging across submarkets that allows LOCI to avoid relying on catchment areas. To directly contrast with other concentration measures once more: traditional concentration measures rely on a single market share calculation based on a fixed geographic area that is thought to approximate where, say, 80 per cent of patients originate from; LOCI relies on an average of many separate market share calculations in all submarkets. LOCI will therefore not only more accurately account for the actual areas where patients originate from, but also take into account 100 per cent of the patients. LOCI does not rely on a threshold for the catchment area, or a measure of the distance or time that a patient travels.

Methodology and interpretation

13. The LOCI methodology is illustrated at first with a worked example. A step-by-step description of the methodology is given after the worked example, as well as a description of how to interpret the LOCI measure.

A worked example

14. The following example is based on an anonymized hospital from our data, but with the number of submarkets reduced to simplify the calculations. We have defined submarkets as outward postcode areas—this is the area that corresponds to the first part of the postcode (eg EC1N, LE12). The calculations are based on the Healthcode data on insured patients—this dataset provides a near-complete picture of patient journeys, and it the single most complete dataset that we have available to us. We restrict attention to inpatient journeys, and 17 specialties of interest. There are around 2,500 submarkets in the data, and the median number of observations per submarket is around 250.
15. The example focuses on a single ‘focal’ hospital. This focal hospital draws patients from around 450 submarkets. For the purposes of this example only four (anonymized) submarkets are considered, denoted: SM1, SM2, SM3 and SM4. To be clear, this is a hypothetical example constructed around one focal hospital and four submarkets. The four submarkets were chosen as each has a substantial number of patients, and the four are roughly equally sized. Table 1 below shows the total number of patients in each submarket (column B), and how many of these patients attended the focal hospital (column C).

Table 1 **Worked example—individual ownership LOCI**

Submarket (A)	Number of patients (B)	Number of patients attending focal hospital (C)	Market share of focal hospital (D) %	Proportion of all patients attending focal hospital (E) %
SM1	2,020	889	44	60
SM2	2,009	557	28	37
SM3	2,420	29	1	2
SM4	2,519	19	1	1
All areas	8,968	1,494	17	100

Source: CC Analysis

Notes: (1) numbers may not sum due to rounding.

16. As shown in the table above, the focal hospital has a different market share in each of the four submarkets (column D), ranging from 1 per cent (SM3 and SM4) to 44 per cent (SM1). The patients from each of these four submarkets also account for a different proportion of the total patients attending the focal hospital (column E)—that is, the areas are of differing importance to the hospital, with SM1 representing the largest proportion of the hospital's patients (60 per cent) and SM4 representing the lowest proportion. LOCI is calculated as: one minus the average market shares for each submarket, weighted according to their importance. That is:

$$\begin{aligned} \text{LOCI} &= 1 - [(0.44 \times 0.60) + (0.28 \times 0.37) + (0.01 \times 0.02) + (0.01 \times 0.01)] \\ &= 0.63 \end{aligned}$$

17. In this example, the LOCI equals 0.63. This is equal to one minus the weighted average market share of 37 per cent. Underlying the calculation are four separate market shares (1 per cent, 1 per cent, 28 per cent and 44 per cent). The weights represent the importance to the focal hospital of each submarket. The area SM1, which the focal hospital draws most of its patients from, has the highest weighting, and SM4 has the lowest weighting.
18. To draw the analogy with traditional concentration measures, suppose that the catchment area contained only areas SM1 and SM2. A traditional market share calculation would then be in principle the same as if LOCI were applied only to these two areas, but with different weightings. The weights implicit in the traditional market share calculation would correspond to the relative size of the two areas—but since both areas are similar in size, the weights would be very similar (50.1 per cent for SM1 and 49.9 per cent for SM2). This would produce a market share figure of 36 per cent (= 50.1% x 44% + 49.9% x 28%). In this instance, the two areas not included in the catchment area (SM3, SM4) are not particularly influential and results of the traditional market share calculation (36 per cent) and LOCI (37 per cent) are similar.
19. However, more pronounced differences can occur between the two methods. Suppose now that the catchment area includes all four areas (SM1, SM2, SM3 and SM4). In this case, the traditional market share calculation would assign the largest weight to SM4, as it is the largest area, and the smallest weight to SM2, as the smallest area. This would lead to a very different market share figure of 17 per cent (= 1,494 / 8,968). The difference occurs because the traditional market share measure assigns different weightings to each area—instead of weighting by importance of each area to the focal hospital, it weights according to the relative size of each area—and it does not reveal the strong heterogeneity in concentration across the four submarkets.

20. The LOCI calculation as described above is referred to as the hospital's 'individual ownership' LOCI, since it ignores any potential relationship that the focal hospital has with other hospitals. It reflects the average market share (across submarkets) of a hospital, and is therefore expected to measure the degree of market power of the hospital across the submarkets it serves. It assumes that the patients who do not attend the hospital attend rival hospitals, which each act as competitive constraints.
21. If, however, the focal hospital is part of a hospital group that owns a network of hospitals, not all hospitals may be rivals and act as competitive constraints. In this case, the individual ownership LOCI may understate the degree of market power possessed by the focal hospital if there are other hospitals owned by the same hospital group operating in one or more of the four submarkets. This is indeed the case with the example. Table 2 below extends the previous table by now showing the total number of patients in each submarket that attend all hospitals owned by the same hospital group as the focal hospital (column C2).

TABLE 2 Worked example—network ownership LOCI

Submarket (A)	Number of patients (B)	Number of patients attending focal hospital (C)	Number of patients attending focal hospital and other hospitals owned by the same group (C2)	Market share of hospitals of group that owns focal hospital (D2) %	Proportion of all patients attending focal hospital (E) %
SM1	2,020	889	1,030	51	60
SM2	2,009	557	893	44	37
SM3	2,420	29	1,397	58	2
SM4	2,519	19	101	4	1
All areas	8,968	1,494	3,421	38	100

Source: CC Analysis

Note: Numbers may not sum due to rounding.

22. As the table above shows, within each submarket there are a substantial number of patients that do not attend the focal hospital, but do attend other hospitals owned by same hospital group (ie the difference between columns C2 and C). Thus, the market share of the hospital group in each submarket (column D2 in Table 2) substantially exceeds the market share of the focal hospital (column D in Table 1)—at the extreme, in SM3, the focal hospital has a market share of only 1 per cent while the hospital group in total has a market share of 58 per cent. Individual ownership LOCI does not reflect the higher market shares, and consequently the increased market power, that are expected to come about through the hospital group's ownership of a hospital network. The LOCI calculation can be modified to reflect this.
23. The LOCI, modified to reflect network ownership, can be derived by calculating the market share of the hospital group in each submarket rather than the market share of the individual hospital in each submarket. The weightings remain the same. In the example given:
- $$\begin{aligned} \text{LOCI} &= 1 - [(0.51 \times 0.60) + (0.44 \times 0.37) + (0.58 \times 0.02) + (0.04 \times 0.01)] \\ &= 0.52 \end{aligned}$$
24. This 'network' LOCI is lower than the individual ownership LOCI, reflecting that the hospital is expected to have a higher degree of market power once the increased market share through its commonly owned hospitals is taken into account.

General methodology

25. To extend the worked example given above, it is simply the case of including in the calculation all submarkets that a hospital operates—for the focal hospital in the example, this means using all 450 submarkets that the hospital draws patients from instead of only the four used in the example. The same calculation is then performed separately for each individual hospital. This produces two LOCI numbers for each hospital, an individual ownership LOCI and a network ownership LOCI. The difference between the two reflects the additional market power that results from the network ownership of hospital groups.
26. The LOCI can also be calculated using different measures of market shares. In addition to the method described above, we have also calculated LOCI using revenue shares. Revenue is calculated as the summation of the episode prices charged for hospital services to insured patients.
27. For clarity, a step-by-step process for calculating LOCI is set out below:
 - (a) define the submarkets that will be dealt with. In our case, these are the outward postcode areas;
 - (b) for each hospital site, calculate the market share of the hospital site in each submarket. In our case, this has been done on the basis of volumes (ie patient numbers) and revenues (ie episode prices for hospital services) for inpatient visits relating to the 17 specialties of interest;
 - (c) for each hospital site, calculate the weightings for each submarket that will be applied when averaging the market shares. In our case, this is the proportion of a hospital site's total volume (or revenue) stemming from that submarket;
 - (d) for each hospital site, calculate a weighted average market share, using the market shares and weights computed above. Individual ownership LOCI is then equal to one minus this weighted average market share; and
 - (e) for network ownership LOCI, repeat the above steps, but in step (b), replace the market share of the hospital site in each submarket with the summation of the market shares for all hospitals owned by the same hospital group in each submarket.
28. The final section of this annex explains how this calculation relates to the economic model that has been used to motivate the LOCI measure.³

Interpretation

29. LOCI always lies between zero and one, and can be interpreted in a similar way to (one minus) market shares. A higher LOCI corresponds to a lower market share, and therefore a 'low LOCI' hospital is expected to have a higher degree of market power than a 'high LOCI' hospital.
30. A LOCI of zero corresponds to a market share of 100 per cent, and therefore can be thought of as the monopoly benchmark. In practice, this means that a hospital draws its patients from a collection of submarkets, and for each submarket there are no

³ See Y O D Akosa Antwi, M Gaynor & W B Vogt, 'A competition index for differentiated products oligopoly with an application to hospital markets', unpublished manuscript, 2006.

patients who visit any other hospital. A LOCI of one corresponds to a hospital having a market share of 0 per cent, and can therefore be thought of a perfectly competitive benchmark. In practice, this will never occur as all hospitals will have at least one patient and therefore, by definition, a market share of above zero in at least one submarket.

31. The difference between the individual ownership LOCI and the network LOCI reflects the difference in market power that arises as a result of the common ownership of hospitals. The two LOCI terms will only be equal if either: the hospital in question is an independent and has no other hospital sites under its control; or, the hospital in question is under common ownership, but the group's other hospitals do not draw any patients from common submarkets (ie the focal hospital and the other commonly hospitals are operating in geographically distinct areas).

Results

32. LOCI has been calculated for general and specialized private hospitals and PUs that have been identified as providing inpatient services for one or more of the 17 specialties of interest (223 hospitals), and that are also present in the Healthcode data. The data limitations mean that we have calculated LOCI for 173 hospitals. The LOCI calculation has been performed once for the period 2009 to 2011; this period has been taken as a reference period, and three years has been used to ensure that the number of observations per submarket is sufficiently large so that the market share calculations are reliable. Only inpatients receiving treatment from a consultant with a primary specialty in our list of 17 specialties of interest have been included in the analysis. There are around 2,500 submarkets, and the median number of observations per submarket is around 250.
33. Results are first presented based on volume shares (ie patient numbers); results based on revenue shares are presented later. Table 3 below summarizes the individual ownership LOCI results by region. The table shows the number of hospital sites that fall into one of five categories of LOCI (up to 0.2, 0.2–0.4, 0.4–0.6, 0.6–0.8, above 0.8).

TABLE 3 Results of individual ownership LOCI by region (number of hospital sites)

Region	Individual LOCI = 0.0–0.2	Individual LOCI = 0.2–0.4	Individual LOCI = 0.4–0.6	Individual LOCI = 0.6–0.8	Individual LOCI = 0.8–1.0	Total
East Midlands	0	3	3	0	2	8
East of England	1	5	7	4	1	18
London	0	0	2	7	20	29
North-East	0	3	1	0	0	4
North-West	0	3	9	3	5	20
Northern Ireland	0	0	0	0	1	1
Scotland	2	2	2	1	0	7
South-East	0	2	14	15	8	39
South-West	0	9	5	0	2	16
Wales	1	1	2	0	0	4
West Midlands	0	1	9	3	1	14
Yorkshire and The Humber	1	2	5	2	3	13
Total	5	31	59	35	43	173

Source: CC Analysis

Note: LOCI calculated based on patient shares.

34. Table 3 above shows that five hospitals have an individual ownership LOCI of less than 0.2—this corresponds to a weighted average market share of 80 per cent or

more. In total, there are 95 hospital sites that have an individual ownership LOCI of less than 0.6—this corresponds to a weighted average market share of 40 per cent or more. The LOCI results in Table 3 do not account for any network ownership and therefore likely understate the market power of hospitals that are owned by hospital groups.

35. Table 4 below summarizes the network ownership LOCI results by region, which account for the common ownership of hospital sites by hospital groups. As with Table 3, these results are based on patient shares.

TABLE 4 Results of network ownership LOCI by region (number of hospital sites)

<i>Region</i>	<i>Network LOCI = 0.0–0.2</i>	<i>Network LOCI = 0.2–0.4</i>	<i>Network LOCI = 0.4–0.6</i>	<i>Network LOCI = 0.6–0.8</i>	<i>Network LOCI = 0.8–1.0</i>	<i>Total</i>
East Midlands	1	3	2	1	1	8
East of England	1	8	5	4	0	18
London	0	4	4	13	8	29
North-East	0	3	1	0	0	4
North-West	2	9	4	3	2	20
Northern Ireland	0	0	0	0	1	1
Scotland	5	1	0	1	0	7
South-East	0	12	12	12	3	39
South-West	1	8	5	0	2	16
Wales	1	1	2	0	0	4
West Midlands	0	6	6	2	0	14
Yorkshire and The Humber	<u>2</u>	<u>4</u>	<u>3</u>	<u>1</u>	<u>3</u>	<u>13</u>
Total	13	59	44	37	20	173

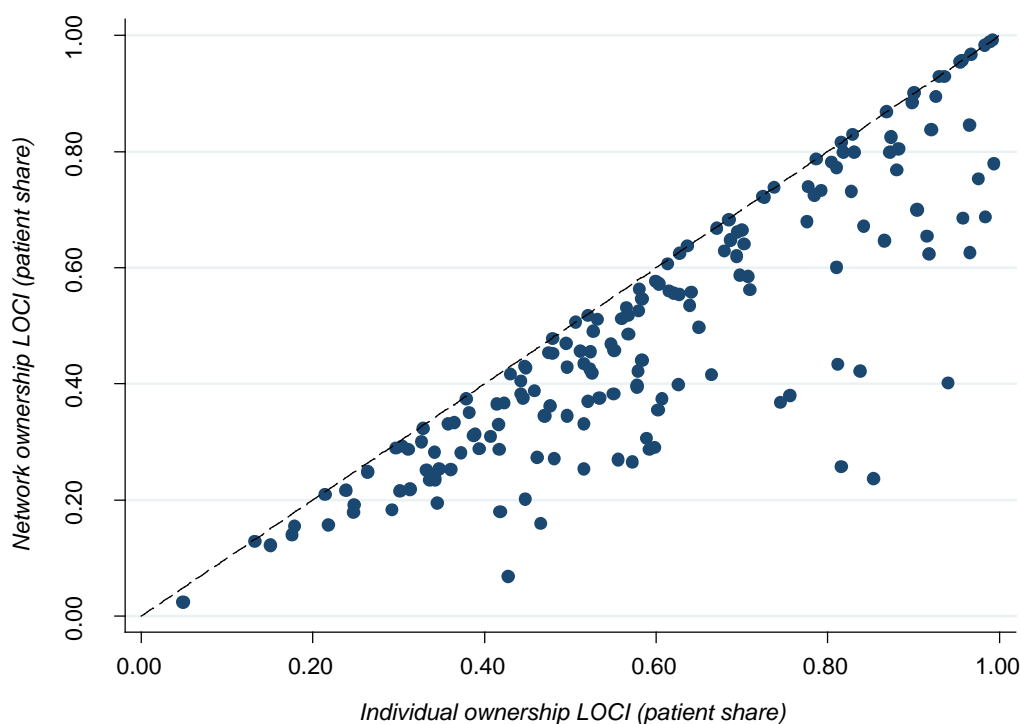
Source: CC Analysis

Note: LOCI calculated based on patient shares.

36. The comparison between Table 3 and Table 4 indicates that hospitals have a significantly higher degree of market power once network ownership is accounted for. Table 4 above shows that 13 hospitals have a network LOCI of less than 0.2, as opposed to five using the individual ownership LOCI. In total, there are 116 hospital sites that have a network LOCI of less than 0.6, as opposed to 95 based on the individual ownership LOCI.
37. Figure 1 below compares individual ownership LOCI with network ownership LOCI.

FIGURE 1

Comparison of individual ownership and network ownership LOCI



Source: CC Analysis

Notes:

1. One dot corresponds to one hospital site.
2. Overlapping dots may mean multiple hospital sites are represented by a single dot.

38. Figure 1 shows network LOCI on the vertical axis and individual ownership LOCI on the horizontal axis. If all hospitals were independently owned, the figure would show all points lying on the 45 degree line (ie network LOCI would equal individual ownership LOCI). Points that lie below the 45 degree line are those hospitals that have a higher network LOCI than their individual ownership LOCI—these hospitals are expected to have a degree of market power that stems from their network ownership, and the fact that the hospitals within those networks draw patients from some common areas.
39. Finally, Table 5 below shows the revenue share LOCI results by region.

TABLE 5 Results of network ownership LOCI using revenues by region (number of hospital sites)

Region	Network LOCI: 0.0–0.2	Network LOCI: 0.2–0.4	Network LOCI: 0.4–0.6	Network LOCI: 0.6–0.8	Network LOCI: 0.8–1.0	Total
East Midlands	0	4	2	0	2	8
East of England	1	3	7	4	3	18
London	0	1	12	6	10	29
North-East	0	3	0	1	0	4
North-West	2	7	5	4	2	20
Northern Ireland	0	0	0	0	1	1
Scotland	4	2	0	1	0	7
South-East	0	5	15	12	7	39
South-West	0	8	5	1	2	16
Wales	1	0	2	1	0	4
West Midlands	0	5	4	4	1	14
Yorkshire and The Humber	<u>1</u>	<u>4</u>	<u>3</u>	<u>3</u>	<u>2</u>	<u>13</u>
Total	9	42	55	37	30	173

Source: CC Analysis

Note: LOCI calculated based on revenue shares.

40. The comparison between Table 4 (network LOCI, by patient share) and Table 5 (network LOCI, by revenue share) shows that for most regions hospitals are recorded as operating in less concentrated areas when the revenue shares rather than patient shares are employed. London hospitals, by contrast, are recorded as operating in more concentrated areas by the revenue share measure. This implies that London hospitals have higher insured episode prices per patient on average, which may be a consequence of having higher prices for treatments and/or a higher value mix of treatments and patients.

Potential issues

41. While the LOCI measure has received some attention in the academic literature, and has been used by the Federal Trade Commission (FTC) and the Dutch competition authority (NZA), it is not widely used as a concentration measure, and has not been used by the CC in previous cases. One factor contributing to this is likely to be the large data requirements for LOCI.
42. We have been able to compute LOCI for this inquiry given the high quality and coverage of the available data. However, despite the quality of the Healthcode data, it does not include every single invoice. This potential impact of these missing invoices is considered here.
43. The main reason for omissions of invoices are that certain hospitals do not use Healthcode as an intermediary with insurers. Invoices are also missing because a small proportion of data was excluded as being erroneous or having missing information. Missing invoices may result in the market shares being misstated. This will happen if the missing invoices are missing systematically for particular hospitals.
44. It is not thought that the missing invoices as a result of data exclusions will cause any problems. There is no systematic basis relating to hospitals that has led to data being excluded.
45. Missing invoices as a result of hospitals not using Healthcode, however, are unlikely to be at random and so will bias the LOCI calculations to a degree. The extent of this bias is thought to be limited since the majority of hospitals are recorded in the data, and it is typically the smaller hospitals that are not recorded in the data. Any bias is

therefore expected to be negligible, and we are of the view that LOCI is an appropriate and reliable concentration measure to use in this inquiry.

Motivating LOCI as a weighted average market share

46. Akosa Antwi, Gaynor and Vogt (2006) provide a derivation of the LOCI measure in the context of an underlying economic model.^{4,5} A model is assumed with the following features:

- (a) a differentiated product market, with observable patient heterogeneity;
- (b) J firms, facing T different types of patient, with N_t patients of each type;
- (c) hospital j maximizes profits by selecting a price such that:

$$\max_{p_j} \pi_j = p_j D_j(p) - C_j(D_j(p))$$

where D_j is hospital j's demand function and C_j is hospital j's cost function; and

- (d) consumer of type t obtains the following utility from attending hospital j:

$$U_{tj} = -\alpha p_j + a_{tj} + \varepsilon_{tj}$$

where the error term, ε_{ij} , is assumed to have a Weibull distribution, and a_{ij} represents the perceived desirability of hospital j to patients of type t.

- 47. The final assumption, (e), implies an underlying multinomial logit demand system.
- 48. The authors of the paper show that under these assumptions the optimal price charged by hospital j is equal to:⁶

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

$$LOCI_j = \sum_{t=1}^T \frac{N_t Pr_{(t \rightarrow j)}}{\sum_{t=1}^T N_t Pr_{(t \rightarrow j)}} (1 - Pr_{(t \rightarrow j)})$$

where $Pr_{(t \rightarrow j)}$ is the probability that a patient of type t attends hospital j. If the patient types are specified according to geographic submarkets, then the probability that a patient of type t attends hospital j is, by definition, equal to hospital j's market share in submarket t.

- 49. Noting that the denominator of the above equation for LOCI can be rewritten as the total number of patients at hospital j, $N_j = \sum_{t=1}^T N_t Pr_{(t \rightarrow j)}$, LOCI can be rewritten as:

$$LOCI_j = 1 - \sum_{t=1}^T w_{tj} Pr_{(t \rightarrow j)}$$

⁴ Y O D Akosa Antwi, M Gaynor & W B Vogt, 'A competition index for differentiated products oligopoly with an application to hospital markets', unpublished manuscript, 2006.

⁵ The model is closely related to the well-known Berry, Levinsohn and Pakes (1995) model.

⁶ The quantity consumed by consumer of type t, denoted \bar{q}_t in the paper, is assumed to equal 1 in this note.

where $w_{tj} = \frac{N_t Pr(t \rightarrow j)}{N_j}$.

50. In this rewritten formula, LOCI can be seen as a weighted average of hospital j's market shares for each patient type t, where the weights, w_{tj} , corresponding to the importance of type t to hospital j.