Location Quotients and Force-field Analysis

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Given that the majority of attendees at the conference did not have an interest in pre-trial jury selection issues, this short paper explains what location quotients are, what a force-field analysis is, and how to use them.

Location Quotients

Location Quotients are a measure of the relative risk in a sub-region compared to a larger study area. The formula for the location quotient is as follows:

$$\mathbf{LQ_i = (c_i / a_i) / (c_R / a_R)}$$

Where:

c represents a crime frequency,

a represents an areal measure or population at risk, and

i represents a sub-region of a larger study area R.

The crime frequency can be a count of any crime type, but care needs to be taken when deciding the appropriate area based measure to use as a denominator. For example, the best denominator (a_i and a_R) for an analysis of residential burglaries would probably be residential household units, while a denominator for assaults would more likely be a population based measure.

Consider the following simple example: A small town has four police districts, each with a variable number of personal robberies and different population densities, as per the table here.

9 robberies 1000 people	10 robberies 500 people
4 robberies 800 people	8 robberies 800 people

The first stage is to calculate a robbery rate for the town:

9 + 10 + 4 + 8 = 31 robberies

1000 + 500 + 800 + 800 = 3100 people

The town rate is therefore 31/3100 = 0.01 robberies per person.

The location quotient (sometimes also called an excess risk ratio) is the local risk relative to the town rate. For the first area (top left) the robbery rate per person is 9 / 1000 = 0.009. The Location Quotient for this area is therefore the local rate divided by the town rate, which is:

LQ (top left district) = 0.009 / 0.01 = 0.9

When the LQ is calculated for the whole town, the LQs for each area are as follows:

LQ = 0.9	LQ = 2.0
LQ = 0.5	LQ = 1.0

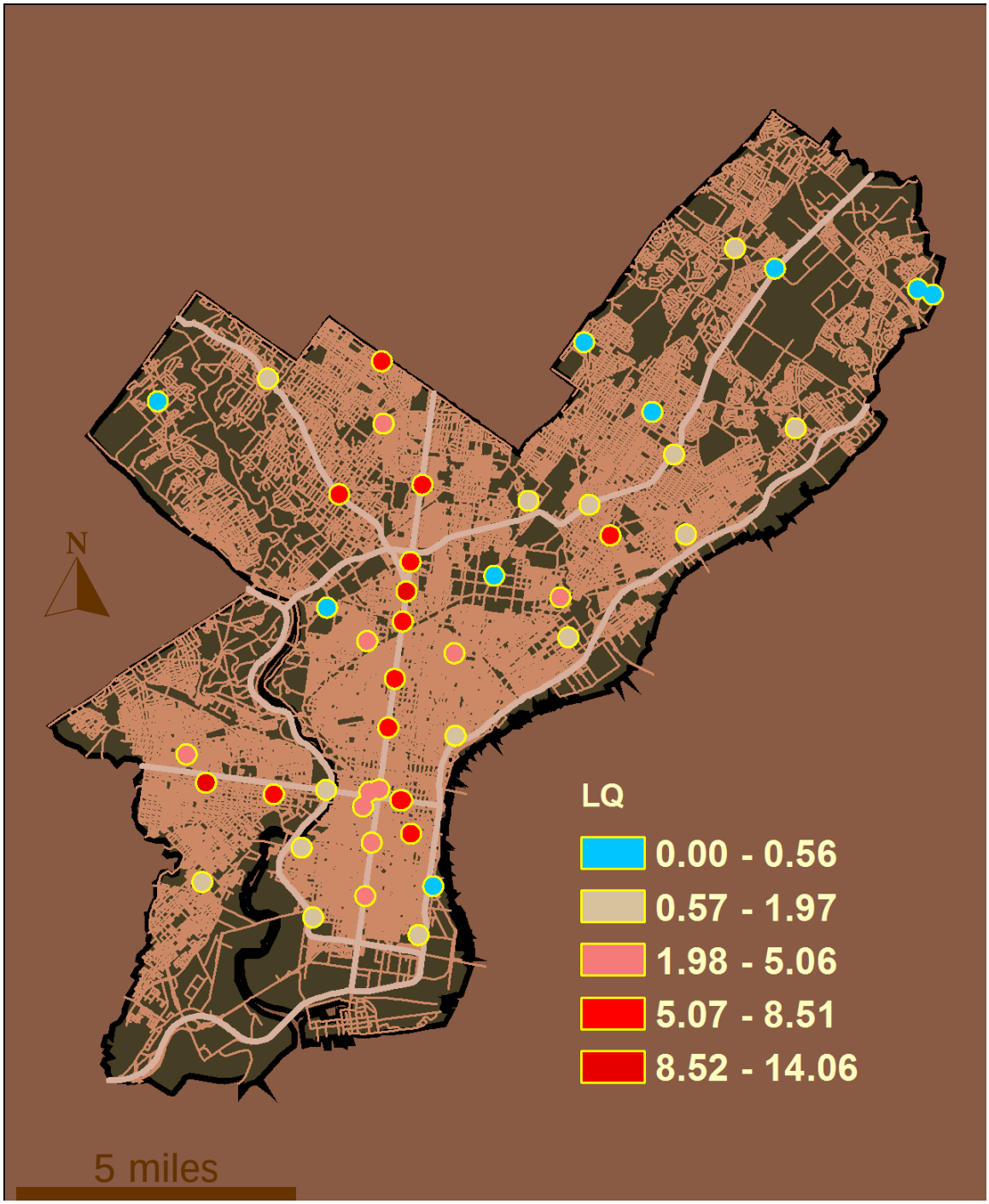
Interpretation of Location Quotients

If a sub-area (such as a police district) has a LQ of exactly one, then the sub-area has a crime rate that is exactly the overall town rate. If the sub-area has a LQ of 0.5 then this means that the local rate is half that of the overall town rate. If the sub-area has a LQ of 2.0 then the crime rate (in this example the robbery rate) is double that of the overall town rate. A LQ of 3 means a rate three times the town rate, and so on.

In the example shown, the top left area has a robbery rate that is slightly lower than the overall town rate, the top right area has a robbery rate that is exactly double the town rate, the lower left sub-area has a rate that is only half the town level, and the last area exactly matches the town rate.

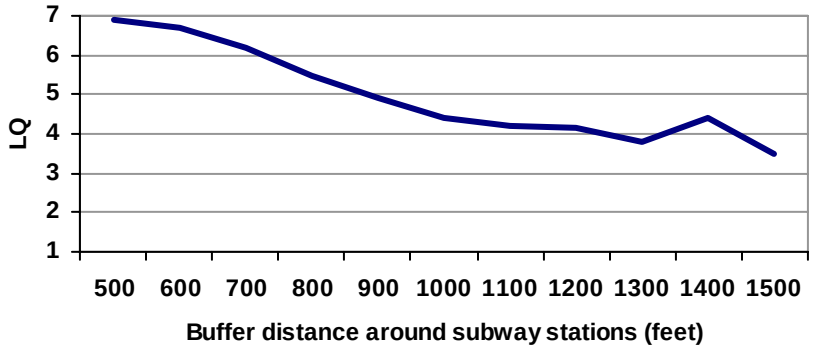
As a concrete example, the following image calculates the robbery LQ for a buffer area of 1000 feet around McDonald's restaurants in the city of Philadelphia, PA. Individual LQs are calculated using the robbery rate per square mile across the whole city, compared to the risk

in the area around each restaurant. Robbery data is based on Philadelphia Police Department robbery data for 2002 and 2003.



Blue disks indicate areas that have considerably lower levels of robbery than the rate across the city as a whole. The red areas show the robbery level in the vicinity of these restaurants is higher than the city rate, and indeed up to 14 times the city rate.

In this example, the choice of buffer distance is significant. If the buffer distance is so large that the buffer encompasses the whole city, then the location quotient for every area will be one (1.0), in other words, equivalent to the city rate. In the McDonald's restaurant example, the LQ is calculated for each individual location. It is also possible to calculate an aggregate rate for a group of locations. When the LQ is calculated for robberies in the vicinity of



subway stations in Philadelphia, a different buffer distance shows a reducing LQ as distance increases. If the buffer distance increased so that the combined buffer areas covered the whole city, the line would drop to 1.0, in other words the city robbery rate per square mile.

Choice of denominator

From this you might gather that the choice of denominator is important. For the small example town with only four areas, the population in each area was an appropriate denominator for a test of robbery risk. However, for other tests a different denominator may be appropriate. For example, maps that show the LQ for residential burglary would be more accurately calculated with a denominator of occupied housing units.

Location quotients are a simple calculation, but provide a more vivid picture of relative risk than normal maps that show a crime density as low to high. They can also be calculated automatically with GeoDa (see http://sal.agecon.uiuc.edu).

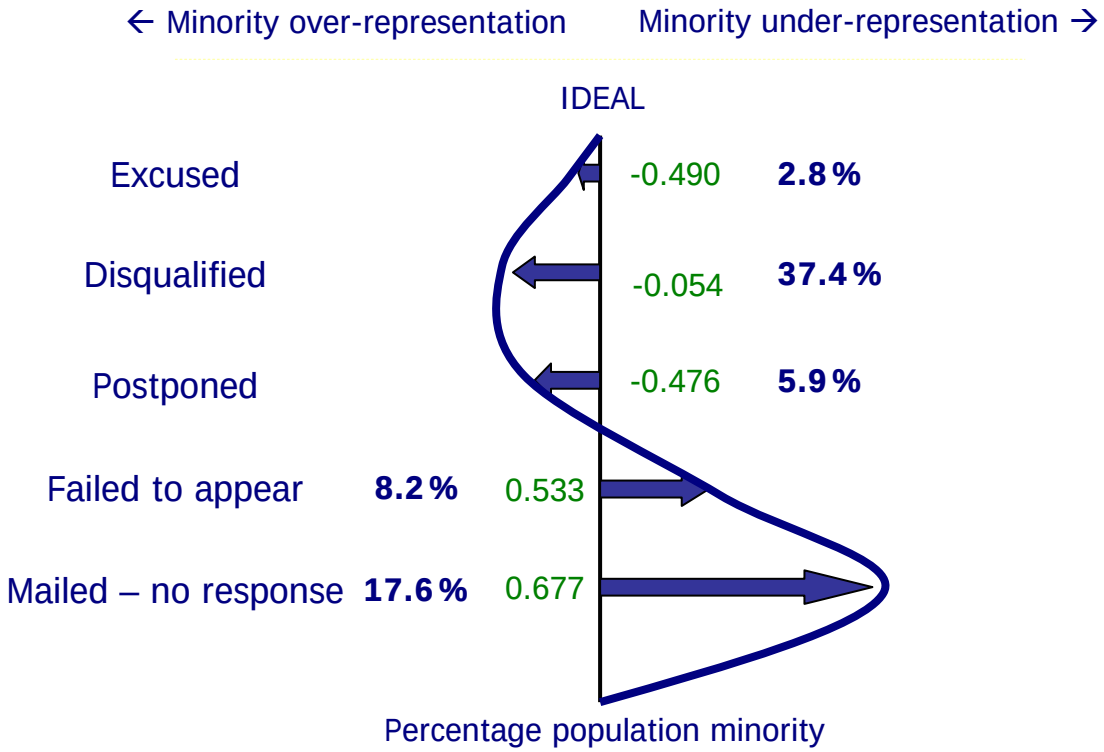
Force-field analysis

Force-field analysis is usually a technique used by strategic intelligence analysts as a qualitative technique to estimate future scenarios in the criminal environment. The approach is designed to allow an analyst or group of analysts to visualise possible leverage points on

the future criminal environment to see where law enforcement advantages can be best exploited.

As Quarmby notes, a force field analysis is a "comparative tool that assists examination of the relative weights of drivers that act for (facilitators) or against (inhibitors) change" (2004: 137). A force field analysis can be depicted visually, with a line that moves one way or another from a central neutral, or ideal, position. Visually, it can show where leverage points exist in a system. These leverage points are places where the system has weaknesses or is able to be exploited for the advantage of the criminal justice system. Quarmby (2004) gives an example that shows a future law enforcement issue five years into the future by comparison with the current environment.

The following (taken from the conference presentation) shows that when the various reasons why people drop out of the pre-jury selection system after being mailed with a letter of request, some interesting patterns appear. The force-field analysis below shows two figures for each drop-out reason. The first figure (in green) shows a correlation coefficient between the location quotient for the particular reason that people were removed from the jury pre-selection process, and the minority population rate for each area. The figure in blue shows the percentage of requested people who are lost to the system for the reason shown. For example, 37.4 percent of the people that are requested to join a jury are not acceptable because they are disqualified from being on a jury. This group of people are slightly negatively correlated with census tracts that have a higher minority population. [Please note that these figures are based on a preliminary analysis and it is anticipated that the figures may change slightly with an anticipated improvement in our geocoding].



The force-field analysis is a visualization technique. Here it that shows that the most significant reason for losing people from the jury system who live in minority areas, is the high correlation between the lack of response to the mailed letter request. These people are responsible for a 17 percent loss of people from the jury system prior to entering the court building. The length of each arrow is therefore a combination of the correlation coefficient combined with a factor that represents the percentage of people that are lost to that reason. For example, although the there is a strong correlation suggesting that most people who are excused for reasons of work commitments or other reasons are from predominantly white neighborhoods (a negative correlation with minority rate) only 2.8 percent of people are lost to the system for this reason, and it therefore in not a significant leverage point. If all of these people were returned to the system, then the number of people attending the court for jury service would not increase significantly.

From the force-field analysis, it can be seen that the most significant leverage point in the system is the high correlation between the number of people lost because they do not return the initial request letter asking them to be on a jury, with the minority rate. This suggests that

if the jury authorities could improve the drop-out rate at this early stage of the process, then this would have a high probability of increasing the minority participation rate in the jury process.

The force-field analysis can be used quantitatively or qualitatively (as in the more usual strategic intelligence setting). This simple visualization technique can clearly show an audience or group of analysts the most appropriate mechanism with which to leverage a particular part of the criminal justice system.

Paper details and further reading

The conference presentation utilized data that was but one small part of a much larger study, released last year, which was conducted on behalf of the work group on jury selection for the Pennsylvania Supreme Court Committee on Racial and Gender Bias in the Justice System. Further details of the research can be found in the final report, on the web site of the Pennsylvania Supreme Court. The research team for this phase was lead by Professor Ralph Taylor, chair of the Department of Criminal Justice at Temple University, and included Lillian Dote, Brian Lawton and Jerry Ratcliffe, all from Temple University.

As a useful reference, one paper that employs location quotients for crime hotspots is **Brantingham, P., and Brantingham, P. (1995). Location quotients and crime hotspots in the city.** In C. Block, M. Dabdoub and S. Fregly (eds) Crime analysis through computer mapping, Washington DC: Police Executive Research Forum.

Force-field analysis is described by Neil Quarmby in the following reference:

Quarmby, N. (2004). Futures work in strategic criminal intelligence. In; Strategic Thinking in Criminal Intelligence, J. H. Ratcliffe (Ed). Sydney, Federation Press, chapter 10.