Abstract: The physical extent of the city is important in a number of respects, not least in relation to the question of city size, an issue of considerable significance in urban and regional analysis. Four definitions of the city are considered here. The first involves the city as a physical entity, or the area devoted to primarily urban uses. This Built City (BC), which has an important economic basis, is perhaps the most familiar definition of the city, largely because it is relatively easy to visualise. The BC forms the core or basis of each of the other three perceptions of the city. These are as follows: the Consumption City (an area within which most of the consumption of goods and service occurs in the BC); the Employment City (an area in which the bulk of the employed workforce works in the BC); and the Dependent City (an area upon which the BC draws for a given majority of its labour requirements). These four definitions of the city are brought together and shown to be interrelated (December 2005).
1. INTRODUCTION

The definition of a city has been approached in a number of distinct ways. Among the more important viewpoints that have been adopted are the economic (Ratcliff, 1949; Sombart, 1902), the sociological (Weber, 1921; Wirth, 1938), the cultural (Mumford, 1938; Zukin, 1995), and the historical (Pirenne, 1936; Weber, 1899). While providing considerable insight into the nature and functioning of the city, these approaches are generally not concerned with the space that it occupies, i.e. its territorial extent. This would appear to be a rather mundane concern, certainly when set alongside the many powerful ideas expounded in the above-mentioned works. Yet spatial definitions are important for a variety of reasons, the most obvious being the determination of a city’s boundaries to establish the jurisdictional competence of government (cities do not always form the basis for local-government structures). Within the field of urban analysis, the definition of a city assumes a crucial importance in relation to the question of city size, a statistic of fundamental significance. Size is of obvious importance in the ranking and hierarchical ordering of cities, as well as their size distribution and how this changes over time. Size is also of relevance in the analysis of such correlates of city size as levels of per capita income, unemployment rates, inequality in levels of well-being, the extent of diversification and specialisation, etc. It is usually the case that city size is measured in terms of some aggregate such as overall population, employment or income, and any measure of this type is only possible with adequate information on the areal extent of the city, i.e. with a specification of its boundary.

On the surface at least, this appears to be straightforward enough. Such is not the case, however, and a couple of simple examples serve to illustrate the point. First,
the 2002 population of the municipality of Nottingham was 274,000, whereas the population of its “continuous urban area” has been estimated at 681,000 (City of Nottingham, 2005a). Second, the municipality of Manchester had a 2001 population of 393,000, while that of Liverpool was 440,000, but the populations of the respective metropolitan counties (Greater Manchester and Merseyside) were 2,482,000 and 1,362,000, representing a reversal in the ranking (United Kingdom, 2003 and 2004). In the Nottingham case the difference in size depends on whether or not the city is being defined as a legal entity (the *de jure* city) or as a physical one (the *de facto* city). In the Manchester/Liverpool case, however, the difference between these cities turns on what type of administrative division is used. Surprisingly, the failure to make these distinctions when comparing cities is common, not simply in everyday discussion or newspaper coverage (often resulting in much confusion), but also in studies concerned with cross-sectional comparisons of cities in terms of population or population-related variables, particularly on an international basis. It hardly needs emphasising that city size must be measured meaningfully and consistently over the entire range of cities under consideration, as would need to be the case, for example, where the population of a city was being treated as an explanatory variable in a multivariate analysis of urban productivity. Similar considerations apply, with no less force, when the concern is with city growth rates, this being of particular relevance in tests of the “law of proportionate effect” (Gibrat, 1931; Eeckhout, 2004)

2. BACKGROUND CONSIDERATIONS

We may begin by briefly considering the city as corresponding to the legal or administrative city. Under certain conditions this definition is perfectly adequate, particularly where the legal boundary of the city is closely coincident with its physical
extent. This represents the case of the so-called “true-bounded city” (International Urban Research, 1959). There are, however, problems with using the legal definition of the city, and these may be especially serious for larger urban areas. Above a certain population level, which varies considerably among nations but which is usually in excess of around 150,000 inhabitants, the legal city exists as part of a broader urban or metropolitan area. In such a setting the boundary of the legal city is very porous in functional terms, with the result that this definition can only have a limited validity in urban analysis. Furthermore, the fact that the population of the legal city relative to that of the overall urban area usually displays considerable variation, renders comparisons among legal cities virtually meaningless. More specifically, using the legal city may cast the city in an unfavourable light, which can have an adverse influence on investment decisions affecting its economy. This is especially the case with older industrial cities. Research by the City of Nottingham (2005b) revealed that if "Greater Nottingham" is used rather than the legal entity, the city's performance will be considerably improved, in terms of such indicators as unemployment, incapacity-benefit uptake, health problems, educational attainment, drug abuse, etc. It is perplexing, therefore, that the legal definition of the city continues to be used in comparative urban analysis.

An important strand of urban research in the last half century has been concerned with relating the city to its broader spatial labour market. In the UK this has involved studies of commuting (Smart, 1974) and, more recently, attempts to reconstitute travel-to-work areas (TTWAs) originally introduced in 1953 (United Kingdom, 1978). These now represent approximations of self-contained labour markets. More specifically, within a given TTWA at least 75 per cent of the resident workforce is employed there, while at least 75 per cent of the employed workforce
resides there. Such TTWAs, which have been subject to certain criticisms (Turok, 1997; Webster, 1997) have been used to track unemployment and to identify areas for economic-development assistance.

In the US the approach has been rather different (somewhat less policy oriented, though still policy relevant), probably reflecting the greater extent of the nation and the higher levels of mobility. To deal with the complex phenomenon of commuting, Berry et al. (1968) introduced the concept of the “functional economic area”. For a particular labour market (a set of counties sending commuters to a given central county), the functional economic area consisted of “all those counties within a labour market, for which the proportion of resident workers commuting to a given central county exceeds the proportion commuting to alternative central counties”. With some modification the concept of the functional economic area was applied in Western Europe (Hall and Hay, 1980), where it has become known as the “functional urban region” (FUR). In a six-nation study of FURs directed by Brunel (2002), a locality was included within the FUR, if it had 10% of its resident workforce commuting to the “core” (generally the metropolitan area). The problem here was that the resulting entity was extremely large: over 120 km in diameter in the cases of Paris and London. As the term indicates, the FUR is a region and not a city, and there is little to be gained by suggesting otherwise. The real conceptual value of the FUR, of course, is its ability to highlight the linkage between the built-up area of the city and a surrounding territory.

It is thus apparent that the city is increasingly regarded not so much as a concentration in its own right, but rather as a focus of some wider space. A particular example of this is an urban-centred territory, termed in Western Europe the “city-region” (Parr, 2005). This refers to a territory within which the city and the area
surrounding it are engaged in a complex and interrelated set of economic and social interactions. The concept of the city-region is employed at different spatial scales, sometimes to avoid an underbounding of the city, but more commonly to emphasise the significance and extent of these interactions. In fact, the FUR, referred to above, can be said to represent a particular scale of city-region. Although the interaction here is frequently concerned with commuting, the FUR may be based on migration, the housing market, patterns of retail trade, etc. (Coombes, 2005). The argument that the city should be viewed as part of a larger continuum, comprising the entire city-region, is an especially strong one that has considerable validity. Nevertheless, there are various justifications for confining attention to the city, while not denying the existence of a wider structure of which it is the focus. The concern here is with four perspectives on the city, one of which is also being used as a foundation for each of the other three. In all cases the focus is on the particularity (rather than the superiority) of each definition. Note that in keeping with current practice in urban research, no distinction is made between the terms “town” and “city”, and that no significance attaches to the designation “city” when this refers to some honorary, historic or religious status.

3. THE BUILT CITY

The initial perspective on the city is concerned with its physical area, and regards the city as the extent of its built-up area, i.e. a continuous or near-continuous tract of territory devoted predominantly to urban uses, including housing, economic activity, transport, public spaces, etc. There is a strong case for imposing a minimum size threshold on this “built city” (the BC), and here we take the arbitrary, though common, level of 50,000 populations as lower limit (below this limit, the categories
of “smaller urban areas” and “rural areas” could be used). There is also some virtue in applying a minimum-density criterion along with certain rules regarding the treatment of ribbon (strip) development and urban areas in very close proximity.

This physical view of the city is of obvious relevance in the case of larger metropolitan areas. Here the BC emerged either as a result of successive rings of peripheral expansion (e.g. Berlin, Chicago, London, Paris, etc.) or because of the coalescence of neighbouring urban areas, to form a single metropolitan area (e.g. Birmingham, Boston, Glasgow, Manchester, the urban agglomeration of Lille-Roubaix-Tourcoing, etc.). The latter examples are more in the spirit of what Geddes (1915) termed a “conurbation”. We should not allow ourselves to be detained by the fact that the BC (whatever its form) may sometimes contain non-urban tracts. Physical impediments to urban growth, the existence of parks, nature reserves, areas devoted to sports, as well as the imposition (by planning authorities) of green wedges and other restrictions on land use, all account for such discontinuities in the urban surface. In contrast to the case of the legal city where it forms part of a much larger urban area, the BC provides a considerably better indication of the relative importance of the city as a focus of economic activity and a concentration of demand for labour. Furthermore, the economy of the BC is typically characterised by complex patterns of internal trade, not only among firms, but also between households and firms.

National statistical agencies have, of course, recognised the importance of this view of the city. In 1951 the census authorities in various parts of the UK introduced a unit termed the “conurbation”, to identify major areas of more or less continuous urbanisation (United Kingdom, 1954 and 1956). The conurbation was based on local-government units, with account taken of density considerations. A locality was “considered for inclusion in a conurbation, to whose focal centre it was strongly
attached as a centre for work, shopping, higher education, sports on entertainment” (United Kingdom, 1956, p. xiv). The conurbation was an accurate representation of the BC, and it was unfortunate that only seven were identified (Robinson, 1953; Dickinson, 1964). This statistical division was not used after the 1961 Census, but the metropolitan counties of England (created in the 1960s) represent reasonable approximations, even if overbounded in certain cases. The “urban area”, introduced in 2001 Census, probably represents as good an approximation to the BC as is possible. This is a “bricks-and-mortar” definition, which includes urban areas below the 50,000-population threshold employed here. In the case of larger urban areas, these are sub-divided into constituent parts. The definition of urban areas in England and Wales differs only slightly from that used in Scotland (United Kingdom, 2004).

The experience of the US deserves mention. In 1949 the Bureau of the Census introduced the concept of the “urbanized area” (Berry et al., 1968; Wrigley, 1950). This unit, having a population exceeding 50,000, was designed in part to emphasise urban-rural differences. Based on minor civil divisions, such a unit was a reasonable representation of the BC. It cannot be stated strongly enough that the “urbanized area” is quite separate from the “metropolitan statistical area” (MSA), first introduced in 1990 and emerging from various previous designations, starting with the “metropolitan district”, used in the 1910 Census. The MSA employs counties as building blocks, and since these often contain a large rural component, it tends to overstate the extent of the BC, especially in certain Western states. This may be a serious problem when cities (i.e. MSAs) are being compared in terms of density or density-related attributes. More generally, when such MSAs continuously cover more than two-thirds of the surface area of California, for example, or when contiguous MSAs form a 1,000km belt from Portland, Maine to Richmond, Virginia, the use of
such a unit as a measure of city size has to be questioned, its advantages in terms of
intertemporal comparability notwithstanding.

An ambitious and in many ways successful attempt to define the major
metropolitan areas of the world on a consistent basis was undertaken in the late 1950s
by a team from the University of California, Berkeley (International Urban Research,
1959). The study employed criteria broadly similar to those used by the US Bureau of
the Census to define the Standard Metropolitan Area (one of the precursors of the
MSA mentioned above), with local-government units added to the “principal city” (in
excess of 50,000), to form the metropolitan area. The study tended to overstate the
extent of the respective BCs in many cases, mainly because, in the absence of travel-
to-work data, it chose to rely on an inclusion criterion of 65 per cent of the
employment in a local-government unit being in non-agricultural employment. Given
the enormous variation in levels of development, this was an imperfect criterion, to
say the least.

While the BC is able to reflect the economic importance of a city, it suffers
from a serious weakness. Over the past half-century (somewhat longer for certain
nations) the boundary of the BC has become increasingly porous, a development
mentioned in the previous section in relation to the legal city when it merely formed
part of a larger BC. It is increasingly the case that the boundary of the BC fails to
reflect adequately the operation of the labour market, the housing market, systems of
service provision (private and public), etc. In the case of the labour market, for
example, a significant share of the employed within the BC resides outside it, the
proportion for London in 2002 being 20% (CEBR, 2005, p. 20). In addition, part of
the employed resident workforce of the BC is employed beyond its boundaries, and
for London in 2001 this amounted to around 7% (Oxford Economic Forecasting,
In other words for the BC there is a lack of correspondence between the location of the workforce and the location of employment.

Problems of this nature have encouraged the search for additional definitions of the city, three of which are considered here. In each case the BC represents the base. To this base a locality in the outer area (i.e. the area surrounding the BC) is added: a) if it satisfies certain specified criteria; b) if it is directly or indirectly contiguous with the BC; and c) if its exclusion would result in a discontinuity in the surface of the BC. These localities in the outer area may consist of 10-km grid squares, for example. Alternatively, the localities could represent local-government jurisdictions. A further possibility is for the localities to be urban-centred territories. Whatever the type of areal unit employed, the question of appropriate frequency is crucial. With too many units, each will tend to lack functional integrity: with too few units these become awkward building blocks. Clearly, the frequency of areal units is likely to require preliminary experimental testing.

4. THE CONSUMPTION CITY

Households in the BC consume goods and services, most of which are supplied by the BC. Households in localities beyond it also consume such goods and services supplied from the BC. This consumption involves expenditures on food, clothing, durable and non-durable goods, and personal services of various kinds, including certain types of social services. From the viewpoint of the economy of the BC, such consumption by non-BC households is exogenous, and is no different in its income-generating effect from the supply of machinery to an overseas market, for example. However, from the viewpoint of the economy of a wider city (to be specified shortly) these expenditures are endogenous. Let us consider why consumption expenditures
by non-BC households should take place in the BC. One reason is that many localities simply lack the purchasing power to permit the provision of specialised goods and services, e.g. a bespoke suit, a rare book, a theatre performance, a concert, etc. The supply of such high-order goods and services is generally confined to larger cities, a tendency that is reinforced by the opportunities there for comparison-shopping. Another reason for goods and services available within the BC being consumed by non-BC households is related to commuting to the BC from the outer localities (something that will be considered in the following section). Commuters typically use the opportunity created by a work trip to the BC for lunchtime shopping, as well as after-work attendance at entertainment and sporting events.

The pattern of consumption expenditure by non-BC households underlies the second perspective on the city: the “consumption city” (the CC). This draws attention to the fact that households primarily dependent on the BC for purposes of consumption are not confined to the BC, itself. A first approximation to defining the CC would involve adding to the BC each locality with more than 50 percent of its consumption expenditures occurring in the BC. However, some of the consumption by BC households will be external to the BC. For example, out of the total consumption by BC households, a certain proportion $x$ is spent on mail-order purchases, Internet shopping, overseas travel, as well as recreation and holiday activity in other regions or overseas. By the same token, households in locality $i$ could be expected to make similar external expenditures beyond the BC. For this reason there needs to be some downward adjustment of total consumption expenditure of locality $i$. The CC, apart from subsuming the BC, will also include each locality $i$ for which the following inequality holds:

$$\left[ \frac{C_{BC}^i}{C_T^i} (1 - x) \right] > 0.5$$

(1)
where:

\[ C'_{iBC} = \text{consumption by locality } i \text{ households in BC}; \]

\[ C'_{iT} = \text{total consumption by locality } i \text{ households}; \]

\[ x = \text{proportion of consumption expenditure made externally by locality } i \]

households, but not in the relevant BC (if \( x \) is known to differ from that of the BC and/or to vary widely among localities, it is possible to use the term \( x' \)).

It follows that the existence of large shopping centres in the outer suburbs of the BC will raise the value on the right-hand side of expression (1), while the presence of branches of major retail chains in locality \( i \) of the outer area will lower this value.

Attention is drawn to three qualifications of this definition of the CC. First, housing expenditures (whether mortgage repayments or rents) are excluded from the consumption package. This is because the choice of location has already been made, whereas for non-housing consumption expenditure a certain degree of locational discretion is possible, with respect to level and composition. The second qualification concerns those services for which there is only a partial charge or no charge at all, e.g. higher education, certain types of medical and related treatment, visits to parks and museums. Since the city is being defined in terms of consumption, services of this type cannot justifiably be excluded, but for the above approach to be used, such consumption items have to be expressed in monetary terms. A third qualification concerns the fact that by the definition of a CC given in inequality (1), one (or more) of the included localities represents a smaller BC, thus having a population in excess of 50,000. Rather than attempt to construct a CC based on this BC, it is expedient to treat such a BC as part of the CC. Thus while the BC is one of the group of BCs, it does not form the basis for as separate CC.
5. THE EMPLOYMENT CITY

It has already been noted that for many cities, especially larger ones, a significant proportion of the employed workforce is resident beyond the boundary of the BC. This forms the background for a third perspective on the city. The underlying premise here is that since the majority of the employed workforce of the BC is employed there, then all localities in the outer area for which this condition holds, should be regarded as part of a wider city, with the BC as its base. This is termed the “employment city” (the EC). A preliminary approach would be to include within the EC each locality in which 50% of the employed workforce commuted to the BC. However, this approach makes no allowance for that element of locally orientated employment which is supported by commuters to the BC, i.e. part of the locality i employment in retailing, entertainment, personal services, local transport, etc. A more realistic condition for the inclusion of a locality within the EC would therefore be for the commuting employment, plus the local employment which this generates, to be greater than 50% of the employed workforce resident within the locality.

In order to be able to define the EC, the following notation is introduced:

\[ E_{BC}^i = \text{resident workforce of locality } i \text{ employed in BC}; \]

\[ E_L^i = \text{resident workforce of locality } i \text{ employed in the locally-oriented sector}; \]

\[ E_r^i = \text{employed workforce resident in locality } i; \]

with

\[ k^i = E_L^i / E_r^i \]

(2)

The direct and indirect employment associated with the BC may therefore be expressed as
\[ E_{bc}^i + E_{bc}^i k^i + E_{bc}^i (k^i)^2 + \ldots = E_{bc}^i \left[ \frac{1}{1 - k^i} \right] \] (3)

Locality \( i \) is therefore included in the EC, if

\[ E_{bc}^i \left[ \frac{1}{1 - k^i} \right] / E_T^i > 0.5 \] (4)

The term \( 1/(1-k^i) \) represents the employment multiplier for locality \( i \). In a related manner the inclusion of a locality within the EC can be approached in terms of income. Now, however, the criterion for inclusion is for the income derived from commuting, plus the local income associated with this, to be greater than 50% of the total income of locality \( i \), i.e. for the following condition to be satisfied:

\[ Y_{bc}^i \left[ \frac{1}{1 - a^i b^i} \right] / Y_T^i > 0.5 \] (5)

where:

\( Y^i \)

locality \( i \);

\( b^i \) = income generated in locality \( i \) per £ of expenditure by locality \( i \)
workforce employed in the BC;

\( Y_j^i \) = total income of locality \( i \), i.e. gross domestic product plus net factor payments received by locality \( i \) (including \( Y_{bc}^i \)).

The term \( 1/(1-a^i b^i) \) is the income multiplier for locality \( i \) (a fuller discussion of this type of multiplier is given in Tiebout, 1962). There is every reason to suppose that the size and shape of the EC would vary according to whether the analysis was in terms of employment or income. In fact, a comparison of the results of the two methods would provide valuable information on the socio-economic characteristics of commuting within a given EC.
The approach may be illustrated (with respect to employment) by a simple example. Suppose that for a given locality beyond the BC, 20% of the resident workforce is employed in the BC, and that a further 25% is employed in local engineering plants, which supply overseas manufacturers, but which have no backward linkages locally. We assume that there is broad comparability between the income distributions for the two sources of employment, and that the value of \( k \) is 0.5 (relatively high for a non-metropolitan economy). In common sense terms it would not be appropriate to regard this locality as part of the EC, simply because the local economy is more dependent on overseas demand for goods than it is on the BC’s demand for the locality’s labour. In more precise terms a similar conclusion is reached if inequality (4) is applied. This is not satisfied, since the workforce employed in the BC, plus the local employment which this supports, amounts to only 40% total locality employment, i.e. 0.4 on the right-hand side of inequality (4). It is worth mentioning that this locality would almost certainly be included in a functional urban region (FUR), as described in Section 2, since the cut-off figure for inclusion in a FUR is usually below 20% of locality employment. But since the FUR is not intended to define the city \textit{qua} city, it is perhaps not surprising that its spatial extent should exceed that of the EC.

In labour-market terms the degree of self-containment between workforce and employment (i.e. the correspondence between the supply and the demand for labour) is greater for the EC than for the BC. This would also be reflected in the balance of payments for each type of city. Thus, the sub-balance relating to commuting (the wages and salaries received by the city for external employment of its resident workforce \textit{minus} and the wages and salaries paid by the city for employment undertaken by an externally resident workforce) is likely to be negative for both types
of city. In absolute terms, however, the sub balance will be greater for the BC than the EC. Alternatively stated, be significantly higher than similar payments made by the EC. It should be mentioned that one of the localities included within the EC may be a BC with a population. Is BC is simply treated as part of the EC, and thus has no separate existence as EC. In the rare instance where locality can be assigned to either of two BCs (to form in each case an EC), it is assigned to that BC attractingees, or (if incomes are being used) that BC providing the higher level of locality incomes.

6. THE DEPENDENT CITY

from the outer areas. This perspective, referred to as the “dependent city” (the DC), is It represents territory required to support a particular volume of employment within the BC, at its present level of efficiency.
of efficiency would be unattainable with a smaller or larger territory. Whereas the third perspective (the EC) involved the employment dependence of the outer areas on concerned with the employment dependence of the BC on the outer areas. The DC bears passing resemblance to the general, and was concerned with the labour- e or more plants rather than for the entire BC. If, for a particular BC, 90% of its employed are resident boundary. Starting from the boundary of a BC, it is possible to construct a series of
contours or closed curves, still using localities in the outer area. Each contour encloses a given percentage of BC employment, e.g. 91, 92, 93, etc. Obviously, the higher the value of the contour, the more extensive will be the area involved.

It is from such a family of contours that the “critical contour” is selected, and it is this contour that defines the DC. Ideally, the 100% contour would be selected, but this is unrealistic, since there is inevitably a relatively small number of persons working in the BC who reside at a very long distance. A contour having a smaller percentage value must therefore be selected. Note that for very high values of the critical contour the DC begins to resemble the FUR or even a broader scale of city-region. An important variant of this perspective (and one which is clearly linked to it) involves undertaking the analysis in terms of wages and salaries rather than employment. Thus each contour would now enclose an area containing a given percentage of the income earnt from employment in the BC. The family of contours based on income could be expected to display significant differences from the family of contours based on employment, and a comparison between the two sets of contours would be valuable.

Whether the approach is in terms of employment or income, this fourth perspective on the city has certain problems. Most important perhaps is the fact that the selection of the critical contour is largely arbitrary. There is no reason why the 95% contour, for example, should have a greater significance than the 94% contour. Selecting a critical contour is therefore likely to be a difficult assignment, although the nature of the research question under consideration may help to determine this. One means of avoiding the problem is for the critical contour to represent that contour which encloses an employed resident workforce that is equal to the level of employment in the BC, so that the following equation holds:
\[ M^{BC} = E^{BC} + \sum_{i=1}^{n} E^{i}_{BC} \]  

where:

- \( M^{BC} \) = employment in the BC;
- \( E^{BC} \) = resident workforce employed in BC;
- \( E^{i}_{BC} \) = resident workforce of locality \( i \) employed in BC;
- \( n \) = number of localities outside the BC but within the critical contour.

Given the actual structure of locality boundaries, expression (6) is likely to represent an approximation. In terms of incomes the equivalent critical contour would refer to that contour which enclosed a resident labour-based income equal to the total labour-based income earned in the BC. This aggregate approach is not entirely satisfactory, since it reflects neither where the resident workforce is employed, nor where the resident incomes are generated, nor indeed whether there is a matching between the supply and demand for occupational skills. Nevertheless, such an approach indicates a benchmark or a hypothetical limit for the extent of the DC. It is also less arbitrary than selecting a contour of particular percentage value.

Another problem associated with the DC involves the construction of the contours around the BC. The use of concentric circles is perhaps the easiest approach, but this is only valid if the in-commuting labour is evenly distributed over the outer area with respect to distance from the BC. In most instances, however, this is not the case, because the housing preferences of commuters are stronger in certain directions than others, and/or because the lines of communication (highways and public-transport routes) are not developed to the same extent in all directions. The problem does not arise if each successive contour is constructed in such a manner that the area, which it encloses, is at a minimum, in which case the contour is likely to be neither
circular nor symmetrical. One further problem arises in relation to neighbouring urban centres beyond the BC. In certain cases the critical contour defining the DC may wholly enclose the critical contour of a neighbouring DC. In other cases the critical contour may intersect (at two points) the corresponding contour for another DC. The problem here is not simply one of cartographic representation. Since a particular territory (and the population therein) may belong to two (or possibly more) DCs, certain adjustments are necessary, in order to avoid double (or even multiple) counting. In the case of a DC that is wholly enclosed by a larger DC, the former simply becomes part of the larger DC. For two DCs whose respective critical contours intersect, the bisector connecting the two intersection points may be taken as the approximate boundary.

The problem of identifying the critical contour and the problem of neighbouring DCs both disappear, if each DC is considered on an individual basis. The focus now turns away from the critical contour to the family of contours for the DC in question and to the manner in which these are positioned to relation to each other. Again, a comparison between the family of contours based on employment and the corresponding family of contours based on incomes can be expected to yield valuable insights into commuting patterns. This treatment of the DC on an individual basis has a strong justification where the neighbouring DCs are located at a considerable distance.

7. FURTHER COMMENTS

The preceding discussion has been concerned with an important, though neglected, aspect of the city, namely, its spatial extent. This has been approached in terms of four different perspectives. One of these (the BC), which is familiar and relatively
easy to visualise, also forms the core for each of the other three. It is apparent that a
given perspective has particular strengths and weaknesses, and should therefore be
seen as essentially complementary with the others, as well as with alternative
conceptions of the city. While these definitions of the city are intended primarily for
the purposes of description, comparison and analysis, this does not prelude their use
in certain planning processes, or in background studies relating to the re-organisation
of local government Clearly, there is no “all-purpose city”, and the type of city
adopted will depend on the nature of the research question under consideration.

The BC, although essentially a physical view of the city, is a useful
representation of the city as a concentration of employment and economic activity.
The BC is of obvious importance in the planning of infrastructure systems as well as
the provision and co-ordination of local services. It is also relevant where land-use
concerns are prominent, especially at the margins of the BC. The CC, by contrast, is
an area within which there is a high level of reliance on the BC for consumption. Such
a view of the city is likely to assume significance where the concern is with marketing
and distribution. In the case of the EC the city represents an area, which is dependent
primarily on the BC for employment. This perspective has an obvious resonance
where the concern is with public transport and regional economic development.
Finally, the DC views the city as a labour-supply area (or alternatively a series of
labour-supply areas). It emphasises the fact that the workforce of the BC is not
confined to the BC itself. In this sense the DC reflects the demands of the BC made
on a wider area, obviously in terms of labour but also with respect to housing and
infrastructure.

No explicit consideration has been given to the internal structure of each type
of city. Particularly revealing in this connection would be an analysis of the TTWA
pattern for each type of city. An alternative approach involves the application of population-density functions (and less commonly population functions), and here there appears to be a high degree of regularity, i.e. adherence to particular functions. The negative-exponential function proposed by Clark (1951) provides a reasonable description of the structure of the BC, although the quadratic function, which incorporates the crater phenomenon near the centre, is generally more accurate (Newling, 1964). Attention has also been directed to the lognormal function (Parr, 1985). This function is able to describe densities accurately within the BC (Parr, O’Neill and Nairn, 1988), but also situations where the radius is larger, as would be case with the CC, the EC, and the DC (Parr and O’Neill, 1989). The spatial structure of employment within various types of city also lends itself to characterisation in terms of density functions.

Without too much difficulty it is possible to draw together the four perspectives. We define as $R_t$ the average radius of a city of type $t$. As a starting point, we have the following set of inequalities:

$$R_{BC} < R_{CC} < R_{EC} < R_{DC}$$  \hspace{1cm} (7)

It is clear that the average radius of the CC is greater than the BC, virtually by the definition. It is also probable that the average radius of the EC is greater than the CC, largely because (in developed nations, at least) household travel to the BC for work declines with distance at a slower rate than household travel there for the purpose of consumption. Nevertheless, the possibility that $R_{EC} < R_{CC}$ cannot be wholly discounted. The average radius of the DC has been indicated in expression (7) as greater than that of the EC. This will certainly be the case where the critical contour has a high value, a situation where the DC begins to assume the aspect of a city-region. For very low values of the critical contour, however, the average radius of the
DC may be less than that of the EC. In view of these reservations, it is possible that the radii of the various types of city might be arranged as follows:

\[ R_{BC} < R_{DC} < R_{EC} < R_{CC} \]  

Whether expression (6) or (7) or some other ordering of magnitudes is appropriate, it is also possible to measure the size of each type of city in terms of the population, employment or income contained within the relevant perimeter. For any single metric, however, the ordering of magnitudes of the various types of city will necessarily be the same as that for the radial extent.

An important feature, common to all four definitions, is that the spatial extent of each type of city is likely to change over a given interval, e.g. from one census date to another. Each of the four average radii can be expected to change in response to improvements in transport technology, locational shifts in employment, changes in housing and amenity preferences, and reconfigurations in the spatial pattern of consumption. Although the change in \( R_{BC} \) may be relatively slight (especially if strong land-use controls are in place), changes in the values of \( R_{CC} \), \( R_{EC} \) and \( R_{DC} \) are more volatile, usually (though not inevitably) in an upward direction. A major factor influencing the various radii involves changes in the level of employment within the BC. Apart from affecting the radius of the BC, such changes are likely to exert an influence on the other average radii. This will be less true, however, if employment in the BC remains static or decreases, as has been the case in major cities in Western European nations over the past four decades. In such cases it is the general factors mentioned above that will influence the positioning of the radii. Some would argue that changes in the spatial extent of various types of city over time do not constitute a problem, and merely reflect the nature of urban and regional change. Others would be concerned about difficulties of comparability in time-series data.
This brings us to the final point. It is generally the case that census authorities are charged *inter alia* with the responsibility of recording population, employment and other socio-economic data in terms of legal or administrative units, often in support of official research relating to planning and various facets of public policy. For some time now, however, census authorities have seen part of their function as assisting private (non-official) researchers, both academic and commercial. This factor, coupled with the developments in GIS and data processing, suggests that serious consideration might be given to alternative perspectives on the city, including those of the kind discussed above.

REFERENCES


City of Nottingham (2005b) "The Misrepresentation of Nottingham and the Need for a National Dataset on Urban Areas or Strategic Sub-Partnerships", Policy and Information Team.


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