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Methodological steps in the development of multivariate indexes for urban and regional policy analysis

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Abstract. Urban and regional policies are increasingly targeted by area. The common feature of this drive towards the targeting of public policy is the need for improved information on the candidate areas and better methodologies to aid the prioritisation process. The pressure for more and better information is also increased by recent academic and policy debates around the importance of identifying the distinctiveness of individual regions and localities in terms of their strengths and weaknesses. In this paper, four basic steps for a well-founded targeting analysis are identified. There is a need: to clarify the concept to be measured; to specify the key issues by which the concept is to be represented; to identify adequate statistical indicators covering those issues; and to create an overall index to summarise the information. In the penultimate section of the paper it is emphasised that there are numerous ways to produce a multivariate index and that the choice between them is not simple but will greatly affect the results obtained. Although it is stressed that different options will be more appropriate for different purposes, some 'best-practice' guidelines are identified.

1 Introduction

Successful urban and regional regeneration policies very much depend on a knowledge of the strengths and weaknesses of different areas. The economic trends of recent years have left persistent urban and regional disparities in prosperity, leading to the danger that differentials in development potential between areas are increasing rather than narrowing (see Lever, 1993). Academic debate over the causes of continuing uneven development has increasingly emphasised the local dimension and the distinctive mix of relative (dis)advantages possessed by each area. It is this mix which makes an area more or less likely to benefit from each distinct type of regeneration opportunity (Fielding and Halford, 1990). For policymakers, then, it is clearly important to assess 'best practice' in the methods for measuring the potential and problems of individual areas for policy targeting and resource allocation (Worrall, 1991).

Improved targeting may also contribute to coordination of the location of different agencies and local economic development programmes. If there is less confusion over which areas should be targeted, then it may be possible to simplify the current 'patchwork of programmes' (Audit Commission, 1989). At the same time, central government is closely scrutinising public programmes and monitoring the effectiveness of individual policy activities in the light of the need to restrain public expenditure. Government departments, local authorities, and quangos have to demonstrate that their spending can provide good value for money. The Commission of the European Communities (CEC, 1991) also has stressed the importance of periodic assessment of the value of European assistance throughout the period of implementation of the Community Support Framework. Spatial targeting and coordination of European aid has also become more important, with the move towards

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'integrated development operation programmes' which bring together numerous policy regimes within the same areas.

The main reasons why improved and reliable intelligence is needed by policymakers, then, is that statistical indicators can be used:

(a) to measure the needs or opportunities of each area (that is, as a basis for resource allocation);

(b) to set up the contextual 'baseline' of an area's conditions (and hence to help measure the additional improvement brought by public policy intervention and assistance); and

(c) to help distinguish just which opportunity or problem is most important for each area.

The use of socioeconomic indicators to inform policy decisions dates back to at least the mid-1960s in the United States and Britain (Horn, 1993; Taylor, 1981). Unfortunately, the initially rapid development of the 'social indicators movement' suffered a setback in the late 1970s, owing to criticism of the conceptual and methodological basis of the early studies (Carley, 1981, pages 19–20). More importantly, the indicators fell into disfavour with policymakers because they were not tailored to measure their policy concerns. Knox (1978) identifies the pitfalls in the design and construction of some indicators, including the difficulties encountered in the selection, availability, and reliability of data, the problem of spatial aggregation of statistics, and problems of interpretation.

In order to ameliorate the danger of a 'garbage in, garbage out' approach, it is important to derive indicators in a systematic manner rather than on an arbitrary basis. In this paper we illustrate one systematic approach for developing a multivariate index, drawing upon the example of an earlier study (Coombes et al, 1992) of ways to analyse cities' potential for urban regeneration. A four-step procedure, working from the general to the specific, is proposed here as the basis for a consistent development process to improve the quality of multivariate indexes.

Step 1. Conceptual consolidation: many of the key terms in policy discourses (such as 'regeneration' or 'disadvantage') are open to numerous interpretations, so it is essential to clarify the content of any such concept which is to be the subject of the analysis.

Step 2. Analytical structuring: once the overall subject has been clarified, the next step is to identify those elements of it which will make up the components of the multivariate index.

Step 3. Identification of indicators: the most familiar step in the procedure is the search for appropriate and robust statistical measures; the two preceding steps here will have defined what is 'appropriate' and 'necessary' for the index.

Step 4. Creation of an index: the final step is the one which combines the selected indicators into a multivariate index; there is an increasing awareness of the very many different techniques which can be used for this synthetic analysis.

The basic principles of each of these four steps are discussed in turn in the four following main sections of this paper.

2 Conceptual consolidation

The first, and probably the most important, step in the process of developing indicators is to clarify the basic concept which is to be represented by the analysis. This is especially important if the eventual index is to be widely accepted as policy-relevant information. In other words, the analysis will be seen to be most relevant if from the very beginning it has been shaped by the answers to basic questions, such as 'what is the purpose of the study?'; 'what is the connection with specific policy or

programme objectives?'; 'what policy instruments can use these findings?'; and 'what is the appropriate set of areas for this analysis?' These questions clarify the role of the analysis within the existing policy framework and can steer the study so that it is producing the information which decisionmakers consider to be most relevant. Specifying the most appropriate spatial units for the analysis, those which will be used for policy targeting, at this stage set the dimensions of all statistical work in the later stages of the analysis.

In this paper we are concerned with the development of multivariate indexes for policy purposes, so it could appear to be trite to stress repeatedly the need to involve policymakers in this process. Will they not inevitably be involved? In practice, their involvement can vary dramatically. On the one hand, there are plenty of policy-targeting indexes which have been entirely developed within a government department or policy agency. For example, the revised map of areas targeted for 'regional policy' assistance in Britain (DTI/SO/WO, 1993) is based on a multivariate index which was devised in-house, with only minor technical inputs from outsiders. On the other hand, an entirely nongovernment analysis such as the *Places Rated Almanac* in the United States (Boyer and Savageau, 1985) may attract so much attention that it begins to be drawn upon in targeting policy. Clearly, each of these extreme cases carries its own danger: the in-house analysis may not draw upon best practice in other related studies, whereas the second-hand research is likely to have been designed for a specific purpose which may make its results somewhat ill-suited for the policy context in which it is then applied. The most promising alternative seems to be for policymakers to devise a targeting analysis explicitly related to the issue of their concern, in collaboration with independent consultants familiar with current best practice in this research field. A successful collaboration would then lie in the repeated interaction between the consultants' awareness of alternative approaches (and their strengths and weaknesses) and the policymakers' concern to anchor the study to the issues at the centre of that policy.

With respect to the specific example of regeneration which is to be followed through in this paper, there *is* a clear need to clarify the issues to be analysed. The concept of regeneration has long been recognised as involving a suite of different issues. One effect of this realisation was that the Urban Programme, operated in England by the Department of the Environment (DoE), became extended from the physical and environmental development issues (within the core policy remit of the DoE) to embrace the wider context of the local economy and social regeneration.

Recognition of the interconnections of the different factors which shape an area's regeneration potential, however, can lead to an obscuring of the key issue to be targeted. For example, European Community (EC) policymakers have not been slow to appreciate the diversity of influential factors for areas' developmental prospects. Despite the daunting problems of statistical incompatibility and incompleteness of data sources in different countries, the CEC (1987) compiled several indicators in order to create a 'synthetic index' for its third state-of-the-regions report. Unfortunately, this index really only 'takes the temperature' of each region, it does not provide much in the way of diagnostics as to each region's potential. To accompany this analysis, then, the CEC has funded research on the key factors operating to fuel the uneven development which remains endemic within and between member countries. A recent example is provided by the Netherlands Economic Institute (NEI, 1992)[1] which focused on mobile investors in manufacturing.

[1] The NEI was commissioned by the CEC to identify the most important location factors for mobile manufacturing investors in Europe. The factors which the investors considered critical or important were then grouped under the six categories shown in figure 1.

As shown in figure 1, twenty-two location factors by which such investors select a country and region for their new investment were identified. The NEI created six groups of these factors, as represented by the left-hand side of figure 1.

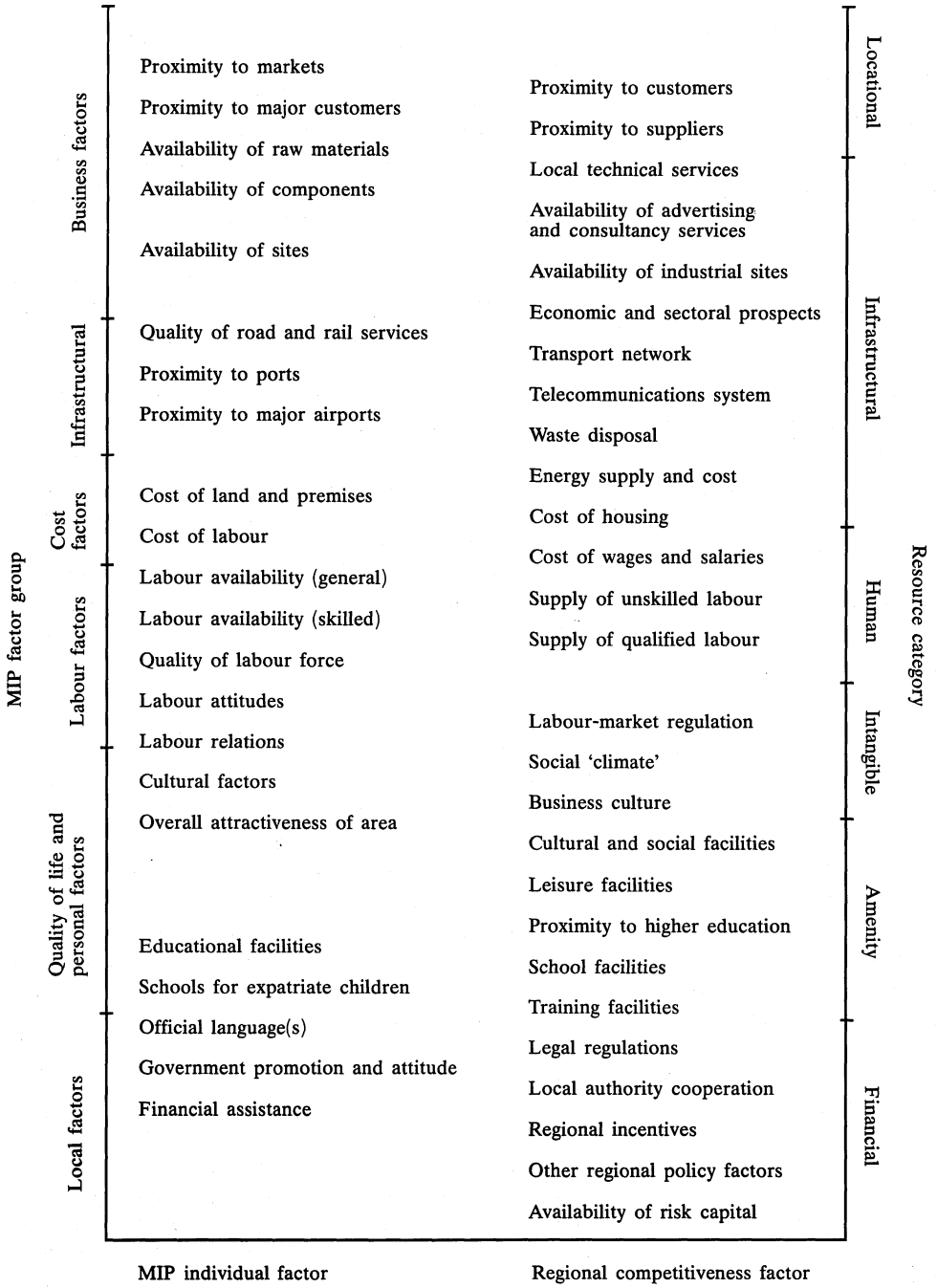

Figure 1. Factors of regional competitive advantage (excluding those which do not vary subnationally; for example, corporation tax levels): European perspectives [sources: mobile investors' perspective (MIP) individual factors and factor groups (NEI, 1992); regional competitiveness factors (IFO, 1990); resource categories (Coombes et al, 1992)].

An earlier study commissioned by the CEC asked several thousand enterprises of all types, stratified by the prosperity or otherwise of their home region, what factors improve a region's competitiveness (IFO, 1990).[2] The thirty-seven factors identified in that study are also shown in figure 1, placed as far as possible within the framework of the NEI approach. Generally, the difference is one of detail and completeness, but the IFO's longer list includes some factors which would be less important to a mobile investor, such as the local cost of credit. The six NEI groupings are thus not an entirely satisfactory typology in this context: for example, the factor 'training facilities' does not clearly belong to any of the six groupings. Six alternative categories which are more broadly based and which are derived from the notion of the types of 'resources' which an area may have are represented by the right-hand side of figure 1 (Coombes et al, 1992).[3] Many different features of an area, not only its training and other facilities, can be seen as forms of resources which contribute to the distinct potential of that area to benefit from certain regeneration opportunities. Thus the first category concerns locational resources, embracing factors such as the relative accessibility of an area to major markets. These six categories are put forward here as a more rounded approach to assessing an area's relative strengths and weaknesses. For some policy purposes a more focused analysis will be appropriate, but the six categories of resources can provide a framework to focus in upon.

In the case of some policies, clarification of the concept to be measured will be relatively straightforward. The example concept here, urban and regional regeneration, is more amorphous so the main issue becomes how far the basic issues of economic and physical development should be extended. This broad approach can be narrowed down if necessary by emphasising only those factors which may be directly influenced by that programme, operated at the subnational level, which is to be targeted by the multivariate index under development in this paper.

3 Analytical structuring

The second step in the index development process moves on from the conceptual discussion of step 1 to provide the structure within which the statistical indicators will be collated. Setting out the precise list of issues to be covered by the analysis provides the rationale for the selection of indicators in step 3, and so can prevent the creation of an ad hoc collection of indicators which are only loosely related to the issues which the policymaker needs to address. In particular, some aspects of these issues are likely to be more readily covered with statistical indicators than are others. For example, the official unemployment rate of an area is readily available, whereas the area's possible image as 'an unemployment blackspot'—which may differ greatly from its actual condition—will be much more difficult to identify. By creating a clear framework for the analysis, it will be possible later to monitor which elements in the comprehensive 'wish list' of issues to be measured are not readily represented by statistical indicators.

[2] The Institute for Economic Research (IFO) conducted a large-scale survey of 9000 companies on behalf of the CEC. In their report (IFO, 1990), they identify the most important positive or negative 'environmental' influences on the competitiveness of establishments (depending upon whether they are located in the lagging, declining, or advanced regions of the EC). These factors are listed in figure 1.

[3] The Centre for Urban and Regional Development Studies at the University of Newcastle-upon-Tyne was commissioned by the DoE to identify indicators for the assessment of the regeneration potential of inner-city areas. Forty-seven indicators were identified to represent aspects of the six regeneration resource categories (Coombes et al, 1992) shown in figure 1.

With regard to regeneration policy analysis, the earlier decision to adopt a broad perspective clearly widens the challenge of developing appropriate measures of each area's strengths and weaknesses. The analytical challenge is all the greater if it is accepted that an area's distinctiveness can *itself* be an advantage. In other words, the area may benefit simply from being unique in its features, not only from having many facilities. This idea is a final twist in the move away from a belief in a single recipe for success. In the days when policymakers suggested that there was a possible universal policy (for example, export-led growth, or a belief in sectoral diversification as a panacea for areas' problems), only one factor needed to be measured. If many factors may be important, then many need to be measured.

There are a number of possible approaches to identifying which are the relevant factors. The 'bottom-up' approach is to list the factors which can be argued to be important individually. In contrast, a 'top-down' approach starts from an a priori analysis of the concept concerned, breaking it down into a typology of factors which then provides a framework for the study. Combining both approaches can be advantageous, because the framework from the top-down a priori approach can be set against the bottom-up list of factors so as to identify any important gaps. An early attempt to recognise the range of relevant factors, in relation to urban and regional regeneration, was the analysis by CURDS (1979)[4] which explored how areas could "mobilise indigenous potential" (that is, maximise the values of their own strengths, whatever these might be). Later research has borne out this view by emphasising that some areas have grown through a high-technology emphasis, others have seen new small firms clustering there because of a distinctive set of circumstances, and yet other areas may have seemed superficially similar at the outset but have developed very differently because of the way in which a different combination of factors can interact (see Myers, 1988).

The earlier discussion about an area's potential for regeneration led to the identification of six broad categories of resources (figure 1). The next step to be

Table 1. Resource categorisation of regeneration factors associated mainly with economic or physical regeneration (source: Coombes et al, 1992).

Resource category	Factor		
	economic regeneration	any regeneration	physical regeneration
Locational	Telecommunications	Accessibility of location	Regional context
Financial	Local linkages Local control	Cost of investment Investment finance	Return on investment Consumer demand
Infrastructural	Industrial structure Research and development	Communications Space constraints	Housing market
Amenity	Educational facilities Welfare facilities	Health facilities Pollution and hazards	Environmental features Leisure facilities Climate
Intangible	Industrial relations	Institutional capacity Community cohesion	Place image Cost and quality of life
Human	Enterprise activity	Labour force	Demographics

[4] The Centre for Urban and Regional Development Studies at the University of Newcastle-upon-Tyne carried out a study on behalf of the Regional Policy Directorate of the EC into the mobilisation of indigenous regeneration potential in the standard regions of the United Kingdom. The study (CURDS, 1979) reviews the constraints acting upon industrial development, focusing on indigenous resources within the UK regions.

taken here towards a more specific framework of analysis involves identifying the key issues for any area's regeneration prospects. This bottom-up approach can draw upon a wide range of literature and policy analysis in Britain and other European countries (for example, Cheshire, 1987; IFO, 1990) as well as the developed debate in the United States on the evaluation of 'State business climates' (for example, Boyle, 1989) and their value in discriminating those areas which achieve better performance (Skoro, 1988).

Thus, in table 1 we identify twenty-nine factors which may be seen to shape an area's regeneration potential either positively or negatively. This check list of key issues is set against the top-down framework of the six resource categories. There seems to be no major mismatch between the outcomes of the two approaches, so the twenty-nine factors make up a plausible framework of policy-related issues on which areas need to be measured by statistical indicators in the next stage. It thus can also be an analytical structure for carrying out SWOT (strengths, weaknesses, opportunities, and threats) analyses of areas to identify their unique mix of potential for different types of regeneration. It is in step 3 of developing the indicators that the emphasis falls fully upon the policymakers' main concerns, and so less emphasis may be placed on more academic questions such as trying to resolve the chain of causation between different factors (Fielding and Halford, 1990).

4 Identification of indicators

Step 3 of index development involves the translation of the key factors into specific measurable indicators. The key factors identified in step 2 now provide a framework for which a wide range of possible indicators are sought. The starting point of drawing a wish list of indicators may well be an extensive review of related academic literature and current practice in that policy area. The policymakers' concerns will become crucial at this point. For example, a key factor in some analyses may be the training facilities for the area's work force. Depending upon the policy for which the analysis is designed, the wish list might include indicators focusing on the *number* of training places, or the *range* of courses, of the *quality* of training. The policy issues might stress provision within the area only, or might include other areas nearby; moreover, whether or not some parts of the area have poor access to this provision may be explicitly considered. The level of provision could be measured directly or be expressed in relation to the likely level of local demand. Last, the recent *trend* in levels of provision may be of most relevance to some policies, whereas other policies will solely be concerned with the current level of provision.

For most key issues, then, numerous alternative indicators can be identified as being potentially relevant (for example, as in Biehl, 1986). Once the data availability problems have been considered, some or many of the candidate indicators are likely to be eliminated. Even if a single perfect indicator could be envisaged which would alone adequately represent each issue, the available data more often lead to indicators which are proxy measures. This imperfect outcome encourages a pragmatic strategy in which a more broadly based set of measures is drawn upon, where each measure is an imperfect portrayal of some aspect of the factor to be represented. In other words, problems of data availability undermine any claim that all that needs to be known about a key factor can be adequately captured within a single indicator. If a number of alternative indicators can be collated, and there is no clear a priori basis for choosing between them, the more defensible approach is to compile all the plausible statistics and to deal with possible data redundancy at the next step of index development.

Recognition of the imperfection of the data available also means that indicator selection cannot be haphazard or random. Assessment of the value and practicability of each potential indicator can be structured by addressing five basic criteria: (1) data availability; (2) geographical specification; (3) time-series prospects; (4) implementability; and (5) interpretability.

4.1 Data availability

Data availability is perhaps the most fundamental problem restricting the eventual set of indicators. Moreover, a considerable proportion of the data relevant to urban and regional development which *is* available is *not* in the public sector. In earlier work it has been found that over half the indicators proposed to assess urban regeneration potential require nongovernment data sources (Coombes et al, 1992). The resource categories which are most affected are those relating to *financial* and *intangible* aspects, whereas *human* resource indicators tend to be based on government data (which perhaps reflects the focus of public data collection upon issues which are of direct social concern). However, many of the potential key government sources (for example, the New Earnings Survey) are from samples whose size is too small for very local analysis.

4.2 Geographical specification

Within the data series which are available, there may be incomplete coverage of the regions or areas with which the policy is concerned. For example, the Tyne and Wear Joint Information System provides an ideal database from which to create indicators related to land-use and property-related regeneration, because it stores information for each rating hereditament, coded to one of over 170 land-use categories (Spicer and Grigg, 1980). Unfortunately, this database can only serve as a pilot for innovative measures: new data sources would have to be collected elsewhere in order for these pilot analyses to be extended beyond Tyne and Wear to areas not covered by this database.

The spatial resolution (that is, the smallest areas for which the data can be made available) of the available data may not be sufficiently good to give adequate precision for some analyses. This may or may not result from the data source relying upon a sample which is too small for very local analysis (as mentioned in section 4.1). On the other hand, some input data available for small areas (such as postcode sectors) need aggregating to the output spatial units for which the data would have most analytical value [for example, the labour-market areas used for policy targeting by DTI/SO/WO (1993)]. In particular, the many indicators which can be derived from the Census of Population are usually available at a subdistrict level (for example, for wards), but most indicators relevant to regeneration would only be interpretable if analysed at a level which was focused on the wider processes which operate in the context of whole towns or local labour-market areas.

4.3 Time-series prospects

Ideally, the information sources identified for the indicators will be frequently updated, not only so that the indicators can be regularly revised but also so that dynamic analysis is possible. However, different information sources are updated with varying frequency, and this often affects indicators which draw upon data from more than one source. The official measures of unemployment rates within Britain are a good example, in that a monthly count is divided by a denominator which is updated less frequently.

One general problem of developing socioeconomic indicators is a tendency for overreliance on census information, which is updated only every ten years. This

problem is more obvious when small-area statistics are required, because there are few noncensus sources with such a fine level of detail in their data. This problem can arise when the analysis itself is *not* actually needed at the small-area level. Policy areas are often not the same as local authority areas, so they have to be recognised by grouping together the small areas. Although the 1991 Census will provide tremendous opportunities for indicator development, the cycle of data obsolescence will return in the medium term. The way forward is to diversify where possible the sources of data in order to give a more contemporaneous picture. For example, a census-based age profile can be updated by using annual population estimates for local authority areas (for example, Worrall, 1991). This approach has attendant dangers, however, because the different data sources may well be based on slightly different universes (or samples thereof) and so not be strictly comparable.

4.4 Implementability

The implementation of some indicators is relatively straightforward, though it may be tedious (for instance, perhaps requiring some kind of mathematical operation, which will be basic to spreadsheet packages). In some other cases, the indicator only becomes available after a lengthy process of collecting primary data, or complex compilation and processing of the original data. Some indicators also require software which is not in the public domain, or geographic information system (GIS) inputs which are not yet familiar in every policy agency or policymaker's office (Laurini and Thompson, 1991). If the analysis does have to be contracted out, this is likely to be a disincentive where the data can and should be frequently updated, because of the need for repeated external inputs (Skoro, 1988).

4.5 Interpretability

The question of interpretability is the single most important part of the evaluation of possible indicators, because the objective in developing the indicators is to provide measures which adequately reflect the key issues of concern. Owing to the difficulties of obtaining direct measures in many cases, there will often need to be recourse to proxy measures, which demand more vigorous validity checks to ensure their appropriateness. Of course, the distinction between proxy indicators and more direct measures is in practice often quite difficult to draw. The very word 'indicator' may suggest that the statistic is only pointing towards the real circumstances rather than directly representing those current conditions which are the exact subject of the policy concerned (Taylor, 1981).

Other problems of measurement reliability include all the standardised statistical data 'health warnings' which can affect the interpretability of indicators. Inspection of the statistical properties of a potential indicator, for example, might show that it varies so abruptly between adjacent areas (which are not thought to be very different) as to cast doubt on its reliability. One way in which the policymaker can participate closely in the procedure of appraising indicators is through examining the pilot results obtained for a few well-understood areas. If their response is that the results do not appear to be 'defensible' then the further development (or even abandonment) of that indicator will be necessary.

4.6 Evaluation framework

The implementation of the above five appraisal criteria should be carried out within a structured schema. In table 2 we give an example of an evaluation framework used to assess indicators of urban regeneration potential (Coombes et al, 1992). The example illustrates how the three indicators for the *location accessibility* factor, proposed in a previous study under the heading of *locational resources*, were evaluated.

Table 2. Evaluation of indicators of locational resources (source: Coombes et al, 1992).

Indicator	Availability		Geographical		Time series	Implementation	Interpretability	Application and opportunities
	source	form	coverage	output				
Rail access to main cities								
1	◇	0	◇	◇	☆	0	☆	X
Peripherality and accessibility								
2	◇	☆	☆	◇	?	0	☆	X
Change in access to markets after '1992'								
3	◇	◇	☆	◇	?	0	◇	S, X
Key:								
☆	All local data from GSS	All local data from on-line databases	UP areas all individually covered	available for wards and postcode sectors	Robustly updatable, at least annually	Easy application (for example, spreadsheets)	Known in the literature, Robust	C Consider collection of new data D Local data needed from other departments
◇	All non-GSS data are openly marketed	Easy manual data input is needed	Some UP areas are combined at source	Output is 'towns'—this fits the issue	Robustly updatable every 2–3 years	A manual input, so may take more time	Appears robust—consult or test	R Research on indicator value needed S Indicator sensitivity to be tested
0	Some data need to be negotiated	Extensive data collation is needed	Not all UP areas covered by data	Areas are too large for this issue	Issue is more dynamic than data set	Major GIS or CURDS software needed	The pilot results justify more work	T Talks with relevant experts needed
?	No source found for required data sets	Unknown until data source is found	Unknown until data source is found	Unknown until data source is found	Unknown until data source is found	Unknown until data source is found	Dubious—on basis of three areas'results	W Possible within GSS X External input needed

Note: CURDS Centre for Urban and Regional Development Studies; GIS geographical information system; GSS Government Statistical Service; UP urban programme.

Indicator (1) summarised the 'generalised cost' of train travel from each centre to all other main business centres in the country—a rather similar analysis to that which Bruinsma and Rietveld (1993) have recently used to compare the relative accessibility of major European cities. Indicator (2) was a more schematised assessment of 'population potential' [similar to the method used by Keeble et al (1982) for their European analysis of centrality-peripherality]. Indicator (3) was an attempt to assess the change in an area's accessibility which could arise from the opening of the Channel Tunnel and the resulting increase in the importance of links with Europe.

So how did these three indicators emerge from the five critera as they were applied in our earlier study (Coombes et al, 1992)? The first criterion, data availability, ruled out many other possible indicators (such as the areas' perceived inaccessibility, which may influence its prospects of attracting investment more than does its actual level of accessibility). From table 2 it can be seen that indicator (1) required intensive collection of data: interestingly, this has been eased recently by release of timetable information in machine-readable form. The second criterion was geographical specification. The timetable information is again the least flexible, because it steers the analysis towards producing an indicator with only one value for each main town or city. However, this level of precision is in fact the appropriate one for the analysis. The third criterion, the potential of the data as a time series, is the one on which indicator (1) scores strongly—though it is unlikely that frequent updating would show much change, or indeed that an analysis of change would provide real insights. This is a helpful conclusion, given that the fourth criterion shows that repeated updating could be costly because each indicator requires customised software. Last, the key issue of interpretability yields positive values for all the indicators, although indicator (3) did not perform very well in the pilot analysis and so is recommended as suitable for further refinement.

5 Creation of an index

The final stage in the development of an index is the process of synthesising the proposed indicators into a single measure which will be used for policy targeting. This process brings with it the challenge of selecting an appropriate weighting method to combine individual indicators into a single index according to their relative importance. One possible approach could be derived from the top down by focusing on the key factors from step 2. However, in the above discussion we have stressed that the selection of indicators is usually too constrained by data availability for them to be considered to represent perfectly the key factors which provide the overall framework for these indicators. These practical limitations may be considered effectively to rule out, for most applications, an approach in which a single indicator would be accepted as representing each key factor. In other words, it will rarely be possible to simply discuss the relative importance of each factor without also having to consider the reliability of the indicators which have been determined.

An appropriate response will usually be initially to undertake some statistical exploration of the database which has been compiled. For example, it may be found that two proxy variables, each of which has been selected as the best indicator available for a different issue, are statistically so similar that they duplicate each other. One, or both, of these indicators would thus seem to be a poor proxy for the issue it seeks to represent because it portrays the same patterns of values as the other indicator (which aims to cover a different issue, one which is thought to have a very different distribution of values). There are a range of well-established statistical tests which can be included in this strictly empirical exploration of the

data (Tufte, 1969). Data validation, along these lines, is altogether separate from the methods of analysis designed to turn the information in the data set into an index which will be appropriate for that specific policy purpose. We now turn to this crucial question of which weighting method to use in order to create a multivariate index.

5.1 Nonstatistical weighting methods

The first group of methods is characterised by an a priori assumption that the collated indicators should be combined in a way which is readily understood. The advantage of simplicity is visibility, in the sense that the decisions on weighting can be easily recognised and debated. However, a simple method may not be so defensible if the context is one which demands that best practice be followed. There is also a tendency for simple methods to be used when a 'general purpose' analysis is sought. The very idea of a general purpose index, claiming to be appropriate for a wide range of issues, can itself be argued to be counter to best practice (Coombes and Raybould, 1989).

5.1.1 *Null*

The default method may be thought of as not applying any weights to the selected measures. The so-called 'Booming Towns' analyses of Green and Champion (1991) provide examples of a preference for applying null weights to the selected indicators. The decision on how many measures of, say, unemployment are included among the indicators is, of course, in effect a 'higher order' form of weighting. The apparent benefit of simplicity from this approach is also clearly a disadvantage in that it assumes all indicators are of equal importance, regardless of the emphasises within the concept involved, the nature of the data available, or the objectives of the specific policy for which the ranking is needed.

5.1.2 *Expert*

A fairly familiar method is to obtain the assessment and opinions of experts (for example, policymakers, administrators, and professionals) in the specific field of application. The weighting scheme used by the Grant Thornton index to measure state business climate is an example of this approach: a poll is conducted every year to ask the state manufacturers' associations to determine what conditions their leadership considers are important to the success of their members' businesses (see Boyle, 1989). The 'underprivileged area' study by Jarman (1984) is a classic example in the literature on deprivation. The weighting scheme could be obtained directly by asking the experts' preferences, or by using an iterative technique such as the 'Dephi method' where the experts are asked to address a problem anonymously in two or more rounds until consensus is achieved (Sackman, 1974). The expert-opinion method has the advantage of integrating practical experience into the analysis. However, it is difficult to decide who are the experts and how to derive the precise weightings from their judgments. Of course, the results of this approach may also be open to criticism in that it may involve personal values, vested interests, or bias.

5.1.3 *Literature*

As an alternative to relying on policy experts, the weighting values can be abstracted from the literature by reference to a respected study in the academic or policy literature. For instance, one of the weighting schemes which combines different components into indexes in the *Development Report Card* (CED, 1991) could be used as a basis for a single index of economic regeneration. However, it is unlikely that there will be a preexisting study which covers exactly the same key

factors as have been identified for another particular policy. Moreover, these weightings would need to be expressed in a set of numerical values, with one such value for each of the indicators which have been generated.

5.1.4 *Public opinion*

A survey of the general public on the relative importance of the issues of concern may provide an objective set of weightings. For example, Rogerson et al (1989) explored the public's assessment of the factors which make up the quality of life available in any area. Once again, however, it is very unlikely that such weightings obtainable off the shelf from an earlier study can be matched onto the indicators generated by another study which has been undertaken for a different purpose. Also, because of the time and expense involved, it may not be a practical option to conduct a new opinion survey. The most ambitious attempt to use public opinion surveys to guide public policy was probably the Continuous National Survey in the United States during the early 1970s, which failed to gain the federal support needed to sustain the necessary constant updating and customisation (Rich, 1981).

5.2 Statistical methods

In response to the difficulties of finding a satisfactory a priori weighting system, an alternative way forward is to focus on a more empirical treatment of the indicators (Bartholomew, 1988). Various statistical techniques, including regression analysis, factor analysis, multicriteria analysis, and cluster analysis, can be used to produce a combined multivariate index from the selected indicators. In the remainder of this section we will discuss the strengths and weaknesses of these four statistical methods, alongside the *Z*-scores method, which can be seen as a basic 'default' method against which to compare these 'higher level' techniques.

5.2.1 *Z-scores*

The method for creating *Z*-scores starts with an examination of the statistical distributions of the raw data for each indicator: those which show a skewed distribution have to go through a normalisation procedure [namely, $y = \ln(x+1)$, where y and x are the transformed and untransformed variables, respectively]. Each variable is then transformed into a standard form so that it has a mean value equal to zero and a standard deviation equal to one. These standardised 'scores' on each indicator for each area are then either added or subtracted, depending upon the interpretation of positive values (for instance, it may be 'good' to have an above-average value on an indicator of employment change, and also be 'good' to have a below-average value on change in unemployment). This form of composite score has the advantage of being a simple and transparent method which can be easily understood and also of facilitating area targeting by ranking at a variety of different spatial levels.

However, these advantages are counterbalanced by three significant weaknesses. First, it is a method which, in many cases, oversimplifies the data by ignoring complex relationships between the issues which the indicators represent. In particular, the key problem of the null weighting method—assuming each indicator is equally important in its own right—is in effect reproduced here. Second, it is less likely to be accepted as appropriate for handling a large number of indicators unless some form of weighting is introduced (which would then reduce the *Z*-scores to a form of preliminary standardisation only). Third, there is no specific treatment of indicators which are highly intercorrelated, leading to the danger of 'double counting' (that is, indirect weighting). These disadvantages have, for example, led to much criticism of the use of *Z*-scores in producing a deprivation index to form the basis of deciding the allocating of extra funding to local authorities (see for example, Hayes, 1986).

5.2.2 *Regression analysis*

Multiple regression analysis provides a convenient summary of the 'importance' of various indicators (the independent variables) according to their strengths in explaining the variation of a single all-important measure (the dependent variable). For example, in another study the relative importance of numerous factors affecting local 'enterprise activity' levels in different parts of the country has been modelled (Coombes and Raybould, 1989). This model takes the form of a set of statistical weightings, one for each independent variable, and so can be used to produce an index value for each area (in effect, the 'expected' level of enterprise activity there, given the available data). Regression analysis can thus be used for description first, and then for prediction. If the descriptive model is found to be robust, and can be argued to apply more widely than to only the dataset analysed, then the model weightings can be interpreted as a summary of the local conditions which are relevant to that issue. For example, the Standard Spending Assessments of local authorities by the DoE (1993) feature regression analyses which relate authorities' level of spending to a range of local factors likely to influence those levels.

A valuable secondary benefit of the technique is that it helps to identify unreliable indicators by diagnosing their statistical characteristics (for example, if two indicators are highly intercorrelated then the model is likely to select only one and thus avoid 'double weighting' that dimension of the database). Ideally, the choice of variables used in the model should be based on some more-or-less widely accepted theories (for example, Biehl, 1986). However, in most cases they are based purely on the past experience of the analyst, who also makes operational decisions on the form of data used—raw or mathematically transformed.

The biggest problem of this method is finding a single valid dependent variable to represent the overall concept in a suitably rounded way. Clearly, if such a variable were available for all the relevant areas, a multivariate index would not need to be developed in the first place. However, there are some contexts where there is a plausible candidate indicator, but it is not available for the present period, or for all the areas which need to be represented, or at a sufficient spatial resolution (as was the case of the data on enterprises, as used by Coombes and Raybould, 1989). In these cases, the model can be built by using independent variables which *are* available for the present time and the necessary areas. The model can then predict the 'missing' values for the areas and period of interest. The problem then lies in the assumption that the relationships in the model are stable across time and/or space.

5.2.3 *Factor analysis*

Factor analysis identifies a relatively small number of factors—*super variables*—which can represent relationships among sets of many variables. All the raw data will be automatically standardised as Z-scores in the statistical procedures before the factors are extracted. The technique is an attempt to summarise as much as possible of the variance in the dataset with the minimum number of factors. An example in the policy field is the use by Duguid and Grant (1983) of factor analysis to combine several indicators into a single deprivation score to prioritise areas of special need in Scotland. Various different outputs can be obtained from this technique:

(a) a single-factor solution, where the nearest possible solution to an all-embracing factor which explains as much of the variance in the dataset as possible is identified;

(b) the first-factor solution, where the first factor, in terms of its explanatory power, is taken from a set of factors which have been selected because they collectively explain most of the variance in the dataset; and

(c) a multifactor solution, where more than one factor is chosen from the same set as is used in solution (b); these factors represent different dimensions of the dataset and can then be used in, for example, a multicriteria analysis.

Most of the strengths of factor analysis are common to all three alternatives. The factor(s) can help to clarify a general issue, syndrome, or latent variable, on the basis of the empirical links within a set of indicators. Further, the technique provides an automatic statistical weighting (or score) of each variable on each factor: these factor scores can then be obtained for each area so that the overall value on any chosen factor can be used for ranking the areas (for example, CES, 1988). The method also deals directly with intercorrelations within the dataset by prompting the analyst to examine the correlation matrix produced in the statistical procedures.

However, this need for the analyst to intervene shows that the application of factor analysis involves critical decisions, including the choice of which statistical options should be used in the statistical procedures. More importantly still, there is no simple rule as to which (of the) factor(s) should be used for the index and subsequent ranking. Although it is the most elegant, the single-factor solution is less likely to be suitable for the analysis if a large number of indicators are included in the dataset, because this form of analysis is most strongly interpretable where a high percentage of the variance in the whole dataset is accounted for by the single factor, and this is highly unlikely if there are many varied indicators to be analysed.

5.2.4 *Multicriteria analysis*

The results from a multiple factor analysis cannot yield a single ranking solution on their own. However they *can* provide the basis for a multicriteria analysis. The factor scores for the chosen factors for each spatial unit can be assessed to see which exceed a threshold value on a set number of qualified factors. Massam (1993) describes several versions of this method to illustrate the ways 'spatial coincidence' of several factors can contribute to policy-related analyses and decision support. This method builds upon the strengths of factor analysis, as factor loadings are obtained to provide weightings of the indicators. However, it is also possible to apply the multicriteria method directly to the indicators themselves (Voogd, 1983).

The key weakness of this method is that it involves several analytical procedures, each of which requires operational decisions that strongly influence the final results and so need to be carefully justified in any policy application. Hence the method is unlikely to find favour in many policy contexts because its procedure requires lengthy and complex explanation. The other disadvantage is that no simple ranking can be calculated for the areas for which the data have been collected. Targeting can be carried out by identifying those areas which qualify on a series of criteria, but this produces outputs in terms of a binary (yes–no) score only. It is, however, possible to rank an 'upper tier' set of areas on the basis of the proportion of these areas' population living within 'lower tier' areas which fall into the target category. For example, if the multicriteria analysis were applied to districts, then counties could be ranked on the proportion of their population living in districts which meet the target criteria.

5.2.5 *Cluster analysis*

Cluster analysis is a statistical technique for which the aim is to classify areas into relatively homogeneous groups (that is, to group together areas with similar characteristics). This method has been widely applied in the private sector to create area-classification schemes as a means of discriminating between variations in consumer behaviour [whereas the 'ACORN' system is used by academics in the Longitudinal Study (Creeser, 1991), and the 'super profiles' are also defined by

academics (Charlton et al, 1985)]. The clustering procedures will be more robust if they are based on variables which initially have been processed within a factor analysis. The characteristics of each cluster can be identified from the descriptive statistics of each variable (for example, the mean value of that variable for member areas of that cluster).

This method can provide a very parsimonious solution by identifying the target areas in just a few clusters, taking into account the different dimensions of the issues concerned within the classification process. A further advantage is that the weighting of the indicators is automatically done in the statistical procedures, yet it provides results which can be simply described. This apparent simplicity, hiding considerable statistical complexity, *could* be a notable disadvantage in policy contexts where a 'black-box' approach is to be strongly avoided.

Cluster analysis requires many detailed and debatable operational decisions throughout the whole statistical procedure, and these do influence the results obtained. It involves two multivariate techniques, so without considerable explanation and clarification, no more than a superficial understanding is obtained. Yet even after this complex analysis, the choice of which clusters should be considered to be the 'target' areas is judgemental. As with multicriteria analyses, no ranking of the input areas can be obtained, because the 'score' for each area is a binary one (that is, in or out of the 'target' clusters). Nevertheless, if some other data sources later give relevant information about the average conditions in each cluster, these may then provide the basis for ranking (as shown by Brown and CDMS Ltd, 1989).

5.3 Overview of index-creation methods

So far, then, varying methodological and practical problems have been encountered with all these alternative methods for combining regeneration indicators into a single measure. It is not often plausible to derive weightings from *experts* because they tend to focus on very specific and short-term policy concerns or programmes and so cannot provide weightings which represent other aspects of the policy context which the index needs to take into account. A more attractive option is to derive weightings from a widely respected study in the *literature*, but unfortunately there does not seem to be a consensus emerging around any past research conclusions which are embodied in a series of weightings. The same disadvantage applies to the *public opinion* weighting scheme, so that an opinion poll would have to be specially conducted and be tailored to the final agreed list of indicators. Last, among the nonstatistical approaches, null weighting is probably the most controversial because its very simplicity disguises (and so fails to justify) an implicit weighting of all the indicators as equally important.

However, some of the statistical options for obtaining weightings can be seen to be questionable on the grounds that they are either impractical or so arbitrary as to be potentially contentious. The null weighting implied by Z-scores is especially arbitrary, even if it initially apears to be a neutral approach. Regression analysis is faced with the need for additional information, and will often be confronted with a lack of data on a single all-important appropriate dependant variable. Multicriteria analysis requires operational decisions which are more explicitly imposed upon the analysis, though this imposition is self-evident and invites a discussion of the assumptions upon which it is based. The decision on how many, and which clusters are to be deemed 'target areas' can also be seen as contentious, although cluster systems are now widely used and the discussion over this decision can readily involve end users, because clusters are more easily recognised and understood than are the factors which need to be examined in the multicriteria analysis. In the recent

methodological reviews by Bartholomew (1988) and Bell (1990) factor analysis emerged as the most robust approach for combining indicators. However, the ideal approach, from a purely empirical viewpoint, would be to carry out a preliminary validation analysis of the assembled database to identify the differences in the outcome produced by different approaches.

The recommendations on which is the preferable method for producing a combined index have to reflect the balance between simplicity, statistical robustness, and flexibility (for instance, the ability to rank the output areas at different spatial scales). In other words, different recommendations will be made for different applications. Consequently, the overview here has to be confined to summarising the methods' strengths and weaknesses which can be achieved by identifying a list of relevant criteria against which the methods can be compared (see Voogd, 1983, pages 13–15). In the discussion in this paper we have stressed those issues of most relevance to policymakers, so these form the criteria which are presented in table 3. Some patterns can be seen in the distribution of strengths (yes's) or weaknesses (no's) across the methods which have been discussed. For example, table 3 shows that as more indicators are added to the database it is more likely that a statistical method will be needed to provide an overall index. The principal message of table 3, however, is that the index method needs to be selected after consultation between policymaker and researcher.

Table 3. An assessment of alternative methods for creating an index.

Selection of criteria which are relevant to policy application	Nonstatistical weightings				Statistical multivariate analyses				
	null	expert	litera-ture	public	regres-sion	*Z*-score	one factor	multi-criteria	cluster
Unambiguous advantages									
simple to explain	Yes	Yes	Yes	Yes	No	–	No	No	–
arguably 'best practice'	No	–	–	No	Yes	–	Yes	–	No
able to highlight dubious input data	No	No	No	No	Yes	No	Yes	–	–
avoids explicit subjectivity	–	No	No	–	–	Yes	Yes	–	No
Probable advantages									
adjustable to match policy shifts	–	Yes	–	No	No	–	–	–	–
not dependent on data structure	Yes	Yes	Yes	Yes	No	Yes	No	–	–
not dependent on additional information	Yes	–	–	No	No	Yes	Yes	Yes	Yes
able to rank the input areas	Yes	Yes	Yes	Yes	Yes	Yes	Yes	–	No
Likely applicability									
for data sets with few indicators	Yes	Yes	Yes	Yes	Yes	Yes	–	–	–
for data sets with many indicators	No	No	No	–	–	–	Yes	Yes	Yes

Yes a strength of the method; No a weakness; – neither a strength nor a weakness.

6 Conclusions

In this paper we aimed to raise a number of methodological issues involved in the development of multivariate indexes for social and economic policy applications. A four-step procedure has been outlined to provide a consistent and coherent

framework to guide the development of targeting and ranking analyses, and to avoid the danger of creating a haphazard collection of indicators (which can occur even when each one, taken in isolation, may be considered to be acceptable). However, the claim here is not that the many problems encountered when one develops indicators have been resolved. The first conclusion, in fact, is that there is rarely a simple right or wrong approach, but that more appropriate solutions can be found if the concept to be measured, and the nature of the database which has been collected, are always borne in mind.

The basic nature of socioeconomic indicators is that they are not value free; value judgments are involved at all stages (see Nijkamp, 1979), as well as in the explicitly numerical values which can make up a form of weighting to produce a combined index. Second, socioeconomic indicators tend to be measurable surrogates or proxies for some unmeasurable concepts or latent variables, such as regeneration potential and enterprise culture. The analysis will, nonetheless, be improved if there is a well-established theoretical understanding to underpin the rationale of the choice of variables to make up the eventual database.

The 'best practice' for the key decision on the method for producing a multivariate index is rooted in the need for an initial exploration of the database of indicators which have been collated. Some indicators may need to be dropped because of unforeseen intercorrelation of measures which were intended to be proxies of very different factors. However, the choice of index method is *certain* to influence the results obtained—and probably will do so even more than the eventual selection of indicators. The ideal approach *might* be an all-embracing single-factor analysis, but some databases will not support this level of simplification (Bell, 1990). In general, the fact that different methods have different strengths and weaknesses shows that there is a need to identify which of the issues raised in table 4 are crucial for each specific application.

Last, some pointers have been thrown up as to the scope for further research to improve the quality of socioeconomic indicators and multivariate indexes. First, theoretical development is urgently needed to examine the causal relationships of different factors in urban and regional development: these relationships could then serve as the foundation for the development of indicators of relevance to urban and regional policymakers (see Fielding and Halford, 1990). For instance, it may be possible to strengthen the understanding of the elements which contribute to a positive 'enterprise culture' in an area—or indeed to demonstrate that this is a vacuous notion which therefore does not justify attempts to measure it.

Second, it is important to urge better practice in the compilation of public data because indicator research always faces the setback of poor availability of data, inadequate updatability, poor spatial aggregation, and patchy spatial coverage. Equally, researchers have to explore data sources which are not in the public domain (for example, Brown and CDMS Ltd, 1989); such sources will become more and more important with the commercialisation of information and the reluctance of central government to compile data for which it does not have an immediate policy need.

Finally, more sophisticated analyses are needed of the data which *are* available. The growing use of GIS techniques will help to familiarise more data users with analyses such as accessibility surfaces (Laurini and Thompson, 1991). Only when policymakers and the public come to accept quite complex analyses, which are strictly driven by policy concerns, will it be possible to get the most value out of the limited available data (Massam, 1993). The challenge for reseachers is to demonstrate the relevance of their techniques and to increase the interest in the skills

which they offer. The incentive for policymakers is to reduce the misallocation of public money which flows from the inadequate methods which are currently used for targeting urban and regional policies.

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