aggregate saving data. (See Deaton and Paxson (1997) for an example.) Until these approaches are reconciled, a firm consensus about the magnitude of demographic effects is unlikely to emerge.

4. Unresolved Issues

There are a number of important issues that have not been resolved and require additional work. First, the saving literature does not yet adequately incorporate the impact of changing institutional arrangements. Studies of saving in the industrialized countries and recent work on developing countries considers the impact of state-sponsored pension programs on saving, but the impact of family support systems has received far too little emphasis. The erosion of the extended family in developing countries is surely one of the factors that has contributed to the rise of saving rates observed in many developing countries.

Second, the role of mortality has received inadequate attention. The importance of lifecycle saving depends on the expected duration of retirement. In high mortality societies, few reach old age and many who do continue to work. Only late in the mortality transition, when there are substantial gains in the years lived late in life, does an important pension motive emerge.

Third, the saving models currently in use are static models and do not capture important dynamics. Recent simulation work that combines realistic demographics with lifecycle saving behavior shows that during the demographic transition countries may experience saving rates that substantially exceed equilibrium values for sustained periods of time (Lee 2000).

Bibliography

Barro R J 1974 Are government bonds net wealth? *Journal of Political Economy* 6 (December): 1095–117

Coale C A, Hoover E M 1958 *Population Growth and Economic Development in Low-income Countries: A Case Study of India's Prospects*. Princeton University Press, Princeton, NJ

Deaton A1989 Saving in developing countries: Theory and review. *Proceedings of the World Bank Annual Conference on Development Economics*, Supplement to the World Bank Economic Review and the World Bank Research Observer, pp. 61–96

Deaton A, Paxson C 1997 The effects of economic and population growth on national saving and inequality. *Demography* 34(1): 97–114

Higgins M, Williamson J G 1997 Age structure dynamics in Asia and dependence on foreign capital. *Population and Development Review* 23(2): 261–94

Kelley A C, Schmidt R M 1996 Saving, dependency and development. *Journal of Population Economics* 9(4): 365–86

Kotlikoff L J 1988 Intergenerational transfers and savings. *Journal of Economic Perspectives* 2(2): 41–58

Lee R D 2000 Intergenerational transfers and the economic life cycle: A cross-cultural perspective. In: Mason A, Tapinos G (eds.) *Sharing the Wealth: Demographic Change and Economic Transfers Between Generations*. Oxford University Press, Oxford, UK

Lee R D, Mason A, Miller T 2000 Life cycle saving and the demographic transition: The case of Taiwan. In: Chu C Y, Lee R D (eds.) *Population and Economic Change in East Asia, Population and Development Review*. 26: 194–219

Mason A 1987 National saving rates and population growth: A new model and new evidence. In: Johnson D G, Lee R D (eds.) *Population Growth and Economic Development: Issues and Evidence*. University of Wisconsin Press, Madison, WI, pp. 5230–60

Modigliani F 1988 The role of intergenerational transfers and life cycle saving in the accumulation of wealth. *Journal of Economic Perspectives* 2(2): 15–40

Modigliani F, Brumberg R 1954 Utility analysis and the consumption function: An interpretation of cross-section data. In: Kurihara K (ed.) *Post-Keynesian Economics*. Rutgers University Press, New Brunswick, NJ

A. Mason

Scale in Geography

Scale is about size, either relative or absolute, and involves a fundamental set of issues in geography. Scale primarily concerns space in geography, and this article will focus on spatial scale. However, the domains of temporal and thematic scale are also important to geographers. Temporal scale deals with the size of time units, thematic scale with the grouping of entities or attributes such as people or weather variables. Whether spatial, temporal, or thematic, scale in fact has several meanings in geography.

1. Three Meanings of Scale

The concept of scale can be confusing, insofar as it has multiple referents. Cartographic scale refers to the depicted size of a feature on a map relative to its actual size in the world. Analysis scale refers to the size of the unit at which some problem is analyzed, such as at the county or state level. Phenomenon scale refers to the size at which human or physical earth structures or processes exist, regardless of how they are studied or represented. Although the three referents of scale frequently are treated independently, they are in fact interrelated in important ways that are relevant to all geographers, and the focus of research for some. For example, choices concerning the scale at which a map

(2001). In N. J. Smelser & P. B. Baltes (Eds.), International Encyclopedia of the Social & Behavioral Sciences (pp. 13501-13504). Oxford: Pergamon Press.

should be made depend in part on the scale at which measurements of earth features are made and the scale at which a phenomenon of interest actually exists.

1.1 Cartographic Scale

Maps are smaller than the part of the earth's surface they depict. Cartographic scale expresses this relationship, traditionally in one of three ways. A verbal scale statement expresses the amount of distance on the map that represents a particular distance on the earth's surface in words, e.g., 'one inch equals a mile.' The representative fraction (RF) expresses scale as a numerical ratio of map distance to earth distance, e.g., '1:63,360.' The RF has the advantage of being a unitless measure. Finally, a graphic scale bar uses a line of particular length drawn on the map and annotated to show how much earth distance it represents. A graphic scale bar has the advantage that it changes size appropriately when the map is enlarged or reduced. Alternatively, all three expressions of scale may refer to areal measurements rather than linear measurements, e.g., a 1-inch square may represent 1 square mile on the earth.

Given a map of fixed size, as the size of the represented earth surface gets larger, the RF gets smaller (i.e., the denominator of the RF becomes a larger number). Hence, a 'large-scale map' shows a relatively small area of the earth, such as a county or city, and a 'small-scale map' shows a relatively large area, such as a continent or a hemisphere of the earth. This cartographic scale terminology is frequently felt to be counterintuitive when applied to analysis or phenomenon scale, where small-scale and large-scale usually refer to small and large entities, respectively.

An important complexity about cartographic scale is that flat maps invariably distort spatial relations on the earth's surface: distance, direction, shape, and/or area. How they distort these relations is part of the topic of map projections. In many projections, especially small-scale maps that show large parts of the earth, this distortion is extreme so that linear or areal scale on one part of the map is very different than on other parts. Even so-called equal area projections maintain equivalent areal scale only for particular global features, and not for all features at all places on the map. Variable scale is sometimes shown on a map by the use of a special symbol or multiple symbols at different locations.

1.2 Analysis Scale

Analysis scale includes the size of the units in which phenomena are measured and the size of the units into which measurements are aggregated for data analysis and mapping. It is essentially the scale of understanding of geographic phenomena. Terms such as 'resolution' or 'granularity' are often used as synonyms for the scale of analysis, particularly when geographers work with digital representations of the earth's surface in a computer by means of a regular grid of small cells in a satellite image (rasters) or on a computer screen (pixels). Analysis scale here refers to the area of earth surface represented by a single cell.

It has long been recognized that in order to observe and study a phenomenon most accurately, the scale of analysis must match the actual scale of the phenomenon. This is true for all three domains of scale—spatial, temporal, and thematic. Identifying the correct scale of phenomena is, thus, a central problem for geographers. Particularly when talking about thematic scale, using data at one scale to make inferences about phenomena at other scales is known as the cross-level fallacy (the narrower case of using aggregated data to make inferences about disaggregated data is well-known as the ecological fallacy).

Geographers often analyze phenomena at what might be called 'available scale,' the units that are present in available data. Many problems of analysis scale arise from this practice, but it is unavoidable given the difficulty and expense involved in collecting many types of data over large parts of the earth's surface. Geographers have little choice in some cases but to analyze phenomena with secondary data, data collected by others not specifically for the purposes of a particular analysis. For example, census bureaus in many countries provide a wealth of data on many social, demographic, and economic characteristics of their populace. Frequently, the phenomenon of interest does not operate according to the boundaries of existing administrative or political units in the data, which after all were not created to serve the needs of geographic analysis. The resolution of image scanners on remote-sensing satellites provides another important example. Landsat imagery is derived from thematic mapper sensors, producing earth measurements at a resolution of about 30 by 30 meters. However, many phenomena occur at finer resolutions than these data can provide.

Most useful is theory about the scale of a phenomenon's existence. Frequently lacking this, but realizing that the available scale may not be suitable, geographers use empirical 'trial-and-error' approaches to try to identify the appropriate scale at which a phenomenon should be analyzed. Given spatial units of a particular size, one can readily aggregate or combine them into larger units; it is not possible without additional information or theory to disaggregate them into smaller units. Even given observations measured at very small units, however, there is still the problem of deciding in what way the units should be aggregated. This is known as the modifiable areal unit problem (MAUP, or MTUP in the case of temporal scale). Various techniques have been developed to study the implications of MAUP (Openshaw 1983).

1.3 Phenomenon Scale

Phenomenon scale refers to the size at which geographic structures exist and over which geographic processes operate in the world. It is the 'true' scale of geographic phenomena. Determining the scale of phenomena is clearly a major research goal in geography. It is a common geographic dictum that scale matters. Numerous concepts in geography reflect the idea that phenomena are scale-dependent or are defined in part by their scale. Vegetation stands are smaller than vegetation regions, and linguistic dialects are distributed over smaller areas than languages. The possibility that some geographic phenomena are scale independent is important, however. Patterns seen at one scale may often be observed at other scales; whether this is a matter of analogy or of the same processes operating at multiple scales is theoretically important. The mathematics of fractals has been applied in geography as a way of understanding and formalizing phenomena such as coastlines that are self-similar at different scales (Lam and Quattrochi 1992).

The belief has often been expressed that the discipline of geography, as the study of the earth as the home of humanity, can be defined partially by its focus on phenomena at certain scales, such as cities or continents, and not other scales. The range of scales of interest to geographers are often summarized by the use of terminological continua such as 'local-global' or 'micro-, meso-, macroscale.' The view that geographers must restrict their focus to particular ranges of scales is not shared universally, however, and advances have and will continue to occur when geographers stretch the boundaries of their subject matter. Nonetheless, few would argue that subatomic or interplanetary scales are properly of concern for geography.

It is widely recognized that various scales of geographic phenomena interact, or that phenomena at one scale emerge from smaller or larger scale phenomena. This is captured by the notion of a 'hierarchy of scales,' in which smaller phenomena are nested within larger phenomena. Local economies are nested within regional economies, rivers are nested within larger hydrologic systems. Conceptualizing and modeling such scale hierarchies can be quite difficult, and the traditional practice within geography of focusing on a single scale largely continues.

2. Generalization

The world can never be studied, modeled, or represented in all of its full detail and complexity. Scale is important in part because of its consequences for the degree to which geographic information is generalized. Generalization refers to the amount of detail included in information; it is essentially an issue of simplification, but also includes aspects of selection and enhancement of features of particular interest. As one studies or represents smaller pieces of the earth, one tends strongly to deal with more detailed or more fine-grained aspects of geographic features. For example, large-scale maps almost always show features on the earth's surface in greater detail than do small-scale maps; rivers appear to meander more when they are shown on large-scale maps, for instance. Studied most extensively by cartographers, generalization is in fact relevant to all three meanings of scale, and to all three domains of spatial, temporal, and thematic scale.

3. Conclusion

Issues of scale have always been central to geographic theory and research. Advances in the understanding of scale and the ability to investigate scale-related problems will continue, particularly with the increasingly common representation of geographic phenomena through the medium of digital geographic information (Goodchild and Proctor 1997). Cartographic scale is becoming 'visualization' scale. How is scale, spatial and temporal, communicated in dynamic, multidimensional, and multimodal representations, including visualization in virtual environments? Progress continues on the problem of automated generalization, programming intelligent machines to make generalization changes in geographic data as scale changes. The ability to perform multiscale and hierarchical analysis will be developed further. More profound than these advances, however, the widespread emergence of the 'digital world' will foster new conceptions of scale in geography.

Bibliography

Buttenfield B P, McMaster R B (eds.) 1991 *Map Generalization: Making Rules for Knowledge Representation*. Wiley, New York

Goodchild M F, Proctor J 1997 Scale in a digital geographic world. *Geographical and Environmental Modeling* 1: 5–23

Hudson J C 1992 Scale in space and time. In: Abler R F, Marcus M G, Olson J M (eds.) *Geography's Inner Worlds: Pervasive Themes in Contemporary American Geography*. Rutgers University Press, New Brunswick, NJ

Lam N S-N, Quattrochi D A 1992 On the issues of scale, resolution, and fractal analysis in the mapping sciences. *The Professional Geographer* 44: 88–98

MacEachren A M 1995 *How Maps Work: Representation, Visualization, and Design*. Guilford Press, New York

Meyer W B, Gregory D, Turner B L, McDowell P F 1992 The local-global continuum. In: Abler R F, Marcus M G, Olson J M (eds.) *Geography's Inner Worlds: Pervasive Themes in Contemporary American Geography*. Rutgers University Press, New Brunswick, NJ

Muehrcke P C, Muehrcke J O 1992 *Map Use: Reading, Analysis, Interpretation*, 3rd edn. JP Publications, Madison, WI
Openshaw S 1983 *The Modifiable Areal Unit Problem*. Geo Books, Norfolk, UK

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Scaling and Classification in Social Measurement

Social measurements translate observed characteristics of individuals, events, relationships, organizations, societies, etc. into symbolic classifications that enable reasoning of a verbal, logical, or mathematical nature. Qualitative research and censuses together define one realm of measurement, concerned with assignment of entities to classification categories embedded within taxonomies and typologies. Another topic in measurement involves scaling discrete items of information such as answers to questions so as to produce quantitative measurements for mathematical analyses. A third issue is the linkage between social measurements and social theories.

1. Classifications

Classification assimilates perceived phenomena into symbolically labeled categories. Anthropological studies of folk classification systems (D'Andrade 1995) have advanced understanding of scientific classification systems, though scientific usages involve criteria that folk systems may not meet entirely.

Two areas of social science employ classification systems centrally. Qualitative analyses such as ethnographies, histories, case studies, etc. offer classifications—sometimes newly invented—for translating experiences in unfamiliar cultures or minds into familiar terms. Censuses of individuals, of occurrences, or of aggregate social units apply classifications—usually traditional—in order to count entities and their variations. Both types of work depend on theoretical constructions that link classification categories.

1.1 Taxonomies

Every classification category is located within a taxonomy. Some more general categorization, Y, determines which entities are in the domain for the focal categorization, X; so an X always must be a kind of Y. 'X is a kind of Y' is the linguistic frame for specifying taxonomies. Concepts constituting a taxonomy form a logic tree, with subordinate elements implying superordinate items.

Taxonomic enclosure of a classification category is a social construction that may have both theoretical and practical consequences. For example, if only violent crimes are subject to classification as homicides, then 'homicide' is a kind of 'violent crime,' and deaths caused by executive directives to release deadly pollution could not be homicides.

1.2 Typologies

A typology differentiates entities at a particular level of a taxonomy in terms of one or more of their properties. The differentiating property (sometimes called a feature or attribute) essentially acts as a modifier of entities at that taxonomic level. For example, in the USA kinship system siblings are distinguished in terms of whether they are male or female; in Japan by comparison, siblings are schematized in terms of whether they are older as well as whether they are male or female.

A scientific typology differentiates entities into types that are exclusive and exhaustive: every entity at the relevant taxonomic level is of one defined type only, and every entity is of some defined type. A division into two types is a dichotomy, into three types a trichotomy, and into more than three types a polytomy.

Polytomous typologies are often constructed by crossing multiple properties, forming a table in which each cell is a theoretical type. (The crossed properties might be referred to as variables, dimensions, or factors in the typology.) For example, members of a multiplex society have been characterized according to whether they do or do not accept the society's goals on the one hand, and whether they do or do not accept the society's means of achieving goals on the other hand; then crossing acceptance of goals and means produces a fourfold table defining conformists and three types of deviants.

Etic–emic analysis involves defining a typology with properties of scientific interest (the etic system) and then discovering ethnographically which types and combinations of types are recognized in folk meanings (the emic system). Latent structure analysis statistically processes observed properties of a sample of entities in order to confirm the existence of hypothesized types and to define the types operationally.

1.3 Aggregate Entities

Aggregate social entities such as organizations, communities, and cultures may be studied as unique cases, where measurements identify and order internal characteristics of the entity rather than relate one aggregate entity to another.

A seeming enigma in social measurement is how aggregate social entities can be described satisfactorily on the basis of the reports of relatively few informants, even though statistical theory calls for substantial samples of respondents to survey populations. The

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