Success and Future of Demography

The Role of Data and Methods

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ABSTRACT: Demography typifies paradigmatic success; that is, cumulative scientific work that has provided useful perspectives on a set of important questions. This success can be traced partly to the core subject matter of demography, which is relatively conducive to quantitative, observational science. The development of demography was further aided by extrinsic factors, such as the import of its data for government administration, for business purposes, and the import of demographic questions for social problems and public policy. These observations make suspect any simple projection of demography's success into the future or the transport of its experience to other disciplines.

KEYWORDS: demography; demographic data; demographic methodology

INTRODUCTION

Demography embodies the definition of a science—*science* defined in a Kuhnian sense as a research community identified by an agreed upon set of questions, agreed upon standards for research, and a cumulative body of research findings.[1] Furthermore, demography has high repute, as measured by the demand for its expertise in academia and beyond. Its status does not appear to be faddish; its repute rests on *real* accomplishments—results and explanations that have been broadly useful. We claim that the success of demography as a science rests on inherent aspects of its data and methods and fortuitous features of its social context. In this paper, we (1) document the success of demography as a cumulative scientific enterprise, (2) argue that demographic data and methods have contributed to demography's success, and (3) discuss how some of the factors contributing to the past successes of demography may weaken as demography moves further away from its core of assessing population composition and dynamics.

Initially, a few notes are in order concerning our scope and intent. First, when we refer to demography we, following Preston,[2] have in mind the technical aspects of demography (formal demography), collection and evaluation of demographic data, research (within any discipline) on the causes and consequences of demographic

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change (i.e., population studies) and descriptive studies of "compositional" variables, such as living arrangements, marital status, and race/ethnicity (i.e., social demography). Our comments on the development of the core of demography refer mainly to the first three components and less to social demography. Second, we do not intend a full inventory of demographic methods; accessible volumes on these topics are available.[c] Instead we speculate on the role of data and methods in demography's past and future development.

BENCHMARKS FOR EVALUATING DEMOGRAPHY AS SCIENCE

Science is a socially constructed way of "knowing." Its attractiveness is not its absolute accuracy, correctness, or usefulness, but its superiority to other ways of knowing. A science is assessed by the usefulness of the given enterprise (i.e., a paradigm). The history of demography is consistent with the Kuhnian observation that science is not only influenced by intrinsic factors associated with its own developments but it is also buffeted by extrinsic factors—social context, politics, and research support.[5,6] Despite its imperfection and the acknowledged import of extrinsic factors, what appeals to many demographers is the internal logic of science (based on systematic observation) that makes possible the falsification of claims and perspectives, or at least their rejection in favor of more accurate or useful claims. Kuhn conceived of most science (i.e., normal science) as the elaboration of a conceptual perspective or theory in conjunction with an accepted methodology. From this perspective, progress can be made only by institutionalizing research so that it may be cumulative. This is the key feature of science: a joint enterprise organized around accepted procedures for research and agreement on key research questions.

Given this definition, it has become common to assess bodies of research in order to see if they appear to be cumulative. The citation of published research by subsequent research is evidence of a network of communication consistent with a cumulative scientific enterprise. A series of articles in *Science* has focused on this aspect of a research literature.[7,8] The measure most frequently adopted is "uncitedness" (or its opposite: citedness) within, for instance, a five-year window from publication. In FIGURE 1 we show the proportion of articles cited within certain sciences. The data for demography are from a recent *Population and Development Review* article by Van Dalen and Henkins;[9] other data are from Hamilton's (1991) article in *Science.*[10] These data suggest that published demographic work is very likely to be subsequently cited: 64% of articles published in demographic journals are cited within five years. This percentage is impressive when compared to other sciences. FIGURE 1 shows that only one of four articles in the social sciences in general are cited within five years, suggesting a much less connected and interacting group of researchers than characterizes demography and some physical sciences. Some have cleverly referred to the desire of the social sciences to emulate the physical sciences as social science "physics envy." However, it would seem, that unlike other social sciences,

[c]The classic compendium of demographic data, tools and techniques is Shryock and Siegel's *The Methods and Materials of Demography.*[3] The book most likely used for a current two-semester course in demography is the new book by Preston, Heuveline, and Guillot, *Demography: Measuring and Modeling Population Processes.*[4]

any demographic *physics envy* rests in perception and not in performance! Demographic research is as likely to be subsequently cited as is published work in physics.

FIGURE 2 provides a closer look at social sciences and humanities. Note that sociology, anthropology, and political science (often considered more theoretical than demography) have unimpressive levels of citedness. (Inclusion of comparable data for economics would be interesting, but comparable data for economics were not found.) Indeed, only social psychology compares with demography in its level of citedness.

The arts/humanities represent the extreme in uncitedness with only 2% of published articles cited within the five years subsequent to publication. High levels of uncitedness (especially those characteristic of the arts and humanities) suggest an enterprise that may be amusing and self-absorbing, but not one conducive to the evolutionary fitness of specific ideas or paradigms. However, those concerned about our use of citedness as a measure of the cumulative nature of demography might argue that demographers are engaged in acts no more productive than those we attribute to the uncited. Demographers could be engaged in an exchange of frivolous citations. We now turn to evidence counter to such claims.

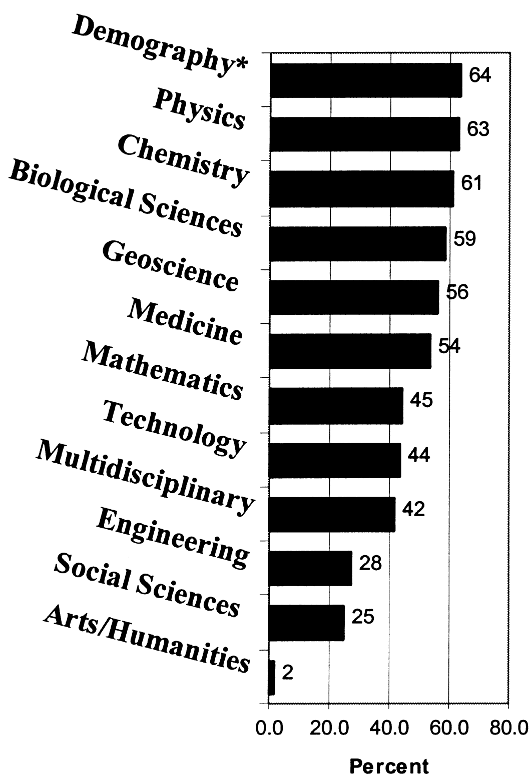

FIGURE 1. Percentage of articles cited within five years of publication.

Van Dalen and Henkins[7] show a pattern of citations for work published in demographic journals that suggests substantial intellectual health. Specifically, demographic work is widely cited outside demographic journals. Particular demographic journals are conduits to other disciplines and sciences. For instance, *Population and Development Review* is frequently cited in *Social Science and Medicine*, the *Annual Review of Sociology*, and *Economic and Political Weekly. Demography* is frequently cited in the *Journal of Marriage and the Family, Social Forces,* and the *American Sociological Review* (see Van Dalen and Henkins 1999: Table 6).

More important than the pattern of citations and what they might suggest, signal measures of scientific impact are the importance of the questions addressed and the usefulness of answers provided. On these fundamental dimensions, the performance of demography is impressive. The key question of the past half century was: *Would rapid population growth cease?* Demography monitored population growth and the impact of population momentum; it examined theories of fertility and mortality decline. Demographers have reached broad agreement concerning the causes of fertility and mortality decline[3]—perhaps the most profound changes of the twentieth century in terms of their impact on individuals' lives. Some would dispute this claim,

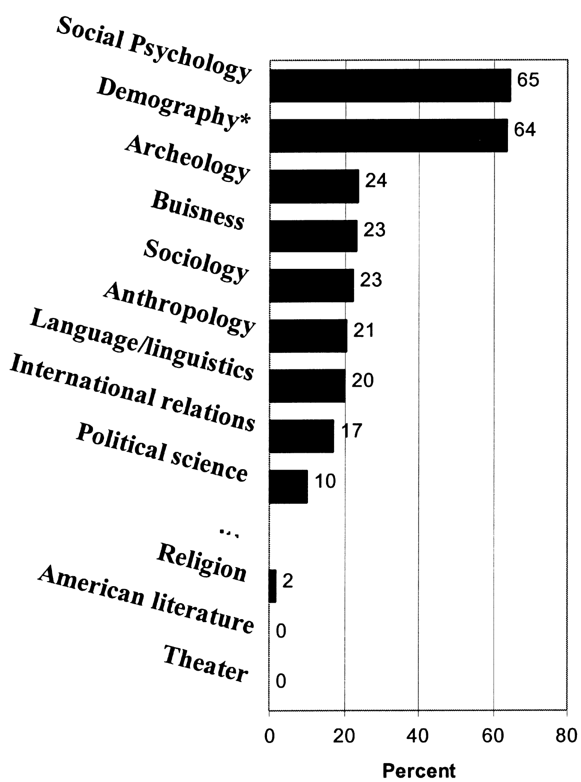

FIGURE 2. Percentage of social science articles cited within five years of publication.

but we argue that the broad contours of an explanation are in place, and that what is missing is the thick description of what happened at particular places and times. For instance, Bongaarts and Watkins[11] (see especially pp. 668–669) offer an explanation of fertility decline that few demographers would dispute.

Other benchmarks of demography's success include: its level of funding support from government and foundations, its reputation within academia, and the value of its skills and products beyond academia. For example, the federal government funds demographic research, research centers, and training grants through both the Population and Behavioral Branch of National Institute of Child Health and Human Development (NICHD) and the National Institute on Aging (NIA). The list of current grants at NICHD (see <http://www.nichd.nih.gov/cpr/dbs/active.cfm?q=2000>) and NIA indicate substantial investment in demographic work.

We have no formal data on discipline prestige rankings, but our claim that demography has high status is not new. In the classic Hauser and Duncan volume,[12] Moore states: "Demography is accordingly recognized by sociologists as one of the more 'advanced' specialties in the field and one of the few that uses precise mathematical models as well as statistical techniques." This favorable view is reflected by the current number of demographers who have been elected into the National Academy of Sciences (NAS). Forty percent of the sociologists in the Social and Political Sciences section of the NAS are demographers and roughly one-third of the entire section are demographers.[d] Additionally, the demand for demographic perspectives and skills outside academia is quite visible. State, national, and local governments need demographic analysis, including population projections, and a reading of any academic employment bulletin or other advertisement within academia reveals a range of non-academic positions available for persons with demographic training.

REASONS FOR THE SUCCESS OF DEMOGRAPHY

Hodgson[5] argues that paradigmatic change in the social sciences can be attributed to *intrinsic* (or internal) factors and/or *extrinsic* (or external) factors. Intrinsic factors are those usually associated with Kuhnian *normal science*—the process of systematic observation and generalization (an inductive approach) or hypothesis derivation, empirical testing and theoretical elaboration (a deductive approach). This process is internally driven and basically independent of outside forces. Extrinsic factors, in contrast, are social, economic and political conditions that can influence all aspects of science from the choice of theory, to conceptualization, measurement, and empirical tests. Although we think the intrinsic/extrinsic distinction is useful, intrinsic scientific work always takes place within a social context. Adequate explanation requires factors from both the intrinsic and extrinsic set and, possibly, attention to interactions between them.

Given our particular question (i.e., why has demography evolved into a cumulative and integrated science?) and the topic we were asked to address (i.e., a charac-

[d]Data taken from <http://www.nas.edu/>. Of the 46 members of the Social and Political Sciences section of NAS, the following 10 are categorized as demographers/sociologists: Bumpass, Duncan, Freedman, Hauser, Keyfitz, Lieberson, Massey, Menken, Preston, and Riley; and four more as primarily demographers: Coale, Lee, Singer, and Wachter.

terization of demographic data and methods), we set out to highlight the importance of demographic data and methods in demography's evolution. Specifically, we suggest that much of the success of demography emanates from agreement on measurement, the ease of quantification, the presence of some key identities, and the scientific yield of induction. Although the impact of data and methods is perhaps more important on intrinsic development, we argue it is also relevant to some extrinsic factors.

Intrinsic Development

Briefly stated, we argue that demography's *normal science* development has benefited greatly from four features of demographic phenomena. Specifically, demography focuses on phenomena that (1) are relatively easily measured, (2) are inherently quantifiable, (3) are highly structured, and (4) can be elegantly incorporated into accounting frameworks or represented by descriptive demographic models.

Ease of Conceptualization and Measurement

Key to the development of an observational science is measurement of important concepts. Observational data are "spread out"; no observer can collect more than a negligible proportion of the data required.[12] Thus, conceptual clarity and a common understanding across observers are crucial. (As Hauser and Duncan[12] state, "In discussing the adequacy of data for an observational science like demography, one must consider the availability of data over time and space and the nature of the observations recorded at different times and places.") Development and institutionalization of a measurement scheme can be as extraordinarily difficult as it is important. The task for demographers, fortunately, has been easier than for some other sciences. The key concepts in demography (people, births, deaths, and time) are directly observable, and measurement validity is high.

A standard undergraduate textbook in sociological methodology[13] claims that "We can measure anything that exists. There are no exceptions. If it exists, we can measure it." Perhaps this is true, but the ease of measurement and its accuracy (i.e., the reliability and validity of measurement) vary greatly depending upon the phenomena. Demography is fortunate in this respect. Moore, in the classic Hauser and Duncan[12] volume, make this point: "… the primary demographic elements (persons and vital events—births and deaths), although involving some problems of definition, are easier to identify than are many elements in other sociological fields (e.g., role, pattern, norm and even community)." Births and deaths are biologically based and are thus anchored in an unmistakable and universal reality; the *meaning* of these events may be socially constructed, but their actual occurrence is universally recognized. Thus, cross-temporal and cross-group measurement is feasible. (Such measurement is not only possible but very likely realized as indicated by United Nations' definitions of key demographic phenomena.[14]) The same is true for sex and age (or other dimensions of time); their social significance may vary, but the fact that there is an objective sex or age (or duration since some event) is unchallenged. A useful comparison to the relative objectivity of a vital event, sex, or age might be the concept of *religiosity.* Such a concept is generally acknowledged to be multidimensional, and its existence not directly observable. Moreover, behaviors that might reflect *religiosity* likely vary dramatically across time and across social groups. Universal agreement on a taxonomy of *religiosity* is at least fraught with great difficulty and is most likely impossible. To provide another example, one within demography, migration is a much less developed area than mortality and fertility. One reason might be the significantly greater difficulty in defining migration.[15] (Kirk referred to migration as the "step-child" of demography because it defied refined measurement comparable to that associated with fertility and mortality.) As another demographic example, measuring *health* (or disability) is also relatively problematic. Since the introduction of the ADL/IADL scales, there has been considerable debate regarding the implications of different question formats (see Glass,[16] for example).

Ease of Quantification (Relatively Transparent Rules of Assignment)

A second key feature of demographic phenomena is that they are inherently categorical, and thus easily counted (i.e., quantifiable). To explain, Duncan[17] refers to a fundamental source of measurement error as *intrinsic variability,* the fact that pure types are rare and thus most assignments entail some error (errors that lower measurement reliability). Duncan[17] attributes the following illustration to Socrates: "There are not many very good or very bad people, but the majority are something between the two… Can you think of anything more unusual than coming across a very large or small man, or dog, or any other creature? Have you never realized that extreme instances are few and rare, while intermediate ones are many and plentiful?" Our point is obvious: births and deaths are inherently dichotomous. Counter to the general case described by Socrates, intermediate instances of birth and death "are few and rare, while the extremes are many and plentiful."[e] As a result, the reliability of measurement for key demographic indicators is high. That is, repeated measurement and intersubjective agreement would likely be very high. In contrast, *religiosity, migration,* and *health* create serious problems of classification, even if the phenomena could be objectively defined.

We do not claim that demographic measurement is easy—only relatively more straightforward than for most other social phenomena. Furthermore, these advantageous features of demographic measurement have been combined with serious effort at improved measurement and even greater attention to assessment of data quality and adjustment. For example, there are surveys of how data are collected,[19,20] procedures for correcting age heaping, and models for assessing the reasonableness of vital counts and their variation (see Shryock and Siegel[3] Vol. I: Chapter 8, on evaluation and adjustment of age data, and Vol. II: Chapters 14 and 16 for mortality and fertility, respectively).

The Presence of Accounting Identities and Other Descriptive Models

Demographic methods of analyzing data have also facilitated its successful development. At its core, traditional demography is concerned with population composition and change therein (dynamics). The basic methods of demography center around the

[e]A counterexample is the distinction between a fetal death and a live birth. No doubt, errors in assignment are made here. However, they are likely reduced by universal agreement on their definition that include operational definitions.[14] Fetal deaths are relatively rare, compared to births, and thus do not generally bias fertility estimates. Fetal death rates and infant mortality rates might be more frequently influenced by misassignment of fetal deaths.

well-known population balancing equation, an identity as fundamental to demography as is the law of the conservation of energy to the physical sciences:[f]

$$P_t = P_{t-1} + B_{t-1,t} - D_{t-1,t} + NM_{t-1,t}\,.$$

The equation states simply that population size at time t is a function of entries into and exits from a population between time $t-1$ and time t.[4] The only methods of entry and exit include fertility (B), migration (here, net migration, NM), and mortality (D), the three core substantive concerns of demography. This identity allows for data quality checks and for strategies of indirect estimation, when only partial data are available.

Further analytic power comes from the fundamental concept of a population at risk. Specifically, the basic measurement task is to estimate the risk of a vital event. The accepted strategy uses a ratio of a count of events (e.g., births, deaths, or migrations) to an estimate of the *person years* exposed to the risk of an event (e.g., years at risk) in a given time period. Like counts of vital events, these event/exposure rates form an identity; that is, the growth rate equals the sum of birth and net migration rates minus death rates. See Preston, Heuveline and Guillot[4] for a systematic development of these concepts and their inter-relationships. Actual estimates of event/exposure vital rates can be produced using vital registration to provide the rate's numerator and years at risk can be estimated from population counts from the census corrected and updated by demographic analysis.[21] Alternatively, both numerators and denominators can come from the same source, such as in retrospective birth histories.

Our first three points stress the commonality of birth/deaths across space and time (that is, guaranteed by the biology of the processes), the near universal conceptualization of births/deaths as dichotomous, and the importance of highly structured relationships among key concepts. We claim that these *structural features* of demographic phenomena have contributed to the relatively speedy and relatively complete institutionalization of the study of demography. Coale and Trussell[22] capture these points in their description of demography: "Demography is a discipline that is particularly suitable for the use of models because its events and entities—such as age, number of persons, number of births, and number of deaths—are unambiguously numerical. A population is a collectivity that increases or decreases by the entry or exit of members. At a given moment each member of a population has a specifiable age, which increases by one unit with the passage of one unit of time. The events or risks that determine entry or exit vary with age, defined as the time since an event that fixes age zero in the specified population (for example, birth in a conventional population, or first marriage in the population of once married persons, where age is the duration since first marriage of persons still in that marriage)."

Given substantial high quality data, the development of an explanatory science depends upon linking data to important concepts and to causal theories that link these concepts. These links can be established deductively or inductively. A number of observers have noted that demography is heavily inductive (see e.g., Preston[2]). Consistent with the arguments above, this may result because demography is one of the few social sciences with sufficient observational data to make such an inductive

[f]Land and Schneider[18] identify a number of fundamental laws or identities in the social and physical sciences, including the example used here.

strategy feasible. Furthermore, induction requires techniques of data reduction to facilitate generalizations. Coale and Trussell[22] stress that the key demographic models "are descriptive and were never intended to be anything else." By establishing regularities one can more clearly see what needs to be explained, thus stimulating a search for underlying causes. The payoff to this kind of work is immense. For instance, the basic demographic technique is decomposition. Crude death rates, for instance, can be represented as the sum of age-specific products of age-specific death rates and the proportion of the population in each age group. This representation allows for an exact decomposition of the difference in crude death rates for two populations into the proportion due to differences in rates and the proportions due to different age structures (see Kitagawa[23] or Preston *et al.*[4]). Such a descriptive analysis directs attention to fundamentally different explanations: differences due to population composition and differences due to variable risks of death across at least some age groups. This standardization/decomposition strategy is remarkably flexible and can be applied to situations with multiple components. Ryder's[24] decomposition of twentieth century fertility, for example, (into parity, tempo, and quantum components) is the most important article ever written on fertility in the U.S. Bongaarts and Potter's decomposition of period fertility into proximate determinants is similarly paradigmatic.[25] Finally, Bongaarts[26,27] shows the reach of the strategy in his models of global warming and world food supply.

The best-known demographic tool, the life table, is an extension of this basic decomposition model. The basic life table was developed several centuries ago; it reveals the age-specific mortality structure of a population. The basic life table shows the age-specific mortality experience of a population (generally cross-sectionally), and ultimately produces life expectancies from this mortality structure, or the expected number of years an individual at a given age will live under the assumption that the mortality schedule remains constant. Interpretations of the life table as a "stationary population" model allow for both novel insights and for checks of common sense expectations (see Preston *et al.*[4]). Although developed as a tool to measure mortality, life tables can be, and have been, applied to numerous other time-dependent phenomena, including marriage and divorce, migration, disability, and education. These applications were aided by important developments in life table methodology, for example, multiple decrement and cause-eliminated life tables, and increment-decrement, or multistate, life tables.[12]

Early advances in basic life table methodology involved change within the basic table itself to allow different shapes for hazards over and between the time intervals observed (e.g., Weibull vs. exponential vs. linear hazards). Other early advances in life table methodology included the development of multiple decrement and cause-eliminated life tables. Multiple decrement tables allow exits from a risk set other than simply death (e.g., perhaps death by various causes or other forms of exit), and cause-eliminated life tables (a special case of the basic method) are constructed by removing individuals who died from specific causes and computing a basic life table with the remaining individuals (see Schoen[28]). The results for both the basic table with all persons and the cause-eliminated table can be compared to determine (theoretically) the gain in life expectancy that could be expected were a disease/cause eliminated (although it is now widely recognized that eliminating one disease may yield an increase in deaths from another, due to comorbidity). Further extensions of the basic life table include the development of increment-decrement, or multistate, life tables. These tables are more general extensions of the multiple decrement table, in which individuals may transfer between various states in any direction. For example, in a multistate table, an individual may transfer from disabled to dead, or from disabled to healthy, or from healthy to disabled, whereas a multiple decrement table would consider transitions only in one direction (e.g., healthy–disabled–dead).

A beneficial synergy exists between demographic data, demographic identities, and the application of relatively simple statistics and accounting/decomposition frameworks. Duncan[17] points out that variation in system parameters can result from (1) errors of measurement, (2) sampling variability, (3) intrinsic variability, and (4) random behavior. When comparing estimated parameters for two populations, one must determine whether estimated differences are due to differences in one of these four components or reflects a genuine difference in system parameters. The challenge is considerable. However, in much demographic work errors of measurement are modest or can be corrected;[29,30] sampling variability is reduced by full enumeration or by very large samples. Intrinsic variability is minimal in the measurement of births and deaths that are inherently dichotomous, as already discussed. Finally, random variation is averaged out by the aggregate nature of demographic analysis. Thus, demographic parameter differences (net of relatively simple stratification or decomposition techniques) provide strong evidence for differences in the risks of an event across populations. The combined features of demographic data and methods provide considerable leverage on the analytic task compared to the data and methods used in many other disciplines.

Extrinsic Influences

As previously mentioned, it would be unreasonable to argue that only intrinsic factors are important for scientific development. Social context—extrinsic phenomena—is certainly important. Several extrinsic factors have links to demographic data and methods. They include a general tendency toward quantification and the "moral authority" of data, government and private interest in demographic data for administrative and business purposes, and the relevance of demographic data for social problems and public policy responses.

The Moral Authority of Quantification

The first author's favorite cartoon shows a group of recognizable world political leaders and the Pope. They have finished a day of debate and will adjourn until the next day. The chairperson announces adjournment and encourages all, except the Pope, to bring supporting data to the next session. This caricature of contemporary sources of legitimacy privileges data, except in very rare cases. Courts of law increasingly feature dueling statisticians, as in the recent debate over presidential voting totals in Florida. The public has broad confidence in quantitative evidence, at least until they witness the process producing them (e.g., the Florida recounts for the 2000 presidential election). Demographers, loaded with quantitative evidence, are generally perceived as being less partisan than those whose arguments are primarily theoretical. In short, demographers gain legitimacy from the links they forge between respected sources of data and substantive claims.

Demography has avoided some of the anti-empirical debates that sap energy from productive enterprises in other disciplines. There are few postmodernist demographers. Rather, Caldwell[31] labels demographers the "inheritors of nineteenth-century positivism." Demographers take social construction and the import of context seriously, but not to an extent that denies the possibility of quantitative, comparative work. Hauser and Duncan[12] commented on this demographic culture four decades ago: "Students of population spend relatively little time debating subtle points in the philosophy of science or in self-criticism at a very general methodological level. Consequently one finds in the literature comparatively few discussions by demographers of the nature of scientific theory and related topics. It does not follow that demographers as a class are unusually naïve about such matters, for they doubtless are as fully exposed as anyone else to the methodological discussions that go on in other disciplines. The evidence of the present symposium is that demographers understand pretty well what science is all about and what theory has to do with it." To drop the subtlety, demographers seem to think they have better things to do. They have "voted with their feet." In short, an acceptance of a single epistemology and ontology has enabled demography to build in a single direction.

Government and Private Interest in Demographic Data

Also enabling the success of demography, key measures and concepts of demography (births, deaths, growth rates, etc.) are of interest to non-demographers. The production of data (through careful measurement) is a time and energy intensive process. "No information, least of all, decently quantified information—comes at zero cost; and costs are borne by somebody."[17] Traditionally, the core demographic resources (i.e., vital registration systems, population registers, and censuses) were for administrative, not scientific, purposes.[17,32] The willingness of government to collect these data and its willingness to invest in their accuracy have provided valuable, high-quality data for demographic work. The standardization of measurement across temporal and spatial units is advantageous for administrative and policy reasons. In the U.S., for example, vital registration is regulated at the state level. However, state and national officials cooperate to standardize reporting, allowing for national estimates and for comparable state data. Likewise, the United Nations encourages the collection of internationally comparable data in population censuses and registration systems.[g] Thus, it is clear that "there are no rates without some organized intelligence system" (Biderman and Reiss cited in Duncan[17]). In the U.S., for instance, the census, vital registration systems, and disease surveillance systems are supported because of their relevance for public policy. The research community is only one interest group supporting these data collection efforts.

[g]The U.S. has produced a series of *standard certificates* for vital events that have increased comparability of data over time. Particular standards are required by the national government before state data can be included in national calculations. Likewise, the United Nations Statistical Office[14] provides definitions of vital events and discussion of recommended procedures and describes the range of practices. United Nations Statistical Office[33] provides similar information for the conduct of censuses.

Relevance of Demographic Data for Social Problems and Public Policy Responses

As an ongoing cumulative enterprise, any science needs substantial support sustained on at least a decadal time scale. Demography gained some of this support from its closeness to government investment in censuses and registration systems (see above). Demography also gained support by focusing on questions deemed important beyond the confines of academia. Part of this may be traced to its aggregate approach. Preston points out that demographers tend to focus on factors that account for substantial difference in aggregate properties, a focus on the *big picture* (see also Caldwell[31]). In Preston's words: "Demographers have proved useful … not only because of their skill in measurement but also because of their framework of analysis. Typically they begin by measuring a phenomenon at the level of a population (e.g., mortality) and then breaking it down into components (causes of death, social groups, regions). Then they can 'decompose' trends or international differences into constituent parts. Such a perspective is useful in framing policy issues, and it is essential for asking questions about broad changes in aggregate properties. …(demographers) have the advantage of being oriented to the big picture."[2]

Demography has also been aided by concern about global population growth and by wide interest in the link between economic development and population growth. The import of this question was heightened by the cold war and debates about whether capitalism or communism could best deal with the associated problems of third-world poverty and rapid population growth.[5] The policy relevance of demography has afforded it substantial monetary and institutional support. Examples include NIH funded research and training programs in population and decades of generous foundation support.

THE FUTURE OF DEMOGRAPHY

The arguments we have provided suggest to us that subsequent development in demography may not be as rapid or as cumulative as was past work. Much of the descriptive and modeling work at the core of demography is largely complete. Preston has made this claim about formal demography; Menken[34] has argued that work on the link between proximate determinants and fertility is largely complete; large steps forward in mortality analysis are not envisioned.[35] Instead the new wave of demography is moving to new topics and to new types of data. Crimmins[36] (see also Lichter[37]) says that theoretical developments are the "engine pulling the field" toward the study of causal mechanisms and of factors more distal from the core of demography. Computers, she claims, "fuel" these theoretical developments, suggesting a synergy between intrinsic and extrinsic factors.

Progress in these new areas has been, and will be, aided by demographic methods and logic, but it will likely be hindered by serious problems of conceptualization, measurement, and quantification. These new areas and questions do not consistently share the advantageous features we attribute to core demographic phenomena. Furthermore, the new wave of demography is more ambitious, aiming toward causal modeling at the individual level. The primary microlevel theories are social–psychological or microeconomic, and the method of choice is based in econometrics.

Where is the demographer's comparative advantage in such individual-level work? (Herb Smith has made this point a number of times in discussions and presentations.)

Recent and Future Intrinsic Development in Demography

Increased attention to individual-level phenomena has engendered greater efforts in explaining heterogeneity. Basic methods of standardization were an early way to account for heterogeneity within one population in order to make it comparable to another population. In recent years, however, standardization techniques have fallen out of favor, and modeling techniques have moved toward regression-based approaches. Regression techniques accomplish the same general task as standardization, given that regression modeling is inherently a tool to control for compositional differences. However, regression modeling allows for higher-dimensional control than typical standardization methods. In addition, standardization methods can be problematic because one must generally choose a population to form the basis for standardization, and this choice can affect the results. Finally, multivariate standardization involves interactions that inhibit straightforward interpretation. Promising solutions to these problems have been offered (see Das Gupta,[38] or for a substantive application, Smith, Morgan, and Koropeckyj-Cox[39]).

Nevertheless, observed heterogeneity has been included increasingly in demographic models via regression techniques. The growing use of regression models has added analytic power, by allowing researchers to better pinpoint differences between and within populations on a host of criteria, net of other nuisance variables. Unfortunately, demographers have not always been astute regarding selection of nuisance variables, and have included endogenous variables as controls. Sometimes, the tendency to control on *everything* has produced "kitchen sink" regressions of suspect value. However, it is our impression that practice in this area is improving, due partly to the influence of economists.

More recently, concern for unobserved heterogeneity has emerged, and unobserved heterogeneity has led to the inclusion of errors terms in demographic models (at its simplest). Typically, demographic models did not include error terms (and hence regression models were simply considered to be *smoothing techniques*), often because demographers have historically worked with complete population data, and the error term (e.g., the standard error of parameters) in statistical models in part reflects sampling error. However, error terms in models can also reflect measurement and other errors, as well as heterogeneity across individuals within a population that is not captured via the variables/controls in the model. Agreed upon strategies for dealing with unmeasured heterogeneity, however, have not yet evolved, and comparison of research results is difficult when different strategies are used. Additionally, some research suggests that results are often not robust to alternate error specifications, at least in hazard models.[39] Unfortunately, error specification frequently matters for substantive conclusions, leaving the substantive issue in considerable doubt.

At the same time dramatic advances have occurred within life-table methodology, regression-based approaches to modeling hazard rates have emerged, the best known of which is the Cox regression model—another micro level technique (see Allison[40]). Linkages between regression modeling and life table methods have grown in recent years, including the ability to construct life tables from regression models with covariates.[41–43]

Perhaps the most important point: the use of regression models with error terms has fostered a methodological link between demography and other disciplines. This change provides demography with an increasing number of methods at its disposal. Indeed, some claim that demography is not a discipline, but rather a *tool kit* of methods. Regardless, the effect of this blurring of methodological boundaries means that the frequently used tools in the demographer's *tool kit* do not differ greatly from those used by other social scientists.

Other important recent trends include more attention by demographers to qualitative work and the popularity of *mixed research strategies*; that is, research that incorporates field research and survey research methods.[44–46] Related efforts at contextual modeling incorporate aspects of the social context or emergent collective properties into individual-level analyses; that is, multilevel modeling strategies (see Smith[47]). These strategies enrich demographic work, but they do nothing to promote its distinctiveness.

The similarity of methods used across the social sciences has not resulted only from demographers' adoption of new techniques. Instead, demographers were the first substantive social science discipline to use data extensively, because macrolevel vital statistics and census data have been available in most (developed) countries for decades if not centuries. The growth in the availability of survey data over the last three decades, and the explosion in computer technology and easy-to-use statistical packages (which are partly extrinsic in nature), have lowered the cost and increased the attractiveness of quantitative work for other social scientists.

Extrinsic Factors Affecting the Future Development of Demography

Projection of extrinsic factors implies projection of more distal social, economic, and political conditions as well as institutional and collective movement responses. Thus, our comments here are even more speculative than our previous musings. Nevertheless, we find hints of possible futures from simple extrapolation of selected recent trends.

First, the core of demography will probably not benefit from the declining visibility of the population problem or population explosion. These issues helped, as argued earlier, to insure research and institutional support on a decadal time scale. Most demographers now forecast an end to global population growth in the twenty-first century, with a total population approximating nine billion.[48] In addition, the sum of demographic evidence has challenged the link between developing country rapid population growth and slowed economic development, a major rationale for efforts to lower fertility in developed countries.[49] Finally, the collapse of the USSR has eased international tensions between capitalist and communist societies. The earlier cold war environment helped generate and perpetuate the idea that rapid population growth retarded economic development.[5]

The declining importance of the population problem leads government institutions and private foundations to identify new areas of priority. Some of these problems continue to have a major demographic component (e.g., the aging of populations, very low fertility, racial and ethnic composition and social inequality). The November 9, 1999 issue of *Time* magazine focused on “100 Questions for the New Century.” Many of these questions had significant demographic components (e.g., Will we live to be 125? Was Malthus right?, etc.) that indicate the continuing import and relevance of demography for issues salient to the public. However, even new foci with smaller demographic components (e.g., human capital and social capital) do not necessarily shut demographers out. Our funders (perhaps impressed by our past successes) ask us to think about new problems, but, stressing our major point, demography's past success may not be readily transferable. We suspect the comparative advantage of demographers vis-à-vis other social scientists may remain, but cumulative progress compared to that observed in the core of demography may be disappointing.

Third, the ubiquitous collection, analysis, and use of data may lead to a general decline in the "moral authority" of data. That these analyses increasingly use samples (and not complete populations) may contribute because of the inherent uncertainty resulting from sampling and the public's poor understanding of the nature of such quantitative information. The recent debates in the Congress regarding sampling-based approaches to census population counts provide an excellent example of this decline, as do attacks on census content. Furthermore, as demographers begin to address more microlevel questions with more difficult to measure concepts, the ease of measurement property that is a bedrock of demography fades and affords post-modernist and other critiques greater relevance. Thus, the future of demography will likely be more like contemporary social demography or with allied fields such as sociology, economics, political science, and anthropology rather than with the past history of demography's core.

CONCLUSION

We have argued that the subject matter of demography has been conducive to the intrinsic development of the core of demography. The development of demography was further aided by extrinsic factors, such as the import of its data for government administration and for business purposes and the import of demographic questions for social problems and public policy. This argument makes suspect any simple projection of the success of demography into the future or to transport its experience to other disciplines.

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