APPLIED DEMOGRAPHY IN THE UNITED STATES AND IMPLICATIONS FOR PRACTICE ELSEWHERE

David A. Swanson*
Department of Sociology and Anthropology
University of Mississippi
University, MS 38677-1848
Email: dswanson@olemiss.edu

and

Louis G. Pol
College of Business Administration
University of Nebraska at Omaha
Omaha, NE 68182
Email: lpol@mail.unomaha.edu

*Corresponding author.

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Abstract

Changes in technology and methodological developments have significantly changed the field of applied demography in the U.S. over the last decade. These have been accompanied by alterations in perceptions of how the demographic perspective contributes to addressing public and private sector issues. This paper focuses on contemporary developments with the goal of identifying areas of future direction. Following a brief history of applied demography, recent developments are placed into five categories: training, including programs; courses and course materials; institutional structures such as the Population Association of America, the Southern Demographic Association and funding agencies; career opportunities in government, educational institutions and the private sector; technological developments in communication and data storage and retrieval; and methodological developments, such as GIS, that allow researchers to extract additional information from data. These developments provide an overall picture of applied demography in the U.S. early in the twenty-first century and provide ideas about the state of the art in applied demography in the near future.

Introduction and History

The sub-discipline within demography labeled applied demography generally is considered to be relatively new (Pol 1998). Evidence for this claim is found in the infrequent use of the term until the late 1970s, and the fact that before the 1980s few demographers considered themselves to be applied demographers. In the U.S., demographers within the Population Association of America (PAA) who identify themselves as applied demographers have only been able to do so in PAA membership surveys since the mid-1980s. State and local and business interest groups within PAA were first established in the early 1980s, although today they are merged into one Applied Demography interest group. *American Demographics* magazine, considered by many to be the first broad-appeal publication to focus almost exclusively on demographic applications, first appeared in 1979. The first book with applied demography in its title was published in 1977 (Keyfitz 1977), although it had little to do with what is considered applied demography today. A second book, which focused for the most part on methods of applied demography, was published in 1984 (Rives and Serow 1984).[1] *Applied Demography*, the official newsletter of the state and local business demography interest groups within PAA, was first published in 1987.

However, a closer examination of the demographic literature leads to a somewhat different conclusion with respect to the origins and recent emergence of applied demography. Although the preponderance of applied demographic research seems to have been conducted since 1980, demographers have engaged in applied activities for a much longer period of time. Demographic and non-demographic literature contains applications that were published in the 1960s (*e.g.*, Casparis 1969, Starsinic and Zitter 1968, Goldstein 1968, and Schmitt 1968), and some of this work had its origins in the 1950s and 1940s. In the late 1950s, Bogue (1957)

introduced the concept micro-demography along with a model of applied demography for small areas. The model presented applications in general planning and was comprised of three components: transportation and facilities, urban renewal, and the market analysis. Included within market analysis was the evaluation of new and existing sites with respect to shopping centers and individual retail establishments. Clearly, what Bogue seems to have had in mind at that time was similar to the lines of inquiry followed today by many applied demographers and consistent with the characterization of applied demography as a decision-making science by Swanson, Burch, and Tedrow (1996).

In the 1940s, the Washington State Census Board, housed at the University of Washington, focused on a number of policy and practice issues related to demography, which are considered part of applied demography today. Demographic trends were studied as both the causes and consequences of social, economic, and political trends, and important methodological advances were made to improve the quality of population estimates and projections. These activities served as the foundation for creation of a statewide agency, located in Olympia, Washington, that currently addresses most of the demographic applications seen today. They paralleled and in some cases preceded similar activities at the U.S. Census Bureau (Eldridge 1947, U. S. Bureau of the Census 1949).

Applied work was done before the 1940s by U. S. demographers but it was infrequently published (Pearl and Reed 1920, Shryock 1938, Whelpton 1928). The infrequency of publication was likely for at least two reasons: (1) the discipline of demography was more narrowly focused than it is today, thus applications and case studies were seen as having limited or no significance, particularly from an academic standpoint, and (2) some of the efforts yielded reports that were proprietary or otherwise sensitive and therefore could not be considered for

broader dissemination. Even today, some applied demographers maintain a low profile because their employers do not wish to have the nature of their work widely known. Some academic-based demographers do not promote their applied activities because they believe that their more mainstream colleagues discount such work.

In addition, some of the applied/non-applied distinction is semantic, and by using a very broad definition for this area of interest it can reasonably be claimed that demographers have been engaged in applied demographic research for many decades (Swanson, Burch, and Tedrow 1996. Much of the work in the area of population estimates and projections (considered by many to be the "heart and soul" of applied demography) was earlier grouped among demographic methods or tools and techniques (e.g., Shryock 1938, Hagood 1941, Jaffe 1951). Moreover, a portion of today's applied demography would have been labeled public sector or policy-oriented demography several decades ago.

History aside, contemporary work in applied demography is extensive in regard to the range of arenas where demographic perspective, data, methods and theories are being applied. In addition, there are more applied demographers than ever before. A large proportion of the PAA membership is identified as having applied demography as one of their three major areas of interest. At the end of 2002, 1,187 PAA members, 41.1 percent of all members, were employed in nonacademic fields, and 268 (9.3%) considered applied demography as one of their primary areas of specialization (Smith 2003). Moreover, 377 (13%) subscribed to the *Applied Demography* newsletter. As noted by Gordon De Jong in the Spring, 2003 issue of *PAA Affairs*, 11.6% of PAA members are employed in nonprofit organizations, 14.3% in government agencies, 6.4% in international organizations, 4.5% in business and industry, and 4.2% in private consulting and other positions. Of course, not everyone with non-academic employment is an

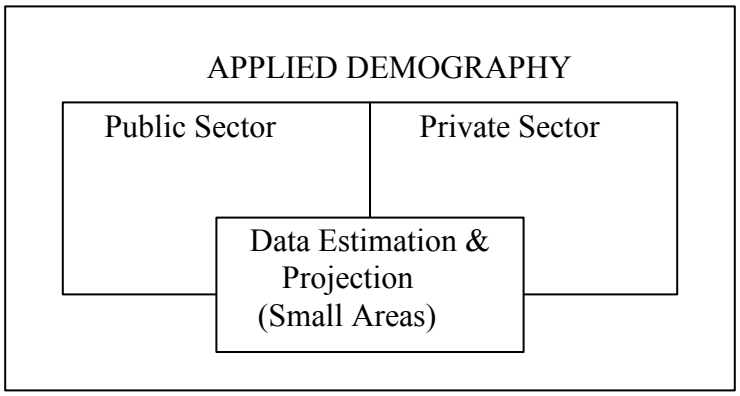
applied demographer, but our analysis of various ways in which the number of applied demographers within PAA could be measured, suggests to us that there are approximately 400 applied demographers in the PAA, or about one of every seven members of the association.[2] As another indicator of interest, at the annual meeting of the PAA, applied demography sessions are among those with the greatest attendance.

Compendia of applied works have been published as well. The first casebook in applied demography was published in 1994 (Kintner, Merrick, Morrison and Voss 1994) and has been well received and is widely read. Other applied and business demography books and monographs have been published (*e.g.*, Rives and Serow 1984, Murdock and Ellis 1991, Pol and Thomas 1997, and Siegel 2002). Two books (one American, the other Italian) on more generic demography have chapters focusing on marketing methods of demographic analysis and marketing and business, including a focus on consumer expenditures (Murdock 1995, DeBartolo 1996). A special issue of *Population Research and Policy Review* focusing solely on applied demography was published in 1996.

In addition, it should be recognized that using the term applied demography to encompass the entire range of public and private sector applications seen today does not adequately depict the wide range of research being conducted. Applied demography in the public and private sectors focuses on the use of demographic data, methods and perspectives in decision-making (Swanson, Burch and Tedrow 1996, Kintner and Pol 1996). That is, managers, chief executive officers (CEOs), chief financial officers (CFOs), elected officials and public planners are responsible for strategy development and implementation. Demographic input is but one of several considerations as new markets are being evaluated and public works projects are being designed. However, as is shown in Figure 1, it useful to distinguish public from private sector

applications. Even though the methods and materials utilized in both types of studies are the same, the unique, profit-oriented and oftentimes proprietary nature of the work justifies separate consideration for business demography. It also is worthwhile to note that much of the public sector applied work seen today has a longer history and might have been classified as part of the more general rubric social demography at an earlier time.

Figure 1 Major Components of Applied Demography & Their Relationships



As can be seen in Figure 1, the development of data through estimation and projection overlaps both sectors, public and private.[3] As stated earlier, estimation and projection is viewed as the "heart and soul" of applied demography. Given this importance, we devote a later section of this paper to factors that that affect these two endeavors.

The development of an applied demographic focus has been driven by the interaction of several elements that have shaped the nature of c ertain streams of research in demography. The first is the rise in the use of the demographic perspective, data and methods in addressing business opportunities and problems. As noted earlier, Bogue (1957) and a few other demographers made references to commercial applications earlier in the 20th century. However, business demography as it is known today is a phenomenon that only emerged in the late 1970s

(Russell 1984, Pol 1987, Serow and Rives 1995, Waldrop 1995). Closely related is the rise in interest regarding demographic applications in micro decision making (*e.g.*, the decision of an individual business in a specific location to expand its market reach). However, without improvements in methods to produce good quality small area demographic estimates, the information needed to drive micro decision-making would not be available. Encouraged in part by the need for small area data, many demographers more recently have focused their efforts on the improvement of techniques and technology needed to generate, display and analyze small area data (*e.g.*, Smith, Tayman, and Swanson 2001). Finally, while the vast majority of demographic research focuses on the demography of geographic units, interest in organizational demography emerged in the last decade (Carroll and Hannan 1999).

Because of these trends, two other phenomena can be observed. First, the number of occupations where demographic skills can be used has grown. Many employed in both the public and private sectors now count themselves as pseudo-demographers, even though they have no formal demographic training. Second, the number of employment opportunities where a combination of demographic and GIS/analytic skills are either required or give an applicant an edge over competitors is growing.[4] In turn, these two phenomena feed the demand for demographic products and expertise.

Training

Like many other scientific disciplines, training in applied demography has a formal education component and a practical or on-the-job segment. Applied demographers must be able to synthesize data, methods and perspectives from a range of disciplines in order to explore the best opportunities and to produce optimal solutions to problems. For example, an applied demographer working on small area real estate development such as a shopping mall would need

to have knowledge of: (1) methods to produce population estimates and projections for sub-county geographic units; (2) zoning regulations for the area(s) of interest; (3) the location and characteristics of current and potential competitors; (4) traffic flows; (5) local and regional government development plans; (6) land costs; (7) construction costs; and (8) financing in order to be a full partner in the project.[5] He or she would have to determine if an adequate return on investment could be realized before the project was advanced.

There are no programs of training that offer the broad-based education needed for a person to participate at the level described in the scenario outlined above. For the most part, demographers receive reasonably good methods training, but only a few programs offer several courses designed to give students exposure to public and private sector applications. Programs and courses are offered at the undergraduate and graduate levels of instruction and most are housed in departments of sociology. Neither the close affiliation of demography with sociology nor its lack of interdisciplinary connections serve the training needs of applied demography very well. In only a few instances are programs and courses within sociology well-designed for applied demography.[6] It also is the case that neither are many found in overtly applied fields outside of sociology nor as part of interdisciplinary efforts. So far, the call by Swanson, Burch and Tedrow(1996) to organize the training of applied demographers under academic disciplines more closely linked to the science of decision-making has gone largely unheeded.

With the recent disbanding of the demography program at Georgetown University, three programs that illustrate the content and focus of the best American efforts are briefly described. The first is virtually the only comprehensive program found within a sociology department in the U.S. It is at *Bowling Green State University*.[7] The program is housed entirely in the department of sociology. Most of the courses focus on demographic methods and statistics, education and

training, but of particular relevance here are: "Techniques of Demographic Analysis I" (Sociology 520); "Techniques of Demographic Analysis II" (Sociology 720); "Introduction to Applied Demography" (Sociology 627); "Data Analysis" (Sociology 627) and "Geographic Information Systems" (Geography 524). Several faculty members participate in this effort.

The second program is one found outside of sociology at *Portland State University*, where a four-course applied demography graduate level certificate can be earned as part of degree programs offered by the School of Urban Studies and Planning.[8] A practicum in applied demography also is part of this program. Two applied demographic methods courses are required of all students who seek the certificate. This is one of very few comprehensive training programs for applied demographers that is linked to a field (planning) that can be labeled as a decision-making science.

The third example is found by a program offered at the *University of Delaware*. Here, the Urban Affairs and Public Policy Ph.D. program at the University of Delaware serves as the home for the Center for Applied Demography and Survey Research. Students take a broad range of research methods and statistics courses as part of the program, and those pursuing a special emphasis in applied demography can gain significant practical experience by working on center research projects. Examples of center research include measuring the effect of demographic trends on public school enrollment, the demographic correlates of teacher supply and demand, and demographic analysis as it is related to transportation and health policy. Again, this is one of the few training programs linked to a decision-making science.

Many colleges and universities offer individual courses in applied demography. These courses cover a broad range of applied demography topics of study and several are taught in the context of a particular line in inquiry. "Applied Demography" is a course in the undergraduate

sociology curriculum at the University of Mississippi. It is a survey course. "Business Demography" is taught to undergraduate business and MBA students at the University of Nebraska at Omaha. It too is a survey course. Graduate level survey courses in applied demography also are offered at: University of California at Berkeley, Marshall University, the University of Wisconsin at Madison, the University of Connecticut, Lehman College, Concordia University and the University of Massachusetts at Amherst, among others. An undergraduate course titled "The Demography of Business/Policy" is offered at Duke University, and a graduate course titled "Demographics for Planning and Policy" is taught at the University of California, Irvine. "Market Research in Public and Private Sector Organizations" is taught at Brown University.

Course Content/Materials

Course content and materials vary widely across programs and offerings. The vast majority of courses meet over a specific period in a given location. While course materials are made available in traditional ways, i.e., textbooks, library and photocopies of articles, Internet usage, the reliance on course support software such as Blackboard and the integration of other software for GIS and statistical analysis are becoming widespread. For purposes of illustration, this section focuses on four courses taught at four different universities. All are graduate level offerings.

The "Introduction to Applied Demography" course taught at Bowling Green State is homework-intensive and focuses on a wide variety of public and private sector applications. Students learn to construct intercensal and postcensal population estimates for both large and small geographic areas.[9] Siegel's (2002) text is required, and additional readings are available in the department laboratory or on the Internet. Students maintain a portfolio throughout the

semester in order to document their progress in the course and to demonstrate that they have strong applied demographic skills. A term project is required, including a proposal with cost estimates, use of multiple methods, a written report and an oral presentation.

"Applied Demography: American Demographics" is taught to graduate and undergraduate students at the University of Wisconsin, Madison. The course focuses on demographic data and methods as they relate to studies in business, government, volunteer work and other applied arenas. Case studies are used in the course in order to illustrate topics, data and methodologies. There are nine exercises/homework sets focusing on a range of issues as well as a required term paper. Moreover, students keep a readings journal and they must contribute to that journal every other week. Two texts are assigned to the students, Siegel (2002) and Hughes and Seneca (1999). A course packet is also available, and it includes cases from the book by Kintner, *et al.* (1994), as well as other material. An extensive list of optional readings is provided.

"Applied Demography: Planning and Policy" is taught to graduate and undergraduate students at the University of Wisconsin, Madison. The course focuses on basic demographic techniques as they relate to public and private sector planning and policy. Readings for the course come primarily from Siegel (2002), Smith, *et al.* (2001) and Kintner, *et al.* (1994). Students must turn in summaries of each reading assigned prior to each class. There are no examinations. There are eight homework assignments covering various applications of demographic data and methods. There is a term paper, which focuses on a "client-driven" demography problem.

"Applied Demography in the Community" is taught at the University of Massachusetts, Amherst. The course is built around the hands-on helping of local agencies including hospitals,

local departments of education, federal and state courts and other community agencies in need of applying demographic data. Students must keep a journal, which is updated weekly and is related to the term project in which students are engaged. A final essay is required, and students draw on their journals, experience as casebook materials as researched for the essay. Only one book is required, Kintner, *et al.* (1994), and a list of supplemental readings is available.

Institutional Structures

The Population Association of America (PAA) represents the single largest organization with which applied demographers are affiliated and as noted earlier, about one of seven PAA members can be classified as an applied demographer. In the mid 1990s, the PAA established a Committee on Applied Demography (CAD) to represent the interests of applied demographers and each year the CAD submits a report to the PAA Board of Directors. The CAD has four members, each serving four-year terms. Traditionally, two members have represented the business demography community and two have represented the state and local demography community.

The CAD is typically involved in three major activities for in PAA meetings:

(1) It holds a business meeting, where ideas for applied demography sessions at next year's meeting are discussed (including organizers, presenters, chairs, and discussants), along with ways to make the PAA and CAD more useful to applied demographers, and a variety of other topics. This meeting is open to all interested persons. Typically around 20 attend

(2) It hosts an annual wine and cheese reception. In 2003, this reception was sponsored by the Annie Casey Foundation and the Population Reference Bureau and featured a panel discussing "Careers in Applied Demography." In 2003, the reception was attended by more than 120 guests.

(3) It sponsors a breakfast meeting for applied demographers, which features a guest speaker. In 2003, about 70 people attended the breakfast.

Although not sponsored by the PAA, an important institutional arrangement for applied demographers (world wide) is the email list server created by Shelley Lapkoff. This mechanism greatly facilitates the timely exchange of information among applied demographers. This has been in operation for several years and, along with the *Applied Demography Newsletter*, serves as a communication vehicle for applied demographers, many of whom are isolated from direct contact with demographic colleagues.

The PAA is not the only professional organization in the U. S. that has a "critical mass" of applied demographers in its membership. The Southern Demographic Association (with about 200 members) provides support in the form of applied demography sessions at its annual meeting, and a forum for applied demography case studies and other articles in its journal, *Population Research and Policy Review*. As one indication of the support given by SDA to applied demography, it sponsors the E. Walter Terrie Award (consisting of a cash prize and certificate) for the best paper in applied demography, especially state and local demography, presented at the annual SDA meeting.

There are, of course, other professional associations with which applied demographers are affiliated (*e.g.*, the American Statistical Association), but the PAA and SDA figure predominantly as institutional structures in the professional lives of applied demographers, serving as communication networks, dissemination vehicles, and employment markets.

Career Opportunities

For the last 40 years, state and local governments represented a sector in which employment opportunities were very good for applied demographers in the United States.[10] The

federal government, however, represented the single largest employer (primarily, but not exclusively, in the Bureau of the Census) outside of academic institutions during this same time. Beginning in the 1970s there was rapid expansion in employment opportunities for applied demographers in the private sector, to include both full-time employment with firms and consulting possibilities. Currently, the demand for demographers in state and local government is very low and there is only one large employer actively seeking applied demographers - the U. S. Census Bureau. Due to retirements and mission changes, the Census Bureau is actively recruiting. This is an interesting development in that it is roughly this point in the decennial census cycle that the Census Bureau contracts in size as the last decennial census effort ramps down.

As an example of a typical job description for an applied demographer working in state and local government, we provide in the Appendix, Exhibit 1, which is a summary of an advertisement by Kansas for a State Demographer in 2000. The characteristics and working conditions described in Exhibit 1 are typical for a demographer working in state and local government in the United States.

Applied demography in the United States, whether in the public or private sector, does not take place in a vacuum. It is subject to broad economic forces that manifest themselves in changes in working conditions. One may take the idea of "outsourcing" as an example. Because of budget and related pressures, work that may once have been performed in-house within many organizations is now outsourced in the form of competitive bids. For applied demographers this represents both an opportunity and a challenge. It is an opportunity in that there is a great deal of part-time consulting work of a project nature; it is a challenge in that this trend represents a

decrease in job security and access to important benefits (such as health insurance) that are normally provided by employers in the United States.

Exhibit 1. Example of a position requiring GIS and Analytical Skills

Statistical Demographer

Description: You will be a key member within the Consulting Unit and responsible for product and service delivery to clients and internal business units. Responsibilities include:

- Prepare population and household forecasts for race, ancestry, ethnicity, age, gender, group quarters, housing starts, owner/renter, vacant units, seasonal units, labor force, occupation, and worker travel time.
- Describe and analyze population characteristics such as age, sex, race, ancestry, education level, employment, occupation, income and household size and composition.
- Forecast consumer expenditures and household income.
- Assist in forecasting and preparing demographic data sets for foreign countries.
- Integrate information from various data sources using MS SQL Server 2000, MS Access, and Excel. Applied experience with SPSS, MapInfo, and/or ArcView a plus.
- Create complex data sets utilizing US census data and forecasting techniques
- Use strong verbal and written communication skills to assist with delivering final presentation to client.
- Conduct research on consumer and lifestyle segmentation.
- Work on simultaneous projects autonomously and/or within a team.
- Be a self-starter who continually develops knowledge and skills.

Requirements: - Outstanding analytical and demographic forecasting skills; SPSS a plus.
- Five+ years of business experience including 3 years of population, household, and housing unit forecasting.
- Experience with international demographics desired.
- Proven skills in conducted lifestyle and customer segmentation research.
- Two years hands-on experience using advanced transactional SQL on SQL Server 2000.
- Experience with data manipulation and interpretation of large data sets required
  marketing applications a plus).
- Strong working knowledge of U.S. Census SF1, SF3, and SF4 data sets, PUMS data, Bureau of Labor Statistics data, and other economic and population data sources.
- Experience using wide range of demographic data variables and creating maps displaying geodemographics is preferred.
- An undergraduate or graduate degree in Demography, Sociology, Geography, Economics, or related field (business-related a plus). Demography and statistics course work required.
- Experience with MapInfo, ArcView, or Atlas GIS a plus.
- Excellent oral and written communications and presentation skills.
- Must have good English communication skills, bi-lingual Spanish or other language is a plus.
- Proficient in MS Access, Excel, Word, and PowerPoint.

Innovation, team player mentality, diligence, high-energy, winning are all key attributes of the person we are looking for. If this describes you, please inquire.

Location: Headquarters in Miami, Florida. USA

To give an idea of this trend, three examples of applied demographers who have taken advantage of the opportunity provided by this consulting are provided. First, Shelley Lapkoff and Jeanne Gobalet have been entrepreneurs running their own private consulting business for more

than 10 years. They have been financially successful by focusing on demographic studies of school districts, particularly in California, and providing enrollment projections for a range of planning needs (For an example of such a study, see Gobalet and Lapkoff, 1991). A second example is provided by Jerry McKibben, who has experienced a similarly successful consulting business with school districts in the mid-west (See, *e.g*., McKibben, 1996). In the third example, a broader range of consulting is provided by the work of Peter Morrison, who has run successful consulting projects for more than 20 years in the United States, dealing with business, government, and school districts (many of which have been published in the form of case studies (See. *e.g*., http://www.rand.org/labor/staff/morrison/pubs.html). Morrison has also engaged in international applied demographic studies.

Examples of the challenge provided by this outsourcing trend include the state of Minnesota, which let go or reallocated staff in its long-standing demographic studies unit in the State Planning Office. Similar challenges have appeared elsewhere – Michigan and New York, for example.

In a broad sense, the availability of consulting projects in applied demography represents a substantial opportunity for demographers employed in academic institutions, where working conditions and incentives encourage the pursuit of project contracts and consulting work. This is particularly true for applied demographers within schools and colleges of business or public policy, where active hands-on participation in projects outside of the academy is generally encouraged.

Methodological and Technological Developments[11]

Here we focus on developments that we believe will continue to profoundly shape how estimates and projections are produced. We start with methodology.

Methodological developments are those affecting the models used to formulate relationships among input data and project those relationships into the future. Objective methods differ in how they use specific variables, data sources, and time periods. They also differ in the ways in which those variables and data sources are related to each other as well as in the assumptions made regarding changes in specific variables and their inter-relationships (de Gans 1999).

Methodological advances are likely in at least six areas: (1) Micro-simulation models; (2) Spatial diffusion models; (3) Artificial neural networks; (4) Integrating expert judgment; (5) Measuring uncertainty; and (6) Combining. All of these developments have the potential to raise the overall utility of population estimates and projections; some of them may improve accuracy as well.

Micro-simulation Models

For many years, population estimates and projections were made primarily at the national and state/provincial levels. In recent decades, they have been carried out at progressively lower levels of geography and now are routinely made for very small areas in the United States – census tracts, block groups, and traffic analysis zones. Methods are already designed for extremely small areas such as blocks and grid cells (*e.g.*, San Diego Association of Governments 1998). We also note a growing demand for estimates and projections for even smaller areas such as tax assessor parcels, block faces, and street segments. Taking this trend to its logical conclusion implies the development of estimates and projections for individual households and people, as evidenced by the TRANSIMS project (University of California, 1999).[12]

Spatial Diffusion Models

Population growth often moves progressively outward from (relatively) densely populated areas. This is a widespread (albeit not universal) pattern that has characterized historical population growth at the national and local levels. Geographers refer to this growth pattern as *spatial diffusion*, defined as the spread of a particular phenomenon over space and time, starting from one specific geographic area. It is a process in which behavior or characteristics in one area change because of what happened *earlier* in some *other* area (Morrill, Gaile, and Thrall 1988: 7). Spatial diffusion models hold a great deal of promise for small area population projections such as traffic analysis zones and blocks (e.g., Wu and Webster 1998).

Artificial Neural Networks(ANN)

Artificial neural networks (sometimes simply called *neural networks*) are mathematical models inspired by the organization and functioning of biological neurons (Hill, Marquez, O'Connor, and Remus 1994: 6).[13] These mathematical models are *not* based on the analyst's specification of relationships among independent and dependent variables; rather, ANN models develop these relationships on their own as they analyze input data by following procedures set forth in the model (*e.g.*, Adya and Collopy 1998, Lippmann 1987, Wasserman 1989, Schocken and Ariav 1994, Zhang et al. 1998).

Integrating Expert Judgment

Every population estimation and projection method requires the application of judgment on the part of the analyst. For example, the cohort-component method requires that assumptions be made regarding mortality, fertility, and migration rates. Structural models require decisions on independent variables and structural forms. Even simple trend extrapolation methods require choices regarding the length of the base period and adjustments for special events.

Very few population researchers have examined the effects of the use of overt judgment on accuracy and the literature is inconclusive. Some researchers have concluded that the application of expert judgment generally leads to more accurate results than can be achieved with strictly objective methods, but others have concluded that it has no consistent impact (Armstrong 1983, Grove and Meehl 1996, Makridakis *et al*. 1993, Roe, Carlson, and Swanson 1992, Webby and O'Connor 1996).

Measuring Uncertainty

Population estimates do not provide perfectly accurate information about the past or the present. Similarly, projections cannot provide perfectly accurate forecasts of future population growth. The uncertainty inherent in population projections, for example, has traditionally been accounted for by developing a range of projections (Campbell 1996, Day 1996). An alternative approach to dealing with uncertainty focuses on "prediction intervals" (*e.g*., Ahlo and Spencer 1997, Cohen 1986, Pflaumer 1988, Lee and Tuljapurkar 1994, Smith and Sincich, 1988, Swanson 1989, Swanson and Beck 1994, Tayman, Schafer, and Carter 1998). Whereas a range provides only a vague indication of uncertainty, prediction intervals provide an explicit statement of the level of error expected to accompany a specific population estimate or forecast, something that users are increasingly demanding (Bongaaarts, Bulatao, and Associates 2000: 215).

Combining

Improvements in accuracy have generally been noted when estimates resulting from different methods are averaged or otherwise combined (Kitagawa *et al.* 1980, Swanson 1978). Similar improvements have been found when projections resulting from different methods are averaged or otherwise combined (Armstrong 2001, Clemen 1989, Webby and O'Connor 1996). Combining can be done in a number of ways, including weighted averages, simple averages,

trimmed means, and composite approaches. Combining may offer the same potential benefits to population estimates and projections that have been achieved in other fields (Ahlburg 1999, Swanson *et al*. 1998).

Technological developments are those affecting the availability of input data and the computing tools used to organize and manipulate those data. Three technological developments—greater data availability, expanded computing power, and Geographic Information Systems (GIS)—are transforming the way small area population estimates and projections are made. These developments promise to have a great impact in the coming years.

Greater Data Availability

As an example of a new data product, consider the American Community Survey (ACS), which was started on a limited basis in 1996 and has been expanded every year since that time. It is expected to cover some three million households annually starting with 2004. By 2008, the U.S. Census Bureau plans to issue annual estimates (based on multi-year averages) down to the block-group level for every county.

Although there have been few recent changes in the *sources* of data used for making population projections, there have been major changes in the *formats* in which those data are available. For centuries, hard copy was the only available format. Recent decades have seen the development of computer tapes, diskettes, CDs, and the Internet. Information technology has revolutionized our ability to access data.

Another example of a data product that is likely to have an impact on the construction of population estimates and projections in the United States is the national Master Address File (MAF) assembled by the Census Bureau in preparation for the 2000 census.[14] The development of a continuously updated MAF/TIGER file will have a dramatic impact on the production of

small area population estimates, particularly if combined with data from the American Community Survey (Hammer, Voss, and Blakely 1999).[15]

Expanded Computing Power

In the early years of the electronic era, "automated" estimation and projection programs were written using a high-level programming language and were run through a centralized computer. The advent and widespread use of spreadsheet programs on personal computers has revolutionized the production, analysis, and evaluation of population estimates and projections. Modern spreadsheets have many built-in functions and macros to perform repetitive tasks, facilitating the creation, display, printing, and graphing of data (*e.g.*, Klosterman, Brail, and Bossard 1993). In addition, greater computing power and lower costs have made possible the development of powerful desktop and laptop software applications, such as GIS and a variety of statistical packages.

Geographic Information Systems (GIS)

A *geographic information system* is designed specifically to work with data referenced by geographic or spatial coordinates (*e.g.*, data coded by latitude and longitude). According to Star and Estes (1990: 24), a GIS has five essential elements: data acquisition, preprocessing (i.e., putting the data into a consistent format), data management, data manipulation and analysis, and product generation. A GIS provides the tools for linking spatial data with non-spatial data. It allows the analyst to organize data from one or more sources into a variety of geographic areas (*e.g.*, census tracts, ZIP codes, blocks, Traffic Analysis Zones, and market areas) and helps data users visualize spatial relationships.

GIS has been used for displaying data and conducting spatial analyses in a number of fields (Marks, Thrall, and Arno 1992, Thrall, 1998). In recent years, it has gained acceptance for

a variety of demographic activities as well (Morrison *et al.* 2002, Pol and Thomas 1997). In the coming years, we believe it will play an increasingly important role in the production of population projections. A study by Swanson *et al.* (1998) illustrates how this might be done.

For the near future, the main value of GIS will likely be developing databases rather than constructing population estimates and projections. In recent years, more and more databases have included geographic identifiers. One company (MapInfo 1998) estimated that 85% of all databases now contain some type of geographic information.

Concluding Observations

While there are challenges to the practice of applied demography in the United States, the opportunities abound. The opportunities are mainly in the form of the well-established understanding of the importance and ubiquity of "demographics" in a broad range of endeavors found within the private and public sectors. This serves as a strong source of demand for the products that applied demographers produce.

The challenges are mainly in the form of training and working conditions. In terms of training, there are two major issues. The first is the close linkage between sociology and demography. One problem with this linkage is that the normative practices within sociology programs in the U.S. are strongly oriented with basic (academic) science. As a consequence, teaching and research in applied areas is neither encouraged nor rewarded. Moreover, the entire field of demography itself is not necessarily welcomed in all sociology departments. The second issue is the lack of cross disciplinary training. Both of these issues represent less than optimal conditions for the training of applied demographers, largely because there are no strong ties to fields that can be classified as decision-making sciences. [16]

The major challenge found in the area of working conditions stems from the increasing trend toward as part-time employment and outsourcing, which is found in virtually all fields of employment in the U.S. These practices serve to enhance neither job security nor access to important benefits, such as health insurance.

As the heart and soul of applied demography, the development of data through estimation and projection (particularly for small areas) has and will continue to be affected by continued improvements in methods and technology. Although our paper has focused on applied demography in the United States, the developments in methodology and technology we described transcend national boundaries and, as such, serve to globalize the practice of applied demography. These developments will, in turn, influence the practice of applied demography in both the public and private sectors not only in the United States, but elsewhere. They suggest that even more skills will be needed by those with a desire to be successful – an understanding of GIS, dealing with large-scale data sets that are "micro" in nature.

In conclusion, we find that Bogue's (1957) prophetic view of "micro-demography" is a valid view of the field in the early 21st century. As was the case with the field of population projections in the early part of the 20th century (de Gans 1999), we see a full "transition to modernity" of applied demography in the early part of the 21st century, as it is practiced not only in the United States but elsewhere. With this transition, we agree with Swanson, Burch, and Tedrow (1996) that there should be a recognition that applied demography is a decision-making science and that much, if not all, of its training should be done in academic units that either share or tolerate this orientation.

ENDNOTES

1. This publication was also notable because it offered the first attempt to define applied demography. This was followed by much a larger book focused on the methods and concepts of applied demography (Murdock, and Ellis 1991). It also provided a definition of applied demography. Using earlier definitions, Swanson, Burch and Tedrow (1996) constructed a definition of applied demography as a decision-making science, and as such, more clearly differentiated it from basic (academic) demography. This definition was subsequently expanded upon by Siegel (2002).
2. This was done primarily by cross-checking PAA members showing a non-academic affiliation against an unduplicated count of the number of members in the online PAA Directory (http://www.popassoc.org) listing as primary areas of specializations any of the following: Business Demography; Data Collection and Processing; Estimates and Projections; Policy and Ethics; and State and Local Demography.
3. This is to say that estimates and projections are done by consultants and companies operating in the private sector as well as public sector organizations within the federal, state, and local governments. Claritas Corporation is an example of a private sector vendor ,while the forecasting unit in the Washington State Office of Financial Management is an example of a public sector organization.
4. An example of these positions can be found by perusing the employment bulletins of a number of professional organizations such as PAA and the Urban and Regional Information Systems Association (URISA), many of which are online. A recent example (May 12th, 2004, from the PAA's online employment service are provided in the Appendix as Exhibit 2.

EXHIBIT 2. JOB DESCRIPTION SUMMARY FOR THE KANSAS STATE DEMOGRAPHER

This position involves collecting and analyzing statewide demographic data, developing population projections for use by all state agencies and responding to demographic information requests. The incumbent assembles demographic data, generates and reviews population estimates and projections, and performs complex research studies involving demographic data. Work also includes preparing demographic data for use by government and private organizations, and preparing written reports on research findings for publication and dissemination. Employees at this level are usually in charge of a large and important organizational unit. They plan and carry out assignments with little supervision. They report regularly to a superior, usually by means of occasional conferences, to discuss work progress or new problems which require advice from above.

Work is of a highly diverse and/or complex nature characterized by a broad range of activities and frequently changing conditions, situations and problems. Considerable analytical thought is necessary for interpreting a variety of factors, problems and alternatives for methods and procedures. Work requires the origination of ideas, techniques and programs for solving technical problems or complicated situations. Workers at this level exercise a high degree of responsibility for independent judgment and may participate in major program changes or policy decisions.

Work may be reviewed by occasional conferences or reports to superiors. When guidelines exist at this level, they are normally characterized by regulations, policies or complex technical manuals. Consequences of actions or decisions at this level are significant as the work may be rarely if ever reviewed, making errors difficult to detect. Errors may cause major program failure or a high degree of confusion. Injuries to others due to errors are serious or incapacitating or both and costs due to errors are substantial.

The Incumbent must be able to is to justify, defend, negotiate, persuade or interrogate to settle matters, maintain good will, gain cooperation or reach compromises when the information is controversial or the individuals or groups have strong differences of opinions or diverse viewpoints. Extensive use of communication techniques and well developed communication skills are required for dealing with others.

The position involves functional leadership responsibility. As a "senior worker", performing essentially the same or similar work as those overseen, responsibility includes training, instructing, scheduling and reviewing. As a "project leader" may be responsible for a phase(s) of a single project which includes planning, coordinating and reviewing the work of others. This level may also involve limited administrative responsibility such as participating in the evaluation of work performance.

EXAMPLES OF WORK PERFORMED

Incumbent confers with representatives of federal, state, local and regional government agencies, and of private sector organizations, to assemble demographic data such as vital statistics, institutional or administrative data, and related information. Performs data processing and statistical analysis tasks to generate and review population estimates and official state population projections, and continuously revises and updates these population estimates.

Incumbent conducts complex research studies requiring sophisticated analyses of demographic data, such as studies on the components and determinants of natural increase, fertility, mortality, and migration, or on estimation and projection techniques; designs system framework for the maintenance of necessary data files and for preparing records and reports. Analyzes or performs calculations on demographic data at the request of state agencies, local governments, and regional groups, for their specialized planning and analytical activities. Prepares written reports and tables on demographic data, analyses and projections, for publication and dissemination to agencies and organizations which utilize population information.

5. It is recognized that many demographers become part of a team of experts and only their demographic expertise is required.
6. This is because sociology as an academic discipline exhibits the value orientation and empirical characteristics of a basic science while applied demography exhibit the value orientation and empirical characteristics of a decision-making science (Swanson, Burch, and Tedrow 1996).

7. A description of the applied demography program at Bowling Green State University can be found at: http://www.bgsu.edu/departments/soc/
8. The four courses are: Principles of Social Demography; Applied Demographic Methods I; Applied Demographic Methods II; and a Research Practicum. A full description of the applied demography program at Portland State University can be found at: http://www.upa.pdx.edu/CPRC/about/appdemog.html.
9. The term "intercensal estimates" refers to historical work, in which determinations of annual population numbers are made for the years between decennial census counts. That is, the Intercensal estimates by census counts that encompass the years for which estimates are desired. The term "post censal" refers to estimates made with only knowledge of past census counts (Bryan 2004).
10. An example of a typical Census Bureau position for an applied demographer is found in the Appendix as Exhibit 3. More details on this and other positions at the Census Bureau can be found online at; http://www.census.gov/hrd/www/jobs/ssdmstat.html.
11. Material in this section was taken from a paper by Swanson, Smith, and Tayman (2001). We are grateful to the authors, in particular, Stan Smith and Jeff Tayman, for the use of this material.
12. "TRANSIMS" is an acronym for "transportation simulation system." As stated in the text, this ambitious endeavor is designed to develop forecasts and related analytical models using households and even people as the units of analysis (University of California 1999).
13. Additional examples of the use of artificial neural networks in demographic applications include work by Zhang (1994), Mitchell, Martin, and Foody (1998) and Chang (1994).

EXHIBIT 3. US CENSUS BUREAU JOB DESCRIPTION

STATISTICIAN (CONCENTRATION IN SOCIAL SCIENCE)

JOB SUMMARY AND QUALIFICATIONS

Would you be interested in:

Designing, managing and analyzing national and international surveys and studies that supply the official population and housing statistics that Congress, state and local government, other Federal agencies and businesses want on such topics as:

- Population Size and Distribution
- Income and Poverty
- Employment and Unemployment
- Family and Fertility
- Health and Disability
- Housing and Neighborhood Characteristics

What you need to know:

Their background includes 15 semester/22 quarter hours in mathematics and statistics in courses plus 9 semester hours in social science, business, or related classes. Examples of the types of classes included in the math and statistics requirement:

- Basic Social Statistics
- Intermediate or Advanced Social Statistics
- Business and Economic Statistics
- Research Methods
- Quantitative and Qualitative Analysis
- Demographic Techniques and Analysis
- College Algebra
- Calculus
- College Math
- Intermediate Procedures for Data Collection

14. “MAF/TIGER” is an acronym for “Master Address File/Topologically Integrated Geographic Encoding and Referencing System.” “MAF,” as noted in the text is the master address file for the entire United States that was created for the200 census and remains in use for 2010 and beyond (Swanson and Stephan 2004: 765). “TIGER” is the digital database of geographic features (e.g., roads, rivers, political boundaries, census statistical boundaries, etc.) covering the entire United States. It was developed by the U.S. Census Bureau to facilitate computerized mapping and areal data analysis (Swanson and Stephan 2004: 776).
15. The United States is not the only country where there has been marked improvement in the availability of data. Within Europe, for example, work has been going on for some time toward developing workable collection procedures, common standards and consistent definitions for the population data collection activities undertaken in Europe (United Nations 2001, Van Bochove 1996). In addition, the importance of small area data is recognized and work continues to improve the availability of these data not only in Europe (Duke-Williams and Rees 1998, Feldmann and Jakob 2000, Thomsen and Kleive-Holmy 1998), but also elsewhere (Man-Kong 1996, Swanson, Carlson, and Williams 1990).
16. If there were more free-standing, degree-granting demography programs within universities in the United States this would be a moot point because there appears to be no huge divide between applied and basic demography (Swanson, Burch, and Tedrow, 1996).

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