APPLIED DEMOGAPHY: ITS BUSINESS AND PUBLIC SECTOR COMPONENTS

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Contents

Summary

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 focus here is on applied demography in the United States, the developments described in methodology and technology transcend national boundaries and, as such, serve to globalize its key features and practice. These developments will, in turn, influence business demography not only in the United States, but elsewhere. They suggest that even more skills and an expanded demographic perspective will be needed by those with a desire to be successful applied demographers.

1. Introduction

Business demography is considered to be relatively new, as is its closely related counterpart, "public sector demography." Together, these two areas can be considered as comprising applied demography. As such, we refer to them collectively as "applied demography" throughout our discussion. What is applied demography? It is primarily concerned with solving exogenously-defined problems by producing the information necessary to effect practical decision-making while minimizing the time and resources needed to produce this information. Basic demography, in comparison, is primarily

concerned with solving endogenously-defined problems by offering convincing explanations of demographic phenomena while viewing time and resources as barriers to surmount in order to maximize precision and explanatory power. Demographers view basic demography as comprised of two distinct subsets, formal demography and population studies.

It also is useful to distinguish business demography from public 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 of "social demography" at an earlier time. As can be seen in Figure 1, the refinement and extension of census and survey data as well as administrative records data (the foundation upon which estimates and projections are based) are accomplished by the processes of estimation and projection, which overlap both sectors. Estimation and projection are viewed as the heart and soul of applied demography.
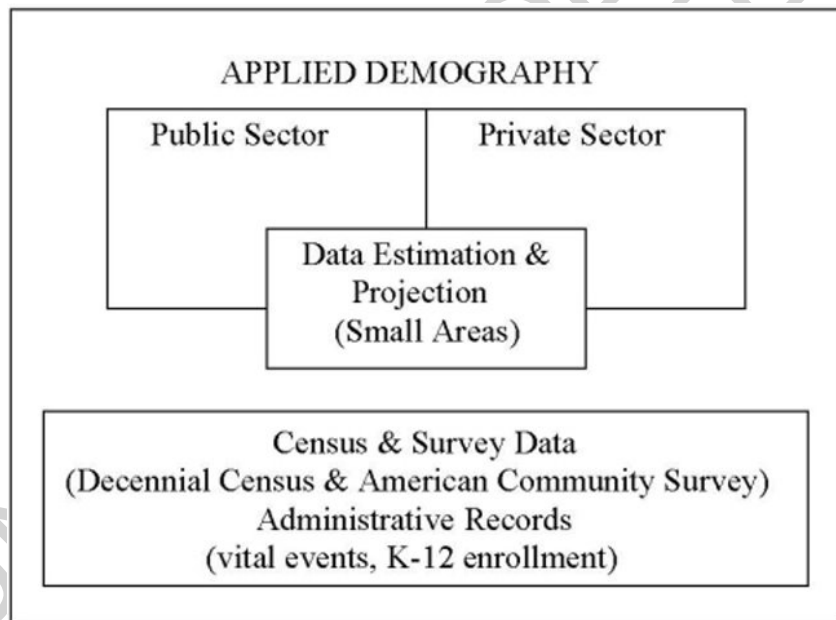

Figure 1 Major Components of Applied Demography & Their Relationships.

Before turning to a discussion of business demography, it is useful to define not only the terms "estimate" and "projection," but also the term "forecast." Because it is more inclusive, we generally use the term "projection" rather than "forecast" in our discussion.

Estimate – A calculation of a current or past population, typically based on symptomatic indicators of population change.

Projection -- The numerical outcome of a particular set of assumptions regarding future

population trends.

Forecast – The projection deemed most accurate for the purpose of predicting future population.

It also is useful to note here that there are two distinct traditions in regard to population estimates (1) demographic; and (2) statistical – that is, the methods used by those who do sample surveys. Demographic methods are used to develop estimates of a total population as well as the ascribed characteristics – age, race, and sex - of a given population. Statistical methods are largely used to estimate the achieved characteristics of a population – educational attainment, employment status, income, and martial status, for example. Among survey statisticians, the demographer's definition of an estimate is generally termed an "indirect estimate" because unlike a sample survey, the data used to construct a demographic estimate are symptomatic indicators of population change (e.g., K-12 enrollment data, births, deaths,) and do not directly represent the phenomenon of interest. Among demographers, the term "indirect estimate" has a different meaning (See "Direct Estimate" and "Indirect Estimate" in the Glossary). As is suggested in Figure 1, most national statistical agencies produce estimates using both of these traditions, demographic and statistical. We return to this issue later when we discuss small area demography. In regard to population projections, the distinction between the demographic tradition and the statistical tradition is less pronounced, however.

It also is important to note that there are two different definitions of "population" used by national statistical agencies. In the United States, for example, the Census Bureau uses a definition based on place of "usual residence." This also is known as the "De Jure" population. The other definition is based on the concept of a "De Facto" population. Examples of de facto populations are many. They include vacationers (of interest, for example, to the hotel owners in Phuket, Thailand, the casino industry in Macao or Las Vegas, and the Hawaii Visitors Bureau), migratory workers (of interest, for example, to health care, school, and other social service providers), and the people who work in the central business district of a large city each day, but leave it largely vacant in the evenings (of interest to the San Francisco City Planning Office, for example). While estimates of De Facto populations are of great interest, they are difficult to make in countries that use the De Jure concept of residency for their census counts. In addition, they are also difficult to evaluate in these countries because there is no "gold standard" against which to measure them in terms of validity and reliability.

2. Business and Public Sector Demography

The development of an applied demographic focus has been driven by the interaction of several elements that have shaped the nature of certain 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. In the late 1950s, Donald Bogue introduced the concept of "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. However, business demography as it is known today is a phenomenon that only emerged in the late 1970s. 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, some of 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, both for the private and the public sectors. Finally, while the vast majority of demographic research focuses on the demography of geographic units, it is worthwhile to note that an interest in organizational demography and other non-geography-based applications has emerged in the last decade or so.

Both Business and Public Sector Demography focus on the use of demographic data, methods and perspectives in decision-making. 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 possibilities in the global marketplace are being evaluated and public works projects are being designed. Demographic data and techniques have been used by businesses for over 100 years. However, the recognition of business demography as a distinct field has only come about in the past 30 or so years. It now is common for many businesses to make decisions on the basis of demographic criteria. To effect these decisions, businesses rely upon the advice of experts who can assemble, analyze, and interpret demographic data.

2.1 Basic Data Sources

In countries that have good census counts, supplemented by reasonable surveys, and maintain some level of administrative records, such as vital events registration (e.g., Australia, Canada, France, India, Japan, New Zealand, the United Kingdom, and the United States), most estimates rely on one or more censuses and use administrative record systems on which different estimation methods for census-defined populations rely (Of course, in countries that have accurate and comprehensive population registers, estimates of this nature are not needed, as is the case in Finland, for example). In the United States, these records include vital events, tax returns, housing permits, assessor parcel files, utility hookups, licensed drivers, covered employment, K-12 enrollment, Medicare counts, and child support payments, among others. It is important to note that there is some variation in availability and quality of administrative records systems by state and by local jurisdictions in the U.S., as well as considerable variation among countries. For example, Alaska makes annual payments to its residents, a unique feature in the United Sates; while in Canada, these records include family allowance payments, as would be the case in other countries with similar pro-natal policies. It also is important to note that the U.S. Census Bureau maintains as much consistency in data sources and methods as it can because among other desirable features it wants to have a consistent set of estimates for a given "vintage" year. We also note here the emergence of an important resource directly collected by the U.S. Census Bureau – a Master

Address File (MAF) constructed for the 2000 census that is updated and maintained until the next census. This is a new resource for the Census Bureau's estimates program because in the previous "mail-out/mail-back censuses, the MAF was constructed from scratch before each census. This housing unit inventory potentially serves as a key resource in the Census Bureau's ability to construct current population estimates. Similar data sets can be found in other countries that conduct regular census counts. It also is useful to note that in these same countries, "record matching" techniques (also known as dual system estimation) can be used to develop estimates. Similar techniques, called "capture-recapture" methods, are used by biologists to estimate the sizes and compositions of wildlife populations such as deer, eagles, and salmon.

In countries that have neither an accurate and comprehensive national population register nor good census counts, surveys, and administrative record systems, the development of population information for business demography is severely limited. In such cases, techniques that emerged from formal demography are needed, such those described in *The Demography of Tropical Africa* by William Brass et al. Another possible approach that could be used is the use of remote sensing (satellite imagery), such as described by Qui, Woller, and Briggs and by Wicks, Vincent, de Almeida, and Swanson, among others.

Demographic and related data of interest to the business demographer are also found in the private sector. CLARITAS, for example, is a global vendor of demographic and related information in the form of estimates and projections, as is PITNEY BOWES MAPINFO (formerly known as MAPINFO). The large U.S.-based credit bureaus, Equifax, Experian (TRW) and TransUnion, for example, have vast amounts of demographic and related data for households and individuals, as does R. L. Polk, a company that sells city directories. At least some of these companies will sell data to other companies and individuals for analytic and other uses related to business demography. While there are a few other companies in the credit bureau business, there are many small companies in the business of selling customized estimates, projections, and other types of analyses. These companies usually rely on a singular feature that distinguishes business demography from public sector demography, namely the interest in information for postal delivery areas (known as zip codes in the United States). Many companies define their market areas by postal delivery areas and while some national statistical agencies provide census data for these pieces of geography, they do not routinely produce estimates and projections for them. Among other sources (e.g., raffle and lottery tickets), customer loyalty cards and credit cards can be used by the companies that offer them to build purchasing records on the people that hold these cards. That is, these records can provide information on the demand for goods and services. When these records can be statistically matched with demographic, income and other information held on these same individuals from the large credit bureaus, the supply side of the picture emerges. These data become a very important source for analyzing patterns and trends when they are aggregated by characteristics on the demand and supply side, as well as by geography and time.

2.2 Tools

The tools of the trade break down generally into those used for estimation and those

used to make projections, although there are important tools that do not neatly fall into either category, such as data mining and GIS (Geographic Information Systems). Neither data mining nor GIS fall neatly into the preceding discussion because they serve largely as precursors to developing either estimates or projections.

The methods generally used to make estimates are generally found under the headings of component methods, ratio methods, regression-based methods, housing unit methods, and combinations of one or more of these methods, including ratio-correlation and synthetic estimation. These terms are defined in the Glossary and described in "Population Estimates," by Tom Bryan, a chapter found in *The Methods and Materials of Demography, 2nd Edition* that provides references to more detailed discussions. Some or all of these methods are not only used by national statistical bureaus in such countries as Australia, Canada, the United Kingdom, and the United States, but also by sub-national entities in these countries such as states, provinces, counties, cities, and councils of government. Some of these same methods can be combined with current sample survey data, to include the ratio methods and regression.

The basic projection methods found in business demography include simple and complex trend extrapolation methods, simple and complex ratio methods, the cohort-component method and its variants (e.g., the Hamilton/Perry Method), and structural models, which include economic/demographic models and integrated land use and transportation models.

2.3 Training

Like many other scientific disciplines, training in applied demography has a formal education component and a practical or on-the-job component. 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. Critical to the mastery of these skills is the ability to use the tools discussed in the preceding section. For example, a business 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 and possible tax incentive programs; (6) land costs; (7) construction costs; (8) an understanding of the markets from which customers will be drawn; and (9) financing in order to be a full partner in the project. 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

serves the training needs of applied demography very well. In only a few instances are programs and courses found within sociology that are well-designed for applied demography, much less business demography. It also is the case that applied demography is neither often found in applied fields (e.g., urban planning departments) nor as part of interdisciplinary efforts (e.g., public policy departments).

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 designed both for majors in sociology and others. "Business Demography" is taught to undergraduate business and MBA students at the University of Nebraska at Omaha. The Helsinki School of Economics offers a course that is specific to business demography: "Demographic Analysis and International Business," while the Department of Business at Macquarie University offers several undergraduate courses in demography, including "Business Demographics." Moreover, the program at Macquarie University is housed in the business department, thus providing some advantages over programs that call Social Science or Arts and Science colleges their home. An undergraduate course titled "The Demography of Business/Policy" is offered at Duke University and "Market Research in Public and Private Sector Organizations" is taught at Brown University. A graduate course titled "Demographics for Planning and Policy" is taught at the University of California, Irvine, which offers an entire Master's Degree program in applied demography. "Applied demography" is taught at the University of Calabria in Italy. Graduate level 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. In terms of pedagogy, the teaching of these courses varies, but some version of the case study method is often found in them. This list of institutions offering courses and programs is meant to be illustrative, not exhaustive, and, as such, we note that new training and education efforts are developing all over the world.

3. Examples.

3.1. The Need for a New Medical Facility

With the advent in the 1980s of intense competition among medical care providers in the U.S., organizations proposing medical facilities such as hospitals were required by local and state health planning board to demonstrate a need for the proposed services by applying for a "certificate of need." In 2006, David Swanson was engaged by a client to evaluate population projections done using geometric extrapolation to support the need for a medical facility in the urban fringe of a large city in the southern U.S. As a basis for his evaluation, Swanson needed to develop three sets of cohort-component population projections comprised of high, medium, and low scenarios, for the set of zip codes comprising the study area. Swanson found that the population forecasted for the study area on behalf of the organization seeking to build the facility lacked face validity, was implausible, and failed to give any indication of the uncertainty inherent in it. As Swanson discussed in his report, compound growth, linear, and other mathematical

extrapolation formulas have their place in the demographer's tool kit and are particularly useful when data series are incomplete and budgets are highly constrained. However, in the case of the population of the study area, the data series were, in fact, quite complete, and Swanson observed that was the organization should not have been so constrained by costs as to require such a simplistic and inexpensive forecasting method, one that resulted in unrealistic results by being carried too far into the future. A less damaging, but important defect in the organization's projection was that it provided no indication of the uncertainty inherent in it. A judge agreed with these findings and found in favor of Swanson's client.

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Keilman, N. 1988. "Dynamic household models" pp. 123-138 in: N. Keilman, A. Kuijsten, and A. Vossen. (eds.) *Modelling Household Formation and Dissolution* Oxford, England: Clarendon Press. The author compares five different macro demographic models and finds that the modeling of individual behavior rather than household behavior is a good strategy. He states that the multidimensional approach holds considerable promise for modeling household behavior and observes that there are three difficulties common to most models (1) the availability of data necessary to run the models; (2) inconsistencies that arise when individuals of different sex are modeled separately; and (3) the exponential increase in the number of states when a detailed household breakdown is considered.

Kimpel, T. and T. J. Lowe. 2007. "Estimating Household Size for use in Population Estimates." *Population Estimates and Projections Research Brief No. 47*. Olympia, WA: Washington State Office of Financial Management. The authors evaluate he accuracy of estimates of household size against results from the 200 census for counties in Washington State and then compare the results of three different regression-based approaches for estimating average household size in 2005. They conclude that additional research in this area is needed as there is presently no single model specification or set of variables that population analysts/demographers agree upon.

Kintner, H. and L. Pol. 1996. "Demography and Decision Making." *Population Research and Policy Review* 15 (5/6): 579-584. The authors describe how demographic input is but one of several components needed to make decisions by businesses and argue that to some extent the future of applied demography will be determined by non-demographers.

Kintner, H. and D. Swanson. 1994. "Estimating Vital Rates from Corporate Databases: How Long will GM's Salaried Retirees Live?" pp. 265 – 295 in H. Kintner, T. Merrick, P. Morrison, and P. Voss (Eds.) *Demographics: A Casebook for Business and Government*. Boulder, CO: Westview Press. The authors described how they used internal company records and standard demographic techniques to develop estimates of the longevity of General Motors' "white collar" retirees. These estimates where then used to generate expected future "white collar" retiree populations.

Kintner, H. and D. Swanson. 1996. "Ties that Bind: A Case Study of the Link Between Employers, Families, and Health Benefits." *Population Research and Policy Review* 15 (5-6): 509-526. The authors examine the linkages among employer policies, employee turnover, and family dynamics. They find that employers face limits to the control that they can exert over the size of the health benefits group associated with their active workforce. Demographic processes unrelated to employee turnover or transfers to layoff or retirement accounted for a large portion of the population change in the case study

Kintner, H., T. Merrick, P. Morrison, and P. Voss. 1994. *Demographics: A Casebook for Business and Government*. Boulder, Colorado: Westview Press. This is a collection of 20 case studies prepared by a group of demographers; professors of economics, sociology, population studies, business, and marketing; and research analysts. It is written in non-technical language and designed for instructional use. It covers applications of applied demography in government planning, long term corporate strategy, forecasting, human resource management, and marketing.

Kitagawa, E. et al. 1980. *Estimating Population and Income of Small Areas*. Washington, D.C.: National Academy Press. In this book, the authors examine the population estimation program of the U. S. Bureau of the Census it provides guidance for improving the Census Bureau's program and for policy makers who use such estimates for allocating funds.

Kliss, B. and W. Alvey 1984. (Eds). *Statistical Uses of Administrative Records: Recent Research and Present Prospects, Volumes I and II*. Washington, D.C.: Department of the Treasury, Internal Revenue Division, Statistics of Income Division. The authors describe research into the use of administrative records for purposes of determining population numbers and the characteristics of these populations. Suggestions on offered in regard to the strengths of weaknesses of using administrative records for these purposes.

Krotki, K. 1978. (Ed.) *Developments in Dual System Estimation of Population Size and Growth*. Edmonton, Alberta, Canada: University of Alberta Press. The authors provide an assessment of costs and benefits using two independent systems for estimating both vital events and population and describe the state of the art for them. Suggestions are made for improving these systems.

Lee, E. S. and H. F. Goldsmith. 1982. (Eds.), *Population Estimates: Methods for Small Area Analysis*. Beverly Hill, CA: Sage Press. These are the proceedings of the 1978 Small Area Estimation Conference sponsored by the U.S. National Institute of Mental Health. Ten papers by various authors are included, together with a series of evaluations and synopses by the editors. The overall theme of the papers is exploring new ways to estimate population numbers and characteristics.

Lee, R. and S. Tuljapurkar, 1994. "Stochastic Population Forecasts for the United States: Beyond High, Medium, and Low." *Journal of the American Statistical Association* 89: 1175-1189. The authors blend mathematical demography and statistical time series methods to estimate stochastic models of mortality and fertility using historical data. They then use random-matrix products to forecast various demographic measures.

Mandell, M. and J. Tayman. 1982. "Measuring Temporal Stability in Regression Models of Population Estimation." *Demography* 19: 135-146. The authors introduce an empirical indicator designed to measure the temporal stability of regression models used to estimate sub-national populations. In a case study using the 67 counties of Florida, they find that variable measurement and type are important determinants of estimation accuracy and that the temporal stability of the regression models' coefficients is not a determining influence in accuracy.

Marks, A. G. Thrall, and M. Arno. 1992. "Siting Hospitals to Provide Cost-Effective Health Care. *Geo Info Systems* 2:58-66. The authors describe how a Geographic Information System (GIS) can be used both to create a spatial data base and to perform a market analysis of the need for additional hospitals. The robustness of a GIS in market analysis is shown by including satellite data for land use-land cover and slope, incorporating data about distance to population decay factors, creating buffers around existing hospitals, and identifying a unique service area for each hospital by applying a weighted Voronoi polygon technique.

McKibben, J. and D. Swanson, 1997. "Linking Substance and Practice: A Case Study of the Relationship Between Socio-Economic Structure and Population Estimation." *Journal of Economic & Social Measurement* 24: 135-147. The authors argue that some ofthe shortcomings in small area population estimation methods would be better understood by linking these methods with the substantive socio-economic and demographic dynamics that underlie them. Using a case study of Indiana over two periods, 1970-1980 and 1980-1990, the authors find that changes in the coefficients of a regression-based estimation model are linked to Indiana's transition to a post-industrial economy. They then describe how this transition operated through demographic dynamics that ultimately affected the estimation model.

Morrison, P. and A. Abrahamse. 1996. "Applying Demographic Analysis to Store Site Selection." *Population Research and Policy Review* 15: 479-489. This case study illustrates how applied demographic analysis can help structure business decision making. The authors screened every one of several thousand square miles within metropolitan Southern California to identify the 10 best locations for a large supermarket catering to one-stop shoppers. The analytic framework for comparing high-potential locations played a central role in structuring the client's thinking.

Morrison, P., D. Swanson, J. Tayman, I. Sharkova, and C. Popoff. 2002. "Meeting Local Information Needs: A Case Study in Team Applied Demography." *Applied Demography* 14 (Spring): 1-3. The authors describe how a set of different skills can be used to develop a small area population estimation system.

Murdock, S. and D. Ellis. 1991. *Applied Demography: An Introduction to Basic concepts, Methods, and Data.* Boulder, Colorado: Westview Press. This book shows the application of demographic techniques in a wide range of areas, including real estate, marketing, and regional and services planning. It includes chapters on demographic concepts and trends, data sources and the principles of data use, basic methods and measures of applied demography, and methods for estimating and projecting populations.

Myers, D (ed.). 1990. *Housing Demography: Linking Demographic Structure and Housing Markets*. Madison, WI: University of Wisconsin Press. This book consists of 13 papers selected to bridge the gap between the separate analysis of population data and housing data in the United States. The approach is interdisciplinary, involving demography, economics, geography, sociology, and urban planning. A major objective of the book is theory building. The papers are grouped under three main headings: linking housing characteristics with household composition, life course and cohort models of housing choice, and housing consumption among the elderly.

Norcross-Bryan, K. and R. George. 2004. "Geographic Information Systems." pp. 733-750 in J. Siegel and D. Swanson (Eds.) *The Methods and Materials of Demography, 2ⁿᵈ Edition*. New York, NY: Elsevier/Academic Press. The authors provide an overview of how Geographic Information Systems can be used by demographers.

Pitkin, J.R. 1992. "A Comparison of Vendor Estimates of Population and Households With 1990 Census Counts in California." *Applied Demography* 7(1):5-8. The author compares the 1990 population estimates of four national demographic data vendors with the actual counts of the 1990 U.S. Census. Differences in accuracy are found among the vendors and between variables.

Plane, D. and P. Rogerson. 1994. *The Geographical Analysis of Population, with Applications to Planning and Business*. New York, NY: John Wiley and Sons. This book focuses on both applied

demographic and planning techniques that rely upon geographical aspects of population data. It is designed to be used for instructional purposes and describes methods used to assess the impact of population change on facility demand, school enrollment, changes in product market, transportation and recreation demand forecasting.

Platek, R., J. Rao, C. Sarndal, and M. Singh (Eds.) 1987. *Small Area Statistics: An International Symposium*. New York, NY: John Wiley. This book covers a range of demographic and statistical techniques used to develop small area and small domain population information.

Pol, L. and R. Thomas. 1997. *Demography for Business Decision Making*. Westport, CT. Quorum Books. The authors provide practitioners and students alike with an introduction to the concepts and methods of business demography. They also present an overview of recent and future demographic trends and provide many examples of real world situations in which demographic methods, data, perspective, and theory are actively applied.

Pol, L. 1998. "Demographic Methods in Applied Demography: An American Perspective." *Genus* 52 (1-2): 159-176. The author explores the usage of demographic methods in applied demography and documents the range of methods being used to help address a wide range of public and private sector opportunities and problems in the United States.

Popoff, C. and D. Judson, 2004. "Some Methods of Estimation for Statistically Underdeveloped Areas." pp. 603-641 in J. Siegel and D. Swanson (Eds.) *The Methods and Materials of Demography, 2ⁿᵈ Edition*. New York, NY: Elsevier Academic Press. The authors describe a wide range of techniques, largely based on formal demography, for making population estimates in countries lacking good census counts and administrative records. They provide illustrations of these techniques.

Pozzi, F., Small, C., and G. Yetman. 2003. "Modeling the distribution of human population with night-time satellite imagery and gridded population of the world." *Earth Observation Magazine* 12(4): 24–30. The authors examine the "World Stable Lights" dataset as a potential means to refine the spatial detail of the population dataset. They found a consistent relationship between population density and light frequency and developed a transfer function to relate light

frequency to population density and a mass-conserving algorithm that relocates fractions of populations within large administrative units to locations of lighted settlements.

Prevost, R. and D. Swanson. 1986. "A New Technique for Assessing Error in Ratio-correlation Estimates of Population: A Preliminary Note." *Applied Demography* 1(November): 1-4. The authors demonstrate the algebraic equivalency of the Ratio-Correlation Method to a weighted average of censal-ratio estimates in which regression slope coefficients serve as weights.

Purcell, N. & Kish, L. 1980. "Postcensal Estimates for Local Areas (or domains)." *International Statistical Review* 48: 3-18. The authors demonstrate how iterative proportional fitting can be used to fit sample data to a flexible nonlinear model to develop estimates that preserve specified relationships found in a preceding census.

Qiu, F., K. Woller, and R. Briggs. 2003. "Modeling Urban Population Growth from Remotely Sensed Imagery and TIGER GIS Road Data." Photogrammetric Engineering and Remote Sensing 69: 1031–1042. Rao, J. 2002. *Small Area Estimation*. San Francisco, CA: Jossey-Bass. The authors modeled population growth from 1990 to 2000 in the north Dallas-Fort Worth Metroplex using two different methods: These methods were applied at both city and census-tract levels and were evaluated against the actual population growth.

Raymondo, J.C. 1992. *Population Estimation and Projection: Methods for Marketing, Demographic, and Planning Personnel*. New York: Quorum Books. The author describes the major methods of population estimation and population projection as a guide for the marketing and planning professionals who are the frequent users of population estimates and projections.

Rees, P., P. Norman, and D. Brown. 2004. "Improving Small Area Population Estimates." *Journal of the Royal Statistical Society, Series* A 167: 5–36. Using data from England, the authors present a framework for small area population estimation that enables users to select a method that is fit for the purpose. They concludes with a discussion of how data, on stream since 1998, might be included in future small area estimates.

Rives, N., W. Serow, A. Lee, H. Goldsmith, and P. Voss. 1995. (Eds.) Madison. *Basic Methods for*

Preparing Small-Area Population Estimates. Madison, WI: Applied Population Laboratory, Department of Rural Sociology, University of Wisconsin. This book covers the standard demographic techniques used to develop small area population estimates.

Rives, N. W., W. Serow, A. Lee, and H. F. Goldsmith. 1989. *Small Area Analysis: Estimating Total Population.* Rockville, MD: U.S. Department of Health and Human Services. This monograph covers the standard demographic techniques used to develop small area population estimates of the total population.

Rives, N. W. and W. Serow. 1984. *Introduction to Applied Demography.* Beverly Hills, California: Sage Publications. This was the first book on applied demography to be published. It covers basi techniques for estimation and projection and the sources of data that provide inputs to these techniques.

Roe, L., J. Carlson, and D. Swanson. 1992. "A Variation of the Housing Unit Method for Estimating the Population of Small, Rural Areas: A Case Study of the Local Expert Procedure." *Survey Methodology* 18(1):155-163. the authors describe a variation of the housing unit method that can be used to develop confidence intervals around population estimates.

Russell, C. 2006. *Best Customers: Demographics of Consumer Demand*. New York, NY: New Strategist Publications. This book identifies the best and biggest customers for hundreds of individual products and services, alerting marketers to potential booms and busts in the years ahead. The author analyzes household spending on more than 300 products and services by age of householder, household income, household type, race and Hispanic origin of householder, region of residence, and new to this edition, educational attainment of householder. She identifies which households spend the most on a product or service and which control the largest share of spending.

Schmitt, Robert C. and Albert H. Crosetti. 1954. "Accuracy of Ratio-Correlation Method for Estimating Postcensal Population," *Land Economics* 30(3): 279- 280, August. The authors introduce the ratio-correlation method by applying it to the 39 counties of Washington State

Shahidullah, M. and M. Flotow. 2005. "Criteria for selecting a suitable method for producing post-2000 county population estimates: A case study of population estimates in Illinois." *Population Research and Policy Review* 24 (3) 215-229. The authors compared 2000 county population estimates using the administrative records method, the ratio correlation method, and an average of the two methods for Illinois against 2000 census counts. The administrative records method performed best.

Siegel, J. 2002. *Applied Demography: Applications to Business, Government, Law and Public Policy,* San Diego, Academic Press. This book provides a comprehensive portrait of applied demography. It covers methods, sources of data and offers many examples.

Siegel, J. and D. A. Swanson.2004. *The Methods and Materials of Demography, 2nd Edition*. San Diego/Amsterdam, Academic Press/Elsevier. This book is a fundamental resource that covers the methods and materials of demography. It includes chapters on population estimation and population projection.

Simpson, S., I. Diamond, P. Tonkin, and R. Tye. 1996. "Updating Small Area Population Estimates in England and Wales." *Journal of the Royal Statistical Society, Series A*, 159 (part 2): 235–247. The author describes how small area population estimates (postal delivery areas and election wards) in England and Wales are not as systematically done as are those for larger areas. Using the type of method along with characteristics of the small area in question as explanatory variables, he finds that the method used is of great importance in determining accuracy.

Smith, S. 1994. "Estimating Temporary Populations." *Applied Demography* 9 (1): 4-7. The author describes the difficulty of tracking temporary short-term population movements (commuting, seasonal visitation, convention and business travel) with a focus on Hawaiian statistician Robert Schmitt's work. The author finds that "Schmitt's contributions toward a methodology for estimating daytime populations were important because this approach utilized data sources that were widely available for small areas on at least an annual basis. Consequently, this approach could be used for frequent updates of the estimates, for many areas and at relatively little cost.

Smith, S. 1989. "Toward a Methodology for Estimating Temporary Residents." *Journal of the American Statistical Association* 84: 430-436. The author discusses the problems of defining and estimating temporary residents, focusing on the strengths and weaknesses of a number of data sources and estimation techniques. He concludes with an assessment of the potential usefulness of developing methods to

estimate temporary residents.

Smith, S. and S. Cody.1994. "Evaluating the Housing Unit Method: A Case Study of 1990 Population Estimates in Florida." *Journal of the American Planning Association*. 60: 209-221. The authors evaluate the accuracy and bias of HU population estimates produced for counties and subcounty areas in Florida for April 1, 1990 and find, among other things, that population size has a negative effect on estimation errors (disregarding sign) but no effect on bias. The authors argue that the HU method offers a number of advantages over other population estimation methods and provides planners and demographers with a powerful tool for small-area analysis.

Smith, S. and M. Mandell. 1984. "A Comparison of Population Estimation Methods: Housing Unit versus Component II, Ratio-Correlation, and Administrative Records." *Journal of the American Statistical Association* 79: 282-289. Using data from Florida, the authors find that the Housing Unit Method performs as well as Component Method II, ration-correlation, and the administrative records method.

Smith, S. and P. Morrison. 2005. "Small-Area and Business Demography." pp. 761-786 in M. Micklin and D. Poston, Jr. (Eds.) *Handbook of Population*. New York, NY: Kluwer Academic/Plenum. The authors provide an overview of business and small area demography.

Smith, S. and T. Sincich. 1988. "Stability over Time in the Distribution of Population Projection Errors." *Demography* 25:461-474. The authors evaluate the assumption that forecast errors remain stable over time by making population projections for [U.S.] states for a number of time periods during the 20th century, comparing these projections with census enumerations to determine forecast errors, and analyzing the stability of the resulting error distributions over time. They find that in the distribution of absolute percentage errors remained relatively stable over time and data on past forecast errors provided very useful predictions of future forecast errors."

Smith, S. K., J. Nogle and S. Cody. 2002. "A Regression Approach to Estimating the Average Number of Persons per Household." *Demography* 39(4): 697-712. The authors develop regression-based estimates of the average number of persons per household and compare the accuracy of these estimates to those generated by other methods. They find that the regressions-based estimates are more precise and less biased than those produced by the other methods.

Smith, S., J. Tayman, and D. Swanson. 2001. *State and Local Population Projections: Methodology and Analysis.* New York: Kluwer/Plenum Academic Press. This book focuses on the methodology and analysis of state and local population projections. It considers the strengths and weaknesses of various projection methods, paying special attention to the unique problems of making projections for small areas, and concludes with an examination of technological and methodological changes affecting the production of small-area population projections.

Statistics Canada. 1987. *Population Estimation Methods, Canada*. Ottawa, ON: Statistics Canada. This monograph describes the methods used to produce official population estimates for Canada are discussed and evaluated. Individual chapters are organized around three recurring themes: (1) method; (2) data sources, and; (3) quality evaluation.

Statistics Finland. 2004. *Use of Register and Administrative Data Sources for Statistical Purposes: Best Practices of Statistics Finland*. Handbook Series, No. 45. Helsinki, Finland: Statistics Finland. This monograph provides a comprehensive look at Finland's population register system and its related components. It includes a history of the development of the population register and gives examples of how it is used.

Swanson, D. 2004. "Advancing Methodological Knowledge within State and Local Demography: A Case Study. *Population Research and Policy Review* 23 (4): 379-398. The author critically evaluates a "fugitive" method used to generate population estimates in the state of Nevada. The evaluation reveals statistical and methodological shortcomings in this model that lead to an alternative model not subject to these shortcomings. The author suggests that states in which estimates are used to allocate resources would be well-served by subjecting new methods being considered for use to academic peer review before they are adopted.

Swanson, D. 1989. "Confidence Intervals for Postcensal Population Estimates: A Case Study for Local Areas." *Survey Methodology* 15 (2): 271-280. The author demonstrates how confidence intervals can be developed for population estimates of small areas

Swanson, D. 1981. "Allocation Accuracy in Population Estimates: An Overlooked Criterion With Fiscal Implications." pp. 13-21 in *Small Area Population Estimates and Their Accuracy, Series GE-41, No. 7.* U.S. Bureau of the Census. Washington, DC: US Government Printing Office. The author argues that population estimates used for purposes of allocating resources in a zero sum environment should be evaluated in terms of mis-allocation error. He proposes the use of the index of dissimilarity for this purpose and provides an example of its uses.

Swanson, D. 1980. "Improving Accuracy in Multiple Regression Estimates of Population using Principles from Causal Modeling." *Demography* 17: 413-428. The author shows how relationships based on matrix algebra can be used to assess coefficient stability and to modify coefficients in the ration-correlation regression model to be consistent with post-censal population changes, thereby providing more accurate estimates.

Swanson, D. and D. Beck. 1994. "A New Short-Term County Population Projection Method." *Journal of Economic and Social Measurement* 20:25-50. The authors introduce the lagged ration-correlation method as a means of producing short term population projections and provide tests of its accuracy. They conclude that the method shows promise.

Swanson, D., and L. Pol. 2005. "Contemporary Developments in Applied Demography within the United States." *Journal of Applied Sociology* 21 (2): 26-56. The authors discuss current developments in the field of applied demography and relate them to broader issues.

Swanson, D., and G. E. Stephan. 2004. "Glossary." pp. 751-778 in J. Siegel and D. Swanson, (Eds.) *The Methods and Materials of Demography*, *2nd Edition.* New York, NY: Elsevier/Academic Press. The authors provide a comprehensive glossary of demographic terms.

Swanson, D., and J. Tayman. 1995. "Between a Rock and a Hard Place: The Evaluation of Demographic Forecasts." *Population Research and Policy Review* 14 (2): 233-249. The authors argue that there is a high level of cognitive dissonance found the process of forecasting, which can be reduced by refocusing forecast evaluations to include utility. They propose for this purpose the Proportionate Reduction in Error (PRE) measure and conclude that including PRE as an evaluation criterion can reduce stress by reducing cognitive dissonance without, at the same time, either trivializing the evaluation process or substantively altering how forecasts are done and presented.

Swanson, D., and L. Tedrow. 1984. "Improving the Measurement of Temporal Change in Regression Models used for County Population Estimates." *Demography* 21: 361-372. The authors introduce the rate-correlation method and provide a test of its accuracy. They conclude that it can provide better accuracy in situations where spatial auto-correlation may be present.

Swanson, D., G. Hough, J. Rodriguez, and C. Clemens. 1998. "K-12 Enrollment Forecasting: Merging Methods and Judgment." *ERS Spectrum* 16:24-31. The authors describe how the cohort-component method can informed by the use of GIS and informed judgment to develop K-12 enrollment forecasts. They provide a test of accuracy and conclude that the method shows promise.

Swanson, D., D. Beck, and J. Tayman. 1995 "On the Utility of Lagged Ratio-Correlation as a Short-term County Population Estimation Method: A Case Study of Washington State." *Journal of Economic and Social Measurement* 21:1-16. The authors evaluate the lagged ratio-correlation method for short term population forecasts by using a context that goes beyond accuracy to include utility. They find that the method performs well.

Swanson, D., T. Burch, and L. Tedrow. 1996. "What is Applied Demography?" *Population Research and Policy Review* 15 (5/6): 403-418. The authors argue that applied demography is intrinsically distinct from basic demography because it exhibits the value-orientation and empirical characteristics of a decision-making science while the latter exhibits the value-orientation and empirical hallmarks of a basic science. They examine this conceptualization of applied demography in terms of the methods and materials that fall within its purview and discuss some important consequences, including research agendas and training programs..

Swanson, D., J. Tayman, and C. Barr. 2000. "A Note on the Measurement of Accuracy for Subnational Demographic Estimates." *Demography* 37: 193-201. The authors argue that the mean absolute percent error (MAPE), a standard measure of accuracy for population estimates overstates error because it is right-skewed. They introduce a revised MAPE called MAPE-R and show how it can be used. The authors argues that MAPE-R should be part of the standard set of evaluation measures.

Swanson, D., R. Forgette, M. Van Boening, C. Holley, and A. Kinnell. 2007. "Assessing Katrina's Demographic and Social Impacts on the Mississippi Gulf Coast." *Journal of the Mississippi Academy of Sciences* 54 (2): 228-242. The authors provide estimates of the demographic and social effects of Hurricane Katrina on the Mississippi Gulf Coast using data collected in a special survey.

Tayman, J. and Pol. L. 1995. Retail Site Selection and Geographic Information Systems. *The Journal of Applied Business Research*, 11(2): 46-54.A guide to using GIS in conjunction with demography and related information to assist in selecting sites for retail outlets.

Tayman, J. 1996. "Forecasting, Growth Management, and Public Policy Decision Making." *Population Research and Policy Review* 15 (5-6): 491-508. The author describes the interplay between forecasting and decision making. He shows how a forecast helped shape public policy and, in turn, how public policy influenced a forecast. He concludes that normative forecasting best describes the relationship between the forecast and these public policy decisions.

Tayman, J., E. Schafer, and L. Carter. 1998. "The Role of Population Size in the Determination and Prediction of Population Forecast Errors: An Evaluation Using Confidence Intervals for subcounty areas." *Population Research and Policy Review* 17: 1-20. The authors describe a technique for making subcounty population forecasts and for generating confidence intervals around their forecast error. They find a non-linear, inverse relationship between population size and forecast accuracy and demonstrate the ability to accurately predict average forecast error and confidence intervals based on this relationship.

Tayman, J., S. Smith, and L. Lin. 2007. "Precision, Bias, and Uncertainty for State Population Forecasts: An Exploratory Analysis of Time Series Models." *Population Research and Policy Review* 26 (6): 347-369. The authors develop and evaluate six ARIMA time series models for states in the United States. Using annual population estimates from 1900 to 2000 and a variety of launch years, base periods, and forecast horizons, they construct population forecasts for four states chosen to reflect a range of population size and growth rate characteristics. They find that prediction intervals based on some ARIMA models provide relatively accurate forecasts of the distribution of future population counts but prediction intervals based on other models do not.

Verma, R., K. Basavarajappa, and R. Bender. 1984. "Estimation of Local Area Population: An International Comparison." pp. 324-329 in *1984 Proceedings of the Social Statistics Section*, Alexandria, VA: American Statistical Association. The authors discuss the current status of methodology on local area population estimation in five developed countries, Australia, Canada, England and Wales, New Zealand, and the U.S.A.

Verma, R., K. Basavarajappa, and R. Bender. 1983. "The Regression Estimates of Population for sub-provincial Areas in Canada." pp. 512-517 in *1983 Proceedings of the Social Statistics Section*, Alexandria, VA: American Statistical Association. The authors describe two sets of post-censal population estimates that are published yearly by the government of Canada. The two sets were found to be statistically similar, though the first set is more timely, and the second providing more details on the components of population change."

Walashek, P. and D. Swanson. 2006 "The Roots of Conflict over U.S. Census Counts in the Late 20th Century and Prospects for the 21st Century." *Journal of Economic and Social Measurement* 31 (3-4): 185-205. The authors described the modern U.S. Census as a "commons," in which private benefits are gained at public expense. They identify the role that historical actions played in making the census into a Commons, thereby setting the stage for modern day census litigation and other forms of conflict. The authors observe that as a Commons, the census is facing a potential collapse that cannot be prevented by methodological developments and conclude by noting that a course of political action may be the best course for preventing such a collapse.

Webster, C. J. 1996. "Population and Dwelling Unit Estimates from Space." *Third World Planning Review* 18(2):155-76. The author reports on attempts to measure the morphological patterns in an urban satellite scene and to use these for image interpretation. The interpretation task addressed is the estimation of residential dwelling units from the patterns discernible in high resolution satellite images of cities. The practical results include dwelling estimates that can be aggregated to any geographical unit of analysis, population estimates for cities and a dwelling density surface that can be categorized into any number of residential land-use classes."

Wicks, J. and D. Swanson (eds.). 1987. *Issues in Applied Demography: Proceedings of the 1986 National*

Conference. PSRC Press: Bowling Green, Ohio. The focus of the conference was on ways in which demographic data and concepts can be used to produce better and more informed business and public policy decisions. Subject headings include applied demography and government policy; technical issues in business demography; relations between public sector and academic demographers; demography and management issues in business; and linking the demographic information needs of business, state and local governments, and universities.

Wicks, J., R. Vincent, L. P. De Almeida, and D. Swanson. 1999. "Population Estimates from Remotely Sensed Data: A Discussion of Recent Technological Developments and Future Research Plans." Paper presented at the Annual Meeting of the Canadian Population Society, Lennoxville, Quebec, Canada. The authors discuss developments that have created opportunities for the advancement of using remotely sensed data to produce accurate and timely population and housing estimates. They outline plans for the design and testing of procedures capable of producing current population estimates from remotely sensed data.

Wolter, K. M. and B. Causey. 1991. "Evaluation of Procedures for Improving Population Estimates for Small Areas." *Journal of the American Statistical Association* 86: 278-284. The authors provide and illustrate methods for evaluating across-the-board ratio estimation and synthetic estimation. They observe that these two techniques have the potential to improve the accuracy of estimates for small areas.

Zeng, Y. K. Land, Z. Wang, and D. Gu. 2006. "U.S. family household momentum and dynamics: an extension and application of the ProFamy Method." *Population Research and Policy Review* 25: 1–41. The authors introduce a household projection method that uses demographic rates as input and provides more detailed household types, sizes, and living arrangements for all members of the population. Tests of projections from 1990 to 2000 show that discrepancies between projections done using this method and census observations in 2000 are reasonably small, validating the new method.

Biographical Sketches

David A. Swanson is Professor of Sociology, University of California Riverside and a Research Associate with the Blakely Center for Sustainable Suburban Development. His Ph.D. is from the University of Hawaii. Dr. Swanson's teaching interests include demographic methods, population forecasting, and business demographics. He regularly returns each summer to the Helsinki School of Economics, where he served as Dean of the English-language bachelor's program from 1999 to 2003, to teach Demographic Analysis and International Business. Dr. Swanson's research focuses on applied demography, especially small area population estimation and population forecasting He has published more than 65 sole- and co-authored refereed journal articles and hundreds of reports. With Stan Smith and Jeff Tayman, he wrote *State and Local Population Projections: Methodology and Analysis* (2001) and with Jay Siegel, edited *The Methods and Materials of Demography 2nd Edition* (2004). He serves as a member of the U.S. Census Bureau's Advisory Committee for Professional Associations and is a past editor of the journal, *Population Research & Policy Review*.

Louis G. Pol is John Becker Dean of the College of Business Administration, University of Nebraska, Omaha. His Ph.D. is from Florida State University. Dr. Pol's teaching interests include business and health demography, marketing research, and statistics. His research interests include demographic applications, research methodology and statistics, and health care policy. Dr. Pol is the author of six books, including *Demography for Business Decision Making* (1997), with Richard Thomas, and *The Demography of Health and Healthcare, 2nd Edition* (2001), also with Richard Thomas. In addition, he has published over 70 articles, book chapters, and research notes. His most recent work focuses on the determinants and consequences of being without health insurance, and developing a methodology for identifying rural areas at risk to not providing adequate health services to their populations. He serves or has served on the editorial boards of *Journal of Hospital Marketing, Journal of Professional Service Marketing*, *Journal of Marketing Theory and Practice*, *Health Marketing Quarterly*, and *Population Research and Policy Review*. He is past president of Southern Demographic Association