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DIFFERENT APPROACHES TO MONITORING LOCAL DEMOGRAPHIC CHANGE,(U)
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P-6743

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SUMMARY

This paper addresses a common problem applied demographers face: how to update demographic variables for small areas in the years following the decennial census. Such postcensal updates serve important planning purposes; they also figure in various formulas for distributing aid from higher to lower levels of government.

As background to considering the merits of a newly-proposed survey-based procedure, the author reviews various other conventional approaches to postcensal estimation--trend extrapolation, component analysis, and the use of symptomatic data. He then considers the survey approach as a complement to these other approaches.

The survey approach to local population estimation exemplifies a more general "information buying" strategy--that is, investment in information to resolve key uncertainties about the variables in question. The approach has obvious advantages: It furnishes high-grade evidence of population change and is adaptable to different local circumstances. Since its principal drawback is its expense, the central considerations favoring its adoption are likely to be situational, not technical.

While not feasible for widespread use, survey-based procedures may be well suited to certain types of settings. More important, the logic behind such procedures may have broader applicability to the uses of evidence--however acquired--in monitoring local demographic processes.

DIFFERENT APPROACHES TO MONITORING LOCAL DEMOGRAPHIC CHANGE[1]

by

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INTRODUCTION

In addressing ourselves to the purpose of this conference, which is to evaluate how the size and composition of small-area populations can be estimated, it is helpful to begin with a list of the variables to be updated. These variables derive from the Mental Health Demographic Profile System (MHDPS) and fall into two categories of priority (see Goldsmith et al., 1975):

Highest priority:

1. Size of total population
2. Percentage black
3. Age-sex composition of total population
4. Age-sex composition of black population

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[1] This paper (prepared originally for the National Institute of Mental Health's Conference on Small-Area Estimation in 1978) is a slightly modified version of a chapter to appear in Everett S. Lee and Harold F. Goldsmith, eds., Population Estimates: Methods for Small Area Analysis (Beverly Hills, CA: Sage Publications).

The author thanks Rand colleague Will Harriss for helpful comments on an earlier draft. Revision of this paper for publication was supported by Rand's Population Research Center Grant No. P-50-HD12639 from the National Institute of Child Health and Human Development, U.S. Department of Health and Human Services.

<u>Lesser priority</u>:

5. Size of low-income population
6. Number of low-income blacks and/or principal minority population
7. Percentage of total household population who are primary individuals
8. Percentage of black household population who are primary individuals
9. Percentage of dwelling units that are single detached
10. Percentage of black-occupied dwelling units that are single detached

These variables are to be estimated for several kinds of areal units: aggregates of census tracts, minor civil divisions (MCDs), census county divisions (CCDs), and whole counties (Goldsmith and Unger, 1973). A variety of estimation techniques might be useful for this task. The choice among them, however, is far from straightforward and involves several criteria.

Part of the assignment is to consider the merits of one such technique--The Survey Approach to Small Area Estimation as presented by Norfleet W. Rives, Jr. (forthcoming). I shall do so from two perspectives: (1) from the perspective of a specific technique to be applied, where considerations of feasibility inevitably enter in, and (2) from an analytical perspective, where we can consider how to extend the logic on which it is based. My conclusion, which I shall state at the outset, is that the procedure is noteworthy, not for its immediate feasibility, but because its underlying logic points toward a powerful strategy for monitoring local demographic change. Accordingly, I shall focus not only on the particulars of Rives's proposed estimation technique (e.g., where the approach might be applicable), but also on the general strategy it suggests and how its logic might be extended.

NATURE OF THE PROBLEM

As background for this inquiry, we need to view the estimation problem in broad perspective. It is that certain variables which have been measured by census enumeration have to be updated: the size of an area's total population and of specific subpopulations within that total defined by age, sex, race, and so forth. Such updates serve several purposes.

First, such demographic information serves important planning purposes, our central concern here. A typical health program, for example, involves facilities, which must be sized and sited; a program, which must be planned and, once in operation, evaluated; and a target population, whose prospective needs must be estimated.

Second, with the advent of revenue sharing and other programs that distribute federal and state aid, localities have learned to attach considerable importance to these estimates, particularly the population totals for small areas. The formulas for distributing this aid typically give weight to the number of inhabitants an area claims.

The MHDPS can potentially address both the planning and the distributional issues. With respect to planning, the system enables the delineation of residential areas having common social rank, life-style, ethnicity, and other related characteristics, and furnishes one of the necessary elements for estimating the health and related needs of the inhabitants of those areas. With respect to distribution, which is fundamentally a political matter, the MHDPS lends itself to developing comparative measures of need that furnish an objective basis for informed decisions about allocating services among underserved areas. With such measures, politically charged questions of which areas merit more service can be negotiated at least partially on the basis of fact.

The need to update information, of course, is premised on the assumption that variables have undergone meaningful change since the last census enumeration--meaningful in a planning sense to those who seek to meet the needs of the ever-changing target populations, and in a political sense to those who may claim that they are (now) underserved.

Certain variables are virtually certain to change, such as total population size, or other absolute measures; others, such as the proportion who are elderly and other similar relative measures, may undergo moderate or minimal change that may scarcely be detectable.

ALTERNATIVE APPROACHES TO POSTCENSAL ESTIMATION

A variety of procedures can be used to update demographic variables for small areas (see Zitter and Cavanaugh, 1980, for an extensive bibliography). Since most readers will be familiar with these procedures, my emphasis in this section will be on their underlying logic. For this purpose, the task of postcensal updating is something like estimating the number of bricks behind the high fence of a brickyard, while one stands outside. The last inventory was in 1980, and yet we must estimate how many bricks, and of what types, there are now. Strategies for doing so include:

1. Extrapolating the observed trend between two previous time points;
2. Compiling statistics on flows, e.g., the daily numbers of bricks trucked in and out;
3. Relying on indicators of activity, e.g., the comparative number of employees today versus 1980;
4. Hiring a surveyor to measure the dimensions of the brick pile from the inside.

The corresponding approaches to postcensal estimation are simple extrapolation, component analysis, analysis of symptomatic data, and direct surveying. Some procedures may combine several of these approaches.

For the kinds of applications under consideration here, each approach has its strengths and weaknesses. Drawing on two earlier documents (Morrison, 1971; 1977), let me quickly summarize them as a prelude to further discussion (see also Shryock et al., 1971; Pittenger, 1976; Irwin, 1977; Greenberg et al., 1978; Burghardt and Geraci, 1980; Zitter and Cavanaugh, 1980).

Trend Extrapolation

The simplest but least satisfactory approach to postcensal estimation is to extrapolate a past trend in net change. Trend-based methods rest on the assumption that change follows a fixed trajectory that can be expressed mathematically or graphically. Although analytically crude, trend-based procedures often suffice for short time horizons and can be useful for updating variables quarterly or semiannually.

For longer time horizons, extrapolation is inadequate on two counts: (1) It does not distinguish analytically the separate components of population change (fertility, mortality, in-migration, and out-migration); and (2) it presumes that those components, interacting over time, will continue to yield the same net effect. A further drawback, especially for health planning, is that simple extrapolation procedures ignore the important dimension of age composition, which can be expected to change in a "non-extrapolatable" way. Because simple trend extrapolation has limited utility in this case, it receives no further discussion here.

Component Analysis

Component analysis, which is the orthodox demographic approach to estimation, amounts to a more sophisticated form of extrapolation in which the observed effects of demographic processes are projected ahead. Explicit account is taken of the components of population change and their influence on population size and structure. Starting with the population distributed by age and sex, the population is "survived" ahead, according to a schedule of recorded or estimated vital events. Allowances are made for migration, either net or gross, on the basis of previously observed rates.

Given the salience of age composition to health planning, component analysis ordinarily would be the favored approach (assuming necessary data are available), but it has certain limitations. Its logic is undermined where population turnover through migration is substantial. This may be a particularly acute problem at the small-area scale. Net migration gains or losses, of course, are only the surface ripples of powerful cross-currents that are continually recomposing a :ality's population. Over just a few years, many of the original r ients may depart and be replaced by newcomers, quite possibly with d rent survivorship characteristics (e.g., departing youth replac . elderly retirees). With so many people coming and going each year, it is misleading to assume that the population will consist of more or less the same people from the base year throughout the estimation period. Population turnover is generally more brisk the smaller the area under consideration. For example, population size in a given census tract may remain about the same over the years, but the membership of that population may include few of the same people.

Analysis of Symptomatic Data

A third approach relies on various symptomatic measures that reflect the size and/or composition of an area's population. For example, changes over time in the Social Security Administration's annual counts of elderly beneficiaries in a given county reflect changes in the size of that county's elderly population and can serve as the basis for developing estimates of yearly change (see McCarthy et al., 1982). Symptomatic data may be records of events occurring regularly in a population (e.g., vital events, income tax returns, voter registration) or of population-related objects and services (e.g., school attendance, occupied dwelling units, building permits, residential telephones, electric and water meters, motor vehicle licenses). The assumption here is that changes in the population's size are reflected in these variables.

For counties, a wide variety of potential symptomatic measures exist. Below the county scale, however, options are severely restricted and vary from state to state (see Carroll et al., 1980). As a general rule, any data series is a potentially useful symptomatic measure if: (1) it is coded to relevant small-area units (e.g., health districts within a city), (2) it contains relevant compositional distinctions (age, sex, race, income, welfare status, etc.), and (3) it is available on a regular and timely basis.

For many cities, vital statistics are the only series that fulfill these three conditions, pointing toward their use as symptomatic indicators. (For one such application to monitoring small-area population changes in cities, see Morrison and Relles, 1975.)

Vital statistics figure in both component and symptomatic approaches, but in fundamentally different ways. In component analysis, births and deaths are like bricks added and subtracted; in symptomatic analysis, they are analogous to the number of brickyard employees--something observable that is coupled to something else we cannot measure directly.

Certain hybrid techniques combine the logics of both component and symptomatic approaches. For example, the component analysis logic may account for how births and deaths have modified a population through natural increase; the symptomatic logic may link changes in net migration to changes in school enrollment or out-of-state drivers' licenses (see Rasmussen, 1974, for an illustration).

Symptomatic analysis is vulnerable to two weaknesses. First, extraneous factors weaken the sensitivity of most indicators. The number of occupied dwelling units in an area, for example, is sensitive to shifts in occupancy rates and average household size as well as to the population's changing size. Second, symptomatic data may be more sensitive to change at some ages than at others. For example, births relate mainly to the number of young adults, whereas deaths tend to reflect the number of elderly persons. Certain estimation techniques (e.g., the Bogue-Duncan Composite Method) take advantage of this fact by building on multiple symptomatic measures, each designed to gauge a particular age group within the population.

Survey Approaches

Approaches that rely directly on survey data defy simple generalization. The method proposed by Rives relies on direct observation to estimate population size and composition for administrative and statistical areas below the state level; e.g., counties, incorporated places, MCDs, school districts, and medical service areas. Essentially, it samples high-grade evidence of population change--glimpses into the brickyard--and uses this evidence (1) to evaluate the current accuracy of the most recent measure of a variable (which amounts to testing the null hypothesis of no change in the variable since it was last measured), and (2) assuming rejection of the null hypothesis, to reestimate the variable. This procedure is noteworthy for the strategy it suggests: namely, to regard the variable measured as being potentially out of date and, as necessary, to "buy" additional information with which it can be updated.

APPRAISING ALTERNATIVE APPROACHES

The logic of the approaches just described translates into various operational procedures that have to be implemented with data that may be imperfect and difficult to obtain. A central interest lies in the population's social differentiation across small areas, because spatial aggregation tends to conceal important differentiations of special concern to health and other planners. Areal scale, therefore, is a major consideration, since important features of such differentiation will be missed if the geographic unit adopted is too large. For example, a rising fraction of elderly residents in a city may warrant establishing new health facilities to service their needs. The facilities may be underused, however, if they are located in the wrong neighborhoods. To have practical applicability, therefore, a method must be able to detect concentrations of the elderly within what may be a large and heterogeneous city.

Health planners inevitably face a trade-off between the competing needs for more spatial resolution and sounder estimation techniques. Any gain in spatial resolution usually restricts the choice of input data and may leave simple extrapolation as the only remaining option.

A second consideration here is that particular estimation methods perform better under some circumstances than others (Morrison, 1971; Voss and Kale, 1977; Isserman, 1977). Looked at another way, each method has distinctive vulnerabilities; there is no single "best" estimation method. Indeed, we are well advised to rely on a combination of methods, since an average of several estimates produced by different methods tends to outperform any single method.

A third consideration, of course, is the budget constraint. Certain methods are many times more costly to implement than others. Even if it promises more accurate results, the more costly procedure may be totally infeasible. As a practical matter, certain approaches become feasible only under the aegis of a federal or state agency that can muster the resources to coordinate the assembly of input data, calibration of methods, and evaluation of precision. (The Population Research Unit in California's State Department of Finance, and Wisconsin's state population estimation unit, are two exemplary cases.) The budget constraint is a major consideration in evaluating survey approaches, since they rank among the more expensive estimation methods.

Selecting the estimation method that is "best" for a given application, then, calls for considered judgment; it is not a simple matter of choosing between the Volkswagen and the Cadillac. The choice depends in part on such considerations as the spatial detail that is needed; whether the demographic setting is one of rapid change or relative stability; and the marginal cost one can afford to pay for improved accuracy.

With this background, we can now consider the survey-based procedure that Rives has proposed. This procedure exemplifies a general approach to updating that can be labeled "information buying," a strategy that entails monetary investments in information to resolve key uncertainties about the variables in question. Viewed in this light, at least three issues figure in an overall assessment of this method:

1. How else this information might be acquired;
2. The circumstances that would warrant such investment in information; and
3. How the technical implementation of this method might be improved.

My overall conclusion in light of these issues can be stated succinctly: The technique Rives has proposed is a sensible one that can complement other techniques that might be used, and is one that no reasonable person can quarrel with, <u>except</u> on grounds of cost. Because it is sure to be costly, though, the central considerations favoring its adoption are likely to be situational, not technical. That is, while the procedure may not be feasible for widespread use, it may be well suited to certain types of settings. What is more important, I believe, is that the logic behind its use may have broader applicability as an information-buying strategy.

THE ROLE OF INFORMATION BUYING IN MONITORING DEMOGRAPHIC CHANGE

The basic strategy suggested by Rives's survey-based method is to purchase information in stages. This logic is reflected in his approach, which entails determining first whether any detectable change has occurred, and then proceeding with actual estimation. Broadening this idea, consider the possibility of <u>monitoring</u> demographic processes more or less continuously. Conventional indicators of fertility and migration at the national and regional scale (from Current Population Reports) could be combined with indicators that signal noteworthy turning points in local-level population dynamics. For example:

1. Do local fertility trends continue to parallel national trends?
2. Has the volume of net migration continued unchanged since it was last measured on the census?
3. Has the age-race composition of gross migration flows continued unchanged since the last census?

Where our monitoring procedures do not detect any significant change, we are then justified in applying component analysis techniques (assuming the necessary data are available) or less sophisticated trend-extrapolation methods.

Where change is apparent, the analyst will want more information, and a survey-based approach is one option for consideration. Other options should be explored, however. Are alternative, less costly, sources of information available? Unlike a decade ago, an array of administrative by-product data is now available and lends itself to monitoring local demographic change, particularly at the county scale (see Carroll et al., 1980). This "free" information includes, for example:

- Annual counts of elderly Social Security recipients by county, going back to the 1950s;
- Estimated gross migration flows into and out of revenue-sharing jurisdictions, based on a match of IRS records. (These estimates were developed in conjunction with the Census

Bureau's preparation of population estimates for revenue sharing, and further refinements have been tested.[2]);

- Annual counts of welfare recipients;
- Vital statistics for health areas within cities, widely available and potentially useful for symptomatic estimation techniques.

In addition to such administrative by-product data, large-scale surveys that furnish current information on specific places have become increasingly common in recent years. Most noteworthy, perhaps, are HUD's Annual Housing Surveys, conducted in several dozen SMSAs. These data can be disaggregated within each SMSA (e.g., by central-city and noncentral-city counties), making them potentially useful sources of information with which to contrast the health needs of such areas. Some of these SMSAs have been resurveyed at a second time point and linked longitudinally, making these data even more useful for monitoring postcensal demographic trends. Other surveys (e.g., the Survey of Income and Education) also may have applications here.

USING EXISTING DATA TO MONITOR LOCAL CHANGE: AN ILLUSTRATION

As an illustration of how administrative by-product data are useful for monitoring local demographic change, I shall outline some possibilities for monitoring changes in the distribution of elderly population at the county scale, using the first of the above data sources: the annual number of elderly Social Security recipients. (For

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[2]The most recent application has been to interstate migration flows. See Engels and Healy (1981).

fuller and more current detail, see McCarthy et al., 1982.) The residential choices of older citizens have important implications for the localities in which they choose to settle. Because their service needs differ from those of other age groups, the elderly impose special service demands. Apart from the decennial census, however, there has been no straightforward procedure for monitoring the geographic redistribution of elderly citizens. Public agencies, especially those involved in health planning where lead-times tend to be long, could benefit from current demographic information that enables them to foresee future service needs.

The relative share of elderly in an area can increase, irrespective of how frequently (or infrequently) the elderly population migrates. This point can be explained with reference to Table 1, which illustrates

Table 1

ANALYTICAL TYPOLOGY

Ratio of Elderly to Total Net Migration Rates	Net Migration Rate, Total Population		
	Strongly Negative	Nominal	Strongly Positive
Well above 1.0	-	+ (recomposition)	+ (congregation)
Approximately 1.0	0	0	0
Well below 1.0	+ (accumulation)	-	-

NOTE: + denotes increasing share of elderly; - denotes declining share of elderly; 0 denotes no change.

how counties can be classified by: (1) the net migration rate for the total (all ages) population, and (2) the ratio between the rates of elderly migration and total net migration.

The sign in each cell of the table indicates, for the given configuration of rates, how the relative share of elderly persons in the population would change. The configurations of primary interest here are the three cells marked with a "+", indicating an increasing concentration of the elderly.

The configuration labeled accumulation describes elderly concentration in an area that comes about through the departure of young and mobile residents and retention of elderly residents. As the population shrinks, the percentage of elderly rises. The configuration labeled recomposition describes a process of age-specific recomposition, which comes about when net migration flows in opposite directions at different ages: A net inflow of elderly people is offset by a net outflow at most other ages. The third configuration, labeled congregation, comes about when the county's population gains migrants of most or all ages, but the elderly in-migration rate exceeds the nonelderly rate.

Annual counts of elderly Social Security beneficiaries by county provide a basic symptomatic measure that closely reflects changes in the elderly population's distribution. Table 2 (drawn from an earlier pilot application to New York State) illustrates one procedure for identifying where New York State's elderly population is now disproportionately concentrated or becoming so. The "Index of Elderly Concentration" shown there is defined as a given county's share of all New York State

Table 2
Concentration of New York State's Social Security Beneficiaries
65 and Older, by County: 1969 and 1975

County	Concentration Index[a] 1969	1975	County	Concentration Index[a] 1969	1975
Albany	1.029	1.067	Niagara	0.920	0.972
Allegany	1.056	1.033	Oneida	1.048	1.068
Bronx	1.054	0.993	Onondaga	0.882	0.195
Broome	1.079	1.124	Ontario	1.069	1.000
Cattaraugus	1.170	1.132	Orange	1.016	0.973
Cayuga	1.098	1.104	Orleans	1.032	1.004
Chautauqua	1.269	1.273	Oswego	0.953	0.886
Chemung	1.103	1.115	Otsego	1.266	1.267
Chenango	1.019	1.111	Putnam	0.791	0.742
Clinton	0.778	0.697	Queens	1.049	1.072
Columbia	1.328	1.355	Rensselaer	1.076	1.064
Cortland	0.938	0.933	Richmond	0.827	0.818
Delaware	1.159	1.162	Rockland	0.597	0.665
Dutchess	0.904	0.912	St. Lawrence	0.934	0.917
Erie	0.933	0.970	Saratoga	0.745	0.744
Essex	1.138	1.249	Schenectady	1.256	1.254
Franklin	1.150	1.131	Schoharie	1.253	1.141
Fulton	1.317	1.260	Schuyler	0.959	0.927
Genesee	1.028	0.990	Seneca	0.978	0.943
Greene	1.574	1.528	Steuben	1.035	1.019
Hamilton	1.432	1.516	Suffolk	0.683	0.718
Herkimer	1.189	1.132	Sullivan	1.308	1.337
Jefferson	1.268	1.222	Tioga	0.777	0.795
Kings	1.084	1.052	Tomkins	0.722	0.727
Lewis	1.003	0.931	Ulster	1.156	1.107
Livingston	0.847	0.832	Warren	1.300	1.262
Madison	0.879	0.855	Washington	0.976	1.020
Monroe	0.940	0.951	Wayne	0.963	0.916
Montgomery	1.482	1.460	Westchester	0.994	1.035
Nassau	0.749	0.834	Wyoming	1.021	1.015
New York	1.292	1.230	Yates	1.371	1.344

[a] Index of elderly concentration defined as:

$$CI = \frac{\text{[county's share of all NYS beneficiaries 65+ in 1969 (or 1975)]}}{\text{[county's share of NYS population in 1970 (or 1975)]}}$$

beneficiaries, divided by the county's share of New York State population. By showing the elderly population per capita at two different time points, such an index enables us to identify counties with, for example, an uncommonly high concentration index (e.g., Greene); a concentration index that has increased over time (e.g., Hamilton); and so forth. Notice that changes in this index vary from county to county. Both Greene and Hamilton Counties have a relatively high concentration index, but it is rising in Hamilton and declining in Greene.

As this example suggests, there are inexpensive alternatives to direct surveys. Although these alternatives may never substitute for even a "peek inside the brickyard," they can add to the analyst's store of evidence and may pinpoint specific places where a survey may be needed. Other sources of administrative by-product data merit careful scrutiny for such applications, for they may usefully complement the expensive survey approach, or at least identify the areas where a survey would pay the greatest dividends.

OVERALL CONCLUSIONS

The survey approach to local population estimation, as exemplified in Rives's method, has obvious advantages: It furnishes high-grade evidence of population change and is adaptable to different local circumstances. Its principal drawback is its expense, which leads one to question whether such an approach can have widespread use. It may be more appropriate to regard such methods as one instrument in the analyst's tool kit, a specialized tool suited to uncommon circumstances.

A more noteworthy observation is that Rives's proposed framework has a logic of its own that should guide the use of evidence (however acquired) for health applications. This aspect of his contribution, expanded to a broader scheme of continuous monitoring, merits further consideration and development.

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