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Samples and Censuses[1]

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Summary

Two related topics receive brief but comprehensive reviews, for guiding decisions about three sources for collecting data. First, the relative advantages of samples, censuses, and registers are compared along eight criteria: cost, detail, timeliness, relevance, etc. Second, 15 methods are indicated for using samples in connection with censuses; they are sorted into five kinds of purposes: as substitutes for, or as aids to, censuses; sampling from census tapes; censuses as auxiliary data for sampling. Finally, current and future paths are indicated for combining the strengths of the three sources, in order to obtain accurate estimates which are both timely and detailed for local areas and small domains.

The Editor draws attention to the timeliness of this contribution in connection with the design and execution of the censuses to be taken in **1980/81** *and the many kinds of sample involved.*

1 Introduction

This brief review paper has a double purpose: first to compare the relative advantages and disadvantages of samples and censuses; and then to indicate the variety of ways for using samples to good advantage in connection with censuses. Thus we note the ways first of competition, then of collaboration between the two sources of data. These two topics are distinct yet closely related, so that a joint treatment should benefit each topic.

The paper is aimed at readers who are acquainted both with sampling methods and with the conduct of complete censuses. Concise reminders of the possibilities and problems of both samples and censuses are listed and noted. Then the many opportunities offered by their combined uses are reviewed. Those possibilities, problems, and opportunities are too numerous to be spelled out in detail, or even to be intelligibly and correctly defined. Instead I merely present a reasonably comprehensive view of the diverse aspects.

First, a list of eight criteria is presented for assessing the relative advantages and problems of samples and of censuses; administrative registers are also compared with them. Then a list of fifteen methods are developed to exhibit the diverse uses of sampling in combination with censuses. Though brief, these two lists should remind readers of methods they read or thought about, or perhaps used. The lists aim to stimulate the reader to think and investigate further; they do not try to supply ready answers for diverse situations. I would compare these lists to the checklists airplane pilots must complete before they take off. I especially hope that these lists will be useful for planning samples in connection with the censuses of 1980 and after, and especially in the vast majority of less developed countries. The remarks focus on censuses of population and housing, but most are also relevant to agricultural, industrial, and other censuses.

Instead of the details and depths of some treatments that these topics received elsewhere (see references), I am aiming here at comprehensiveness. I hope and expect that the readers

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will supply the technical details and the necessary parameters (cost, variances, requirements) for their own specific situations.

2 Comparisons of samples with censuses

The list of eight criteria I use here grew through discussions, from introspection, and from recollecting experiences without recording their sources. The eight criteria grew from only three, and the number could be expanded if a longer list would be more useful. The scopes of some of the criteria are expanded with several closely related meanings appearing on a single line.

Table 1

Eight criteria for comparing three sources of data

Criteria	Samples	Census	Adm. Registers
Rich, Complex, Diverse, Flexible	* * *		
Accurate, Relevant, Pertinent	*		?
Inexpensive	*		* * *
Timely, opportune, seasonal	* *		*
Precise (large and complete)		*	*
Detailed		* *	*
Inclusive (coverage), credible, P.R.		*	?
Population content	* *	*	

These eight criteria represent my compromise between brevity and completeness. They seem to me to cover adequately the needs of diverse situations. There are no criteria for choosing criteria – here or elsewhere. But the reader must judge their adequacy for any situation, also how well they would be met by the three sources of data.

This list aims to overcome the common practice of choosing one data source, then justifying it with a single criterion. One director may say: 'We use sampling because it is much cheaper than a census would be'; and another in a similar situation counters, 'We prefer a census because it yields abundant geographic detail'. Both statements are correct but incomplete: all criteria should be considered jointly for a reasoned decision.

Checks (*) are used under each source to indicate its relative advantage according to each of the eight criteria. The relative advantages of samples and censuses are complementary: one is stronger where the other is weaker. These are my rough judgments for most situations, and the user can change them to suit specific situations. Yet the list may be useful and stimulating even when my checks seem arbitrary, and obviously subject to exceptions; for example, there are many inaccurate sample surveys, also censuses with poor coverage.

Sample surveys can be designed to obtain wide varieties of complex data, rich and deep in content. They can be tailored flexibly to fit a variety of needs and methods of collection. Such data are not gathered with complete censuses; attempts to do so would result in very high costs and also in low quality. Even less should one try to stretch the scope of administrative registers to those tasks. The observation procedures in sample surveys can be directed to obtain data which are relevant and pertinent to research and for decisions, and which are reasonably accurate for defined aims in many situations.

That small samples can be made inexpensive is well appreciated. But we should also stress that samples are and can be much more timely, and repeated more often – yearly, monthly, even weekly, if planned. For rapidly changing or fluctuating variables this can more than make up for their small sizes; I note epidemics as one example and seasonal crops as another. Flexibility in timing, in spacing, and in methods can be had in samples. They can meet the needs for timing in seasonal activities in crops, employment, etc. that censuses cannot.

Because they are large and complete, censuses are precise and detailed. Precision refers to the inverse of sampling variability; but censuses may be more inaccurate than samples due to biases of measurement. Censuses give data in great detail for small domains and especially for local areas, which samples fail to provide; and this is probably their principal continuing utility. But even here we sound several cautions. First, detail and precision are both lost over time, especially for unstable variables and populations (Waksberg, 1968). (Consider epidemics, industrial output, and fertility in these times of changing birth rates!) Second, precision for small local areas is subject to random fluctuations in time, and to relatively large correlated errors of enumerators (Hansen, Hurwitz, and Bershad, 1961).

Censuses seem often (though not always, nor necessarily) to obtain better coverage than sample surveys. Thus they tend to be more inclusive in population extent than sample surveys. This is partly because it is less difficult to check complete than sample coverage, but mostly because of the credibility aroused by the public relations campaigns for censuses. These can greatly improve censuses; though the propaganda can prejudice some attitude surveys – and even some census counts. But content – as distinct from the extent – of the survey population can be controlled and directed toward survey aims better in specialized surveys than in complete censuses, which must have more general aims. The definition of the population can be made to suit the survey's aims, but this flexibility may be prohibited by the public aspects of the census.

Its very high cost (roughly one hour's pay *per capita*) is the great disadvantage of complete censuses; also a reason for not doing them more often, or with greater depth and richness of data. Even if money were available, human and technical resources would be difficult to marshal for the sporadic efforts; even current censuses face formidable obstacles. Furthermore, beyond financial costs and strains on resources, we should consider also the social costs of the burdens on the time and attention of the respondents. The burden of public relation campaigns should be noted; but the campaigns may also contribute to national social cohesion, and yield benefits in self-assessment. Yet this may perhaps be done better if not repeated too often.

Another advantage of samples – overlooked but worth attention – is the confidentiality imparted by random selection. With the identification of respondents kept confidential, the source of individual responses is hidden in the published results. Confidentiality requirements are posing obstacles and limits to statistics for local areas and small domains. For these reasons deliberate random errors are being proposed – and these will tend to undermine the principal arguments for complete censuses.

The contrasts of costs and of other features are greater for large populations, because desired sample sizes tend to be fixed rather than proportional to population sizes. Thus a sample of 10 000 dwellings is only 1 : 10 000 in a country of 100 000 000 dwellings, but it would be a sample of 1 : 10 from 100 000. Thus the contrasts of sample/census in costs and in detail have different dimensions in different situations; and those also affect the other criteria.

3 Administrative registers

Registers exist for a great variety of purposes in a bewildering variety of quality. Vital registers in Northern European countries (and few other places) have excellent coverage of basic population data, but not in most countries. There are also registers for voting, social security (welfare), medical care; lists for special populations in education, fertility clinics, hospitals. Also lists for utilities like electricity; telephones cover a large portion of dwellings in some places, but much less in others. And so on.

Registers can often be competitive sources to samples and censuses. Financing comes from

their principal functions, and statistical uses are only auxiliary. Information may exist in files, on cards; or on tapes and discs more recently, which can make their use especially cheap – so cheap that sampling may not be needed. Of course, society pays for the true costs somehow, but with other aims in view. Changing the techniques of collection to provide good (complete, accurate, diverse) statistics would entail great additional expenses.

Data from registers, like censuses, are detailed and precise. However, their accuracy varies greatly: electric bills and reported wages may be more accurate than interviews; but birth and death registers are known to be woefully inaccurate in many countries. The data are often timely and up-to-date. The population coverage may be good or poor, and 'compulsory' reporting does not mean good coverage. Think of school records and of the history of establishing compulsory education in many countries. Many registers (like utilities) may have high coverage or low, and their contents may also differ greatly from the populations one needs. Primarily, data from registers differ from other sources in being far from rich, but very inexpensive.

That leads to an attractive prospect: to utilize registers, especially registers with good coverage, to obtain richer data. Registers are financed to serve the needs of individuals (like medical and utility lists) or of society (like taxes and military service); it seems attractive to obtain statistical data for 'little' extra cost. Without those registers we would not have historical demography, because budgets just for statistical data are not old.

However, we should be more careful with our enthusiasm: how good and how cheap are the data? And these two qualities may well conflict. Obtaining and keeping data involves administrative costs, plus social burdens on the respondents. The richness of the data should be severely limited, because their quality would suffer from being a fringe activity of clerks and respondents, whose interests are elsewhere.

I believe we should separate personal data from statistical data. Personal data are needed for the individual's own use; should be confidential; need individual identification; and can have individualized form and content. In full contrast, statistical data are needed for population aggregates and averages; for public use; should be anonymous; and must be standardized in form and content. Because of those conflicts I believe that sampling should be used to collect the statistical data which are not needed for personal data on registers. Sampling should get better and richer data from specially trained personnel, and cheaper data because of great reductions in size of the effort.

4 Samples connected with censuses

Methods of survey sampling have a large literature that needs no summary here. The methods are oriented to designs for distinct and separate surveys, but those methods have general applicability. Yet the applications of those methods to samples connected with censuses deserve some special attention here; these samples differ from surveys because of their double roots. They share methods, techniques, and theory with the survey samples. But their connection with censuses gives them both special functions and special advantages in funds and in resources. Hence they often have large sizes; especially in class I, as noted below. But they also share with censuses some inflexibilities in timing, also in the contents of their populations, and especially in the restrictions on data that official censuses can afford to collect without jeopardizing the wide cooperation they need and get.

The list of available methods should be inspected for their possible utilization and practical utility. If needed, any of the methods may be placed on one of four levels of availability for any specific situation, referring either to actual or to potential use: (1) successfully used; (2) used but not successfully or adequately; (3) not used though available; and (4) resources not now available. Needed methods at levels 2, 3, or 4 should be examined for possible transfer

to level 1. But methods not needed badly enough currently belong elsewhere. On the other hand, methods which would be needed, but are not now available, should deserve special considerations from appropriate technicians.

Most of the methods listed here have appeared in the literature on samples connected with censuses. Those methods are described in some detail, with justifications and procedures, in the references; especially in Gurney and Manno (1976). Our treatment is much briefer, but our list is more complete than those in the references.

These references are for the reader's convenience, and are far from complete. A documented search of the literature would be too difficult, and it would undoubtedly run into conflicts of priorities, and into obscure and difficult descriptions. Furthermore, a reported success (or failure) in any situation may be due to special and unknown circumstances, resources – or even to mistaken perceptions; the history of one office may not be the best guide to the future of another.

Table 2

Samples connected with censuses

1. Sample enumerations to supplement complete censuses:
   (a) Obtain richer, more diverse, detailed, deeper data
   (b) Reduce costs of collection and of tabulation
   (c) Reduce aggregate social burden on respondents
2. Samples added to complete censuses to evaluate and to improve them:
   (a) Evaluation studies of content (Post Evaluation Studies)
   (b) Coverage checks; dual coverage
   (c) Pilot studies of questions and techniques before the census
   (d) Quality control of individual enumerators, coders, processors
3. Samples from census records, microfilms, tapes:
   (a) Early (advanced, preliminary) tabulation and release
   (b) Complex, multivariate analyses of relations
   (c) Public use tapes for further, deeper analyses, without identification
4. Census as auxiliary data for samples:
   (a) Data for selections: measures of size, stratifiers, maps of enumeration areas; seldom addresses or names
   (b) Data for improved estimation with ratios, regressions
   (c) Samples added to censuses to serve as bases for continuing surveys
5. Joint uses of several sources:
   (a) Current estimates for local areas and small domains
   (b) Rotating (moving) monthly samples of 1/120 (or weekly 1/520)

There has been great recent growth in the use of samples connected with censuses, and in 1980 probably most countries will use one or more of the methods listed in Table 2. Their uses seem to be very uneven, more uneven probably than dictated by genuine differences in objective situations. There seems to be a great deal of arbitrariness in what methods have been used and where, depending on the choices of statisticians and on the decisions of ministers.

The presentation aims to help future choices and decisions. I hope especially that it can stimulate the combined use of several methods, where feasible. The list (Table 2) is meant to be complete, and the descriptions are brief but, I hope, adequate as reminders for readers who are acquainted with the methods, and can look up details elsewhere.

My five classes for 15 methods are somewhat arbitrary but useful, I hope. The classification is by different purposes, and notes will be made later about different procedures which may

be used. The timing of the samples may be before, during, or after the census. The sample schedule may be added to the census schedule or be separate from it; and they may be independent from or be dependent on the census schedule. The sampling units may be households, enumeration areas (EA's), or administrative units. Some of the possible combination of procedures and purposes are better than others.

4.1 *Sample enumerations as portions of and substitutes for complete censuses*

On complete censuses each question is expensive, because it is multiplied by the sizes of the populations (of households, persons, farms, etc.). Hence, censuses are kept brief and simple, sometimes with precoded or easily coded items, to save costs of collection and tabulation. And – we add again – to reduce the respondent burden on society. However, ever more diverse data are being obtained with samples which are portions of the entire census. These samples are substitutes for complete censuses; hence, they tend to be large, ranging from perhaps 1 : 100 to 1 : 4 of the complete census. These are very large compared to the usual survey samples, yet they can achieve most of the savings that sampling from censuses can yield.

It may be both rational and feasible to use two or more samples for diverse purposes. A widely spread and large (1 : 4 to 1 : 10) sample may be desired for items needed in great detail and for local areas, and for items which are not too difficult to obtain. On the other hand, smaller (1 : 100 to 1 : 20) and more concentrated samples may suffice for difficult data, for national statistics and for large domains; special enumerators may be used for those difficult data.

When several samples are used to get different data, there is a conflict concerning spreading them over many different units versus concentrating them in all the same units. Spreading the schedules avoids the concentration of respondent burden. But concentrating them reduces the total cost, and yields more information in the relations between the sets of variables. Thus, for example, one may design, as addition to a complete core census, one sample of 10 per cent, denoted by (AB), which combines both the (A) easier, and the (B) more difficult items. Alternatively the two samples may be separated into (A) a 10 per cent sample of easier items, and (B) a 2 per cent sample of difficult items. But we may prefer (AB) a 2 per cent combined sample plus (A) an 8 per cent sample of easier items. Furthermore, this last (A) may be an 8 per cent selection of households in all EA's done by the regular enumerators, with the (AB) added as a 2 per cent sample of EA's by special enumerators.

Reasonable sample plans should be influenced by three important factors: the number of visits to the household (or other respondent units); the kinds of enumerators used for the complete census, and for the sample; and the nature and size of the EA's. The number of visits to the household are caused by three census tasks: (a) prelisting of all households within the EA's, (b) plus the complete census of core questions, (c) plus the sample enumerations. The three tasks may be done in one visit (abc), to save enumerators' travel and respondent burden. Or the prelisting (a) may be separated from a combined visit (bc) for the complete and sample censuses. The sample schedule may incorporate and replace the census schedule in plans (bc) and (abc), or the two may be given separately on the same visits. Or prelisting plus census visit (ab) may be separated from sample visit (c) and schedules. Or all three visits may be separate (a)(b)(c). Each plan has been proposed somewhere.

Methods and units of selection may also vary for diverse situations. Selecting individual persons is too bothersome; and it is not worthwhile, because individuals of the household tend to enter different cells in the tabulations by age, sex, etc. But households may be selected separately to spread the sample widely in all (or many) areas. Selecting households and using a combined schedule on single visits would involve all enumerators, hence may not be desirable for more difficult items. Selection of households also poses problems, and it is best done after prelisting households, which may involve additional costs. However, if the sample

questionnaires are given after the census, special enumerators may be sent to the sample of households.

However, the travel of specially trained enumerators may be reduced and single visits to sample households obtained, when enumeration areas (EA's) are used for selecting the sample. This procedure concentrates the sample and gives less detail (greater fluctuation) for local areas. But this fluctuation is less important where the EA's are smaller. It is also less important for many statistics which are less needed for local areas. If selections of entire EA's can be tolerated they are simpler to administer, because selection of households can cause problems and biases. It is less desirable to use larger units, administrative districts, for sample enumerations.

Diverse possibilities on several factors could lead to a great variety of possible designs; but considering connections between the factors, five designs may seem most salient, each with its own advantages and its own faults.

1. Households selected in all EA's on a single visit cut down the traveling cost and respondent burden, and spread the sample into all EA's. However, selection biases seem inevitable and often bad. Furthermore, by precluding the use of special enumerators, the observational biases of the regular enumerators also seem inevitable.

2. Households selected in all EA's after prelisting can be made, with care, to avoid (reduce) selection biases, and also to spread the sample. Expenses are increased by the special sample visit, especially if special enumerators are sent to all the EA's.

3. Selection of complete EA's can avoid the extra expenses, eliminate selection bias, and permit effective utilization of special interviewer. I also like it for its simplicity. Of course it increases the variances of statistics, because of clustering both of characteristics and of interviewer effects.

   This increase of the variance must be faced realistically. (a) It may be important in statistics for small geographical domains based on a few EA's. (b) For national statistics and for major provinces it may be less important than a reduced bias. (c) For statistics of most domains (like age, occupation, education), which are not geographic and cut across EA's, the increase in the variance is less. (d) Correction with ratio estimates to the full sample can become more effective here than in household selection, and can greatly reduce the clustering effect.

4. Two-stage selections of EA's then of households may bring effective compromises between (2) and (3). But it may be too complex for some situations.

5. It may be effective to use different methods in different areas. Especially, in urban areas (2) may not be too expensive, and (3) reserved for rural areas where homogeneity within EA's may be less.

Finally three technical points about the conflict of variance versus bias in selecting EA's versus households. First, that ratio adjustment to the complete census *may* reduce much of the selection bias of method (1), or the higher variance of method (3). Second, that the conflict is greater with small than with large sampling fractions. Third, that the clustering of method (3) makes the computation of variances more important. The 'design effect' of clustering may be large for some global national and local statistics; it will be much less for statistics based on small domains that cut across the EA's. On the other hand, 'design effects' are bound to be small, probably negligible, in most situations where households were selected with method (1) or (2).

We may note here the double function of enumeration areas for censuses; they partition the area of the population with clear, stable, and identifiable boundaries to facilitate its complete

and unique coverage; and they also attempt to create equal and feasible work loads. These two aims often conflict and need to be harmonized and compromised. In addition, EA's are also used for sample surveys as well as for census samples, for both of which smaller units are preferred. The compact populations of EA's are more or less homogeneous; they also suffer from the homogeneity of correlated biases of enumerators. These factors need to be considered before using them for sampling units. Nevertheless they are convenient for samples connected with censuses. In separated sample surveys they are usually subsampled.

Much variation exists between censuses in the average size of EA's used. Smaller EA's are more efficient for complete (compact) sampling units. Smaller units can also be used to reduce the effects of correlated response variances of enumerators; this can be done either by restricting the workloads to single EA's or by spreading these among different local areas. Smaller EA's can also be used for flexibility in assigning unequal workloads to enumerators.

There is no need to make each enumerator's workload exactly one EA; better boundaries and flexible workloads may be had by combining EA's into workloads. On the other hand, larger units permit choosing better boundaries. They may also be more convenient to administer uniformly. Finally, larger EA's are likely to have smaller co-efficients of variation per EA but not per area, and probably larger variances per EA.

The size of EA's should also be related to the type of enumerators used, and to the kind of employment and the form of payment used. All of those can vary a great deal. They can be volunteers, or temporary employees, or a class of employees (teachers, civil servants) on temporary assignments. Basic needed qualifications can be varied according to need and to available labor supply. Those factors should affect the size of the EA's, the workloads, the period of the census, and also the feasible complexity and quality of the data collected. They should also influence the possible selection of special enumerators for the sample enumeration and for evaluation studies.

4.2 *Samples added to censuses to evaluate and improve them*

Whereas the portions above substitute for and resemble censuses, samples added to improve censuses differ more from both of them. Those samples are usually smaller, perhaps from 1 : 100 down to 1 : 1000, or even to 1 : 10 000.

Post-enumeration studies (PES) have been used to evaluate and check the quality of census enumerations to estimate biases, and to measure response errors. In some versions the PES enumerators are given the census responses for their samples cases, then they use them to get the 'best' answers with more and better questions. In other versions, the PES interviewers are kept ignorant of census responses in order to get PES responses 'independent' of them. However, independence is not complete, because the respondents have not entirely forgotten. Reconciliation of the pairs of responses for a 'best' answer can come later.

Checks for completeness of coverage would usually follow the first version: the check enumerators would have a list of units in defined areas, and then try to find missed units. Checks for coverage independent of the census are less likely. On the other hand, sample studies using the techniques of 'dual coverage' (Marks, 1974) for estimating undercoverage are possible where lists of households (or other units) are available from some source. The procedures for and coverage from this source should be quite different from the census methods for the technique to be fairly effective.

Instead of a PES done after the census, a sample of high quality enumeration may be done simultaneously with the census. (Quality checks before the census seem unlikely.) A sample of EA's may be covered with better methods, better enumerators, longer questionnaires, instead of the census methods used in the remainder of the country. The extra expense is less than with double coverage of sample areas, and the respondent burdens of double interviews are avoided also. The contrast of these check areas with areas covered by census methods

yields estimates of the net bias. These estimates of the net differences from the sample/census comparisons have higher sampling errors than with double coverage. Also the method lacks estimates for gross errors which may be obtained from double coverage. But on the whole this is a simpler and cheaper method. The sample areas should be selected with careful matching (stratification) of control areas. The sampling units for quality checks are more likely to be EA's or administrative districts than households, because these would be inconvenient.

It may be possible to use for content and for coverage studies the same sample of EA's as for a sample enumeration; or the evaluation EA's may be a subsample of the enumeration EA's. However, it may be difficult to insist on good samples of the entire country for quality checks. It may be necessary to make inferences from restricted areas of the population, in the expectation that the results found there holds for the nation. Perhaps some 'experimental' design for representing diverse conditions can give adequate results. But such results seem convincing only if the sample/census differences are similar. If those differences vary we probably lack strong models for estimating average differences over the population.

For pilot studies it has been common practice to choose areas which are convenient and believed to yield a good test of questions and of techniques. This approach assumes that areas of difficulty are well known. It may be useful to supplant or supplement the subjective approach with a pretest based on a probability sample; this has been done in Hungary. This gives a 'Micro-census' in advance of the census; it may be investigated especially in difficult areas, perhaps, with increased sampling rates.

Evaluation surveys are designed to check the average quality of the census and of its major components. Quality control and correction of individual enumerators are different matters; they need specific treatment suited to actual field conditions, and to procedures of supervision. The quality control of editors and coders in the office is another specialized matter we may omit to treat here.

4.3. *Sampling from census records, microfilms, tapes*

Where early tabulations and releases are wanted, it is convenient to base them on selections of entire EA's (or even administrative districts) in accord with the system of returns from the field collection. The selections should be predesignated and speeded along. They should represent good and valid samples; not merely the first arrivals which are bound to be a biased portion of the population. Perhaps methods should be prespecified for substituting for a *few* late arrivals. The need for these early tabulations is less for modern situations and procedures which are completely mechanized, such as prepunched variables.

Continuing advances both in statistical and in computing methods have made possible more complex analyses of census data. Demands exist for deeper multivariate analyses of relations. For some of these it is convenient to select samples from the entire census to reduce computations; though the need for sampling may be reduced with faster machines and better programs.

Public use tapes are also prepared from census records for the use of researchers. Identifying data are removed from the tapes, and a random selection helps greatly to prevent identification. Samples of households are preferred for these uses; spreading the sample reduces the level of sampling errors, and it also facilitates the estimation of those errors by avoiding clustering. Households are easier to select than persons, and they provide samples of persons, families, and households. The clustering of individuals in households matters little in analyses which seldom group multiple members of the same households.

4.4 *Censuses as auxiliary data for samples*

When comparing the advantages of sampling, we must also remember that good samples need and are based on census data. These are the chief sources in the selection process for

measures in size for PPS sampling, and for stratifying variables; also for maps and other aids for sampling units, such as EA's. But addresses and names from censuses are seldom used, both because of confidentiality and because of their obsolescence. Census data can also be used to improve statistics, especially through ratio and regression estimates.

Some of the samples described in earlier sections could be used directly as bases for continuing surveys. This is especially true for samples of EA's, or larger units used for longer questionnaires or for quality checks. These could then have direct links with the census.

I end here with the suggestion that it may be useful to have a simple design that uses the same sample of EA's for pilot studies (IIc), sample enumeration (I), evaluation of content and coverage (IIa and IIb), early tabulation (IIIa), and for continuing surveys (IVc). This master sample can be augmented where needed, especially for the sample enumeration.

5 Joint uses of several sources

Census data are usually obsolete, data from registers inadequate, and sample data lack detail, especially for local areas. Since the strengths and weaknesses of the three sources are complementary, it seems reasonable to try to combine the strengths of the three sources to obtain estimates for small domains, especially for local areas; estimates which are current, pertinent, and accurate. To the general needs of researchers have been added the needs of social planners, of administrators, and of policy makers for valid, current data for small domains and local areas.

Local area estimation has become a fast developing field, being pushed by increasing demands, as well as being simultaneously pulled along by new developments in computing technology and by new statistical techniques.

Demographers have combined census data with registers of births, deaths, auto and school registrations, etc. There are 'component methods' (U.S. Bureau of the Census, 1966), and 'ratio–correlation methods'. Census and sample data may be combined in 'synthetic estimates' (Gonzales and Hoza, 1978), and all three sources with a regression method (Ericksen, 1973, 1974). A new review of all these and other methods with extensive bibliography is by Purcell and Kish (1979). There appears to be no uniquely best procedure; results depend not only on the needed statistics, but especially on the qualities of the three sources; and those qualities vary widely from situation to situation.

I also believe that we may have future designs to obtain the detailed data of censuses from rotating samples. For example, a rotating monthly sample of 1 : 120 can cover the nation in 10 years. If needed to measure monthly changes you can have samples of 1 : 60 with 50 per cent overlaps. The collection period may be spread over the entire month, or be confined into representative weeks.

The problems of local areas may also be approached from currently available samples. We must distinguish the periods of *collection*, *reference*, and *reporting*. For example, suppose the collection period is the first week of each month, and the reference period is the previous month. A monthly sample of 1 : 400 would yield yearly samples of 12 : 400 = 3 : 100, without overlaps or 1.5 : 100 with overlaps of 1/2. When properly designed, such samples could yield useful data annually or biennially for small domains and local areas. Their precision could be further improved with the methods noted above.

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Résumé

Deux sujets liés sont passés en revue rapidement mais avec compréhension, en vue de guiger les décisions sur trois sources de collecte de données. D'abord on compare les avantages respectifs des échantillons, recensements et fichiers, suivant huit critères: coût, détails, délais, convenance, ... En second lieu, on indique quinze méthodes pour l'emploi d'échantillons en liaison avec des recensements, triées selon cinq objets: pour se substituer, ou pour aider aux recensements; sondage sur les bandes magnétiques de recensements; recensements comme sources d'informations pour les sondages. Finalement les voies habituelles et futures, en vue de combiner les moyens des trois sources, ont été indiquées, en vue d'obtenir des estimations précises qui soient à la fois à jour et détaillées suivant de petites régions et de petits domaines d'étude.