Analyzing the Weighting Strategy for the Statistics of Income 1987 Estate Study

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ABSTRACT

The Internal Revenue Service's Statistics of Income Division (SOI) samples estate tax returns annually in order to provide regular estimates of the financial characteristics of estate tax filers. Currently, an estate tax return can be filed up to 9 months after a decedent's death and extensions are frequent beyond that. This makes it necessary to emphasize a single year of death over a three-year period, if estimates of a specific year of death are desired. The SOI estate program is designed such that a focus year of death occurs every 3rd or 4th year. These data are also used to estimate the wealth of the living population.

This paper will briefly examine the sample design for the 1987 Estate Study, as background to a discussion of weighting strategies. For the sample representing the 1987 filing year, post-stratification was investigated as a method of increasing the precision of estimates. A detailed comparison of the resulting variances attributable to each set of weights is presented.

I. HISTORY OF THE ESTATE TAX

The modern Estate Tax has been in effect since 1916. Estate and inheritance taxes, however, had been instituted periodically before this, usually to raise revenue during wartime. The estate tax is a tax on the transfer of assets from the decedent rather than on the value of assets inherited by a decedent's beneficiaries. The purpose of the tax is to raise revenue and to redistribute wealth in order to prevent the concentration of wealth in a small number of dynastic families. Initially, the tax rates ranged from 1 percent to 10 percent, with an exemption of $40,000. The tax rates have varied widely over the years depending on revenue needs. The exemption remained between $40,000 and $60,000 until 1976 when it was raised to $175,000 as a part of that year's tax reform legislation. The basic structure of the tax has remained intact since 1916, although there have been modifications to the tax law since then. In particular, certain provisions have been added to allow for alternate valuation of assets should their value decrease shortly after death, and to include a deduction for bequests to the surviving spouse.

Changes in estate tax law as a result of the Economic Recovery Tax Act of 1981 took effect for decedents who died after December 31, 1981. The major tax law changes as a result of this act were an increase in the basic exemption, gradually, from $175,000 in 1981 to $600,000 by 1987. This act also abolished limits on the allowable deduction for assets bequested to the surviving spouse, and reduced the maximum estate tax rate from 65% on assets in excess of $4,000,000 in 1981, to 50% on all assets in excess of $2,500,000 by 1988 (Bentz, 1984).

II. SAMPLE DESIGN

The Statistics of Income Division compiles a sample of the estate tax returns filed each year in order to estimate their characteristics. The sample selection occurs while the returns are being processed for revenue purposes. Thus, returns are selected on a flow basis using a Poisson probability sampling method where the rate is set a priori based on the desired sample size and an estimate of the population. The current estate study is designed to cycle every three or four years; that is, returns filed in three consecutive years are combined to create a file which focuses on a specified year of death.

This structure accommodates the filing requirements which allow an estate up to 9 months after the decedent's death to file an estate tax return. (An additional 6 months extension is often attainable.) For example, the return for a decedent who died in December 1986 might not be filed until March 1988. The sample focuses on year of death rather than filing year to parallel tax law changes. The estate tax data are also used to compute wealth estimates of the living population by using the Estate Multiplier Technique (see Schwartz, 1983).

The 1987 Estate Study is the second year in a 3-year program concentrating on 1986 year of death decedents. Thus, most of the returns filed in 1987 correspond to decedents with a 1986 year of death. The combined filings for 1986-1988 will contain virtually complete information on 1986 decedents, so that research can be conducted concerning those persons dying in 1986 whose estates required the filing of an estate tax return. Additionally, each of the annual estate studies are designed so that good estimates of the financial characteristics of those filing in the respective year are available.

Stratification Variables

Data for the Estate Study is collected through a stratified sample design; the basic nature of which has not changed since it was first implemented in 1982. The design has 3 stratification variables:

- Year of Death of decedent (YOD);
- Age at Death of decedent (AGE); and
- Total Gross Estate (TGE).

For the 1987 Estate Study, the YOD variable is separated into 2 categories: 1986 year of death and non-1986 year of death. The AGE and TGE variables are noted in Figure 1. The unbounded categories for the TGE variable and the category corresponding to the youngest age group are selected with certainty. In fact, in the 1987 study, 15 out of the 24 categories are selected with certainty.

The goals of the users of the estate data influenced the calculation of the sampling rates

Figure 1.--Stratification Categories for the 1987 Estate Study

AGE AT DEATH CATEGORIES
Under 40 years
40 under 50 years
50 under 65 years
65 years and older, or age unknown
TOTAL GROSS ESTATE CATEGORIES
$500,000 under $1,000,000
$1,000,000 under $5,000,000
$5,000,000 or more

for the non "take-all" categories. In particular, adjustments were made to account for the wealth estimates which are desired for the living population as opposed to the population filing estate tax returns. This was done by using an estimate of the living population when determining the strata allocation using the Neyman allocation scheme (Cochran, 1977). The significance of this adjustment is that the distribution over age of the estate population is heavily concentrated in older persons, while that of the living population has, necessarily, a higher proportion of younger persons.

Adjustment of Sample Weights Due to Misclassification

As mentioned earlier, the estate sample is selected during revenue processing. This means that the information coded for the initial revenue processing is the information which determines the assignment of a return to a stratum. When the returns selected for the study undergo a complete edit, misclassification errors sometimes appear. For the 1987 estate study, the misclassification rate in the selected returns was .016. These errors influence the calculation of sample weights in two ways:

- First, if an adjustment is made to the stratum assignment of a return, how should the corresponding population counts be adjusted?
- Second, how should the uncertainty in the distribution of the population over the different sampling categories be represented?

The first concern has been addressed for the 1987 estate study and the decisions are discussed below. The second concern will be researched at a later time and is not discussed further in this paper. (See Mulrow and Jones, 1989, for a discussion of similar misclassification errors in the SOI Corporation Study).

Since the assignment of a return to a stratum depends on the values of the TGE, AGE, and YOD variables, there are several factors which could contribute to its misclassification. For the 1987 study, there were 181 misclassified returns; 63 were due solely to an incorrect calculation of age at death, and 116 were due solely to adjustments in the calculation of the total gross estate (total gross estate often increases during SOI editing as assets which were valued net of any related indebtedness are revalued at their gross value). No returns required both a change in age at death and total gross estate.

Of the 63 changes due to a miscalculation of the AGE variable, 42 were due to transcription errors during administrative processing which transformed decedents older than 100 into children. The most notable changes in TGE were 4 returns whose total gross estate changed from the lowest TGE category to the unbounded TGE category.

To determine if any adjustment was necessary to the misclassified returns, the effects of the misclassification on the desired estimates of total gross estate and other financial variables were considered. It was decided to adjust only the stratum assignment of those 4 returns which were initially assigned to the lowest total gross estate category, but should have been assigned to the highest TGE category. That is, the total gross estate changed from between $500,000 under $1,000,000 to over $5,000,000.

The sample design is such that returns with total gross estate over $5,000,000 are included with certainty. The above 4 sampled returns were sampled in a "take some" stratum that would be assigned a sample weight greater than one; however, such a weight assignment affects both population and financial estimates. The question becomes, how should the population counts be adjusted to account for the movement of the misclassified return?. There are two models which we considered:

- The misclassification is modeled as though the misclassified returns in the sample were the only misclassified returns in the population. (In this case the adjustments to the population are unweighted.)

- The misclassification is modeled to account for similar misclassification on unsampled returns. (In this case the population count adjustments correspond with the sampling weight of the misclassified return.)

To investigate which population adjustment to make, the distribution over age of the returns with total gross estate $5,000,000 or more was considered. Distributional information from the 1982-1984 Estate Studies and that for the 1986 Estate Study was used for this investigation. The distribution over age implied under each of the aforementioned models was compared to that of data for prior years. These distributions are depicted in Figure 2 below. The approach taken was that an unweighted adjustment was presumed correct unless the evidence strongly favored a weighted adjustment. That is, we assumed no misclassification among the unsampled returns since this had the smallest variance impact, provided there was no strong evidence that bias would result. The data from 1987 under these different assumptions are denoted: 1987 Unweighted and 1987 Weighted in Figure 2.

This table shows that a weighted adjustment to the population counts leads to a much higher proportion of those age 65 and over than had

FIGURE 2. - - ESTIMATED PERCENT DISTRIBUTION OVER AGE FOR DECEDENTS WITH TOTAL GROSS ESTATE OVER $5,000,000

FILING YEAR	AGE AT DEATH			
	under 40	40 under 50	50 under 65	over 65, unknown
1982	.010	.035	.156	.799
1983	.006	.034	.237	.723
1984	.007	.021	.239	.733
1986	.011	.033	.143	.813
1987-unweighted	.003	.041	.137	.819
1987-weighted	.002	.036	.118	.844

been estimated for the previous years. Although such a distributional shift is not infeasible, the population counts created using the unweighted adjustment are more attuned to the counts from prior years. Thus we decided to use the unweighted adjustment for the population counts.

III. POST-STRATIFICATION

Selection of the estate sample is based on information captured during revenue processing of the return. Because these data are mainly accounting data, the sample selection has been somewhat limited by a lack of demographic data on the tax filers. As a result, it may be that the 3 stratifiers, (YOD, TGE, and AGE) may not provide for the most homogenous groupings of the estate population. Further, because the distribution of estate tax filers is continuously changing, particularly in light of recent tax law changes, the sample may not adequately represent all groups for which estimates are desired. Post-stratification was considered as a means of improving the overall estimates and of investigating the representation of selected groups in the population.

It was decided to limit this investigation to 3 variables: tax status (taxable or nontaxable), sex, and filing region (as an approximation of a decedent's state of residence). It was hoped that post-stratification using one or more of these characteristics, within the framework of the original sample design, would make the estimates more precise. Data on the entire population were available at the end of the processing year. Population counts were obtained for each of the 3 variables under investigation from the Internal Revenue Service's Return Transaction File (RTF). These counts were used to calculate a post-stratified weight. Estimates were then generated for a number of different variables using both the sample and post-stratified weights.

Estimation Methodology

The sampling distribution conditional on the stratum sample sizes actually attained was chosen. The formulas used for estimating the mean and variance are as follows:

$$\hat{\bar{y}} = \sum_h \frac{N_h}{N} \bar{y}_h \; ;$$

$$V(\hat{\bar{y}}) = \frac{1}{N^2} \sum_h N_h \frac{(N_h - n_h)}{n_h} S_h^2 \; ;$$

$$\hat{\bar{y}}_{ps} = \sum_{hm} \frac{N_{hm}}{N} \bar{y}_{hm} \; ; \text{ and}$$

$$V(\hat{\bar{y}}_{ps}) = \frac{1}{N^2} \sum_{hm} N_{hm} \frac{(N_{hm} - n_{hm})}{n_{hm}} S_{hm}^2$$

$h = 1,2,\ldots,24$
$m = 1,2,\ldots,M.$

Here h represents the sampling strata and m represents the post-strata within sampling strata, M the total number of post-strata, is constant over h. The subscripted variables n, N, y, and s^2 refer in the traditional manner to the sample, population, calculated mean and variance for the stratum or post-stratum of interest. The overall estate population is referred to by N. (Holt and Smith, 1979). The variance was used to compare the estimates. (Note: the population counts in the post-strata are assumed known, thus justifying the use of the variance as opposed to the mean squared error to compare the estimates. Only in the case where categorizing by sex is there cause for concern about bias caused by uncertainty of the population totals.)

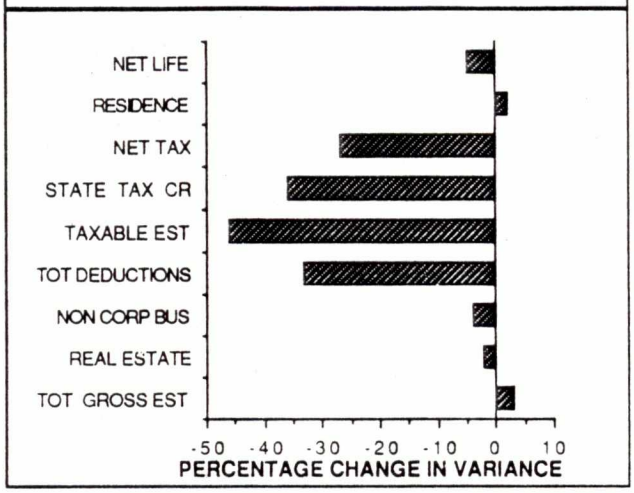
Comparing the Different Weighting Strategies

The estimates of nine different financial variables from the estate tax file were compared using the different weighting strategies. The estimates derived from the original stratified design were used as a base for comparison. For each of the post-stratified variables considered, the percent change in variance with respect to the variance of the corresponding estimate using the original weight was calculated. The financial variables considered were: total gross estate, real estate, noncorporate business assets, total deductions, net taxable estate, state death tax credit, net tax due, value of personal residence and net value of life insurance. The results for each post-stratification variable considered are detailed below.

Tax Status

A variable, TAX, was assigned to each individual in both the sample and the population by looking at the variable, "net estate tax after credits." If this variable was greater than zero, then the return was classified taxable; otherwise it was considered nontaxable. Figure 3 shows the percent change in variance between estimates generated using the original weight and post-stratified weight based on the tax status. The variance of the estimates was reduced for seven of the nine variables examined. As one might expect, the greatest reductions in variance were attained for those variables relating to the computation of the estate tax. The variances of estimates relating to the calculation of gross estate and

FIGURE 3
PERCENTAGE CHANGE IN VARIANCE
DUE TO POST-STRATIFYING BY TAX STATUS



its component assets were less affected by the post-stratified weight, actually increasing slightly in two cases.

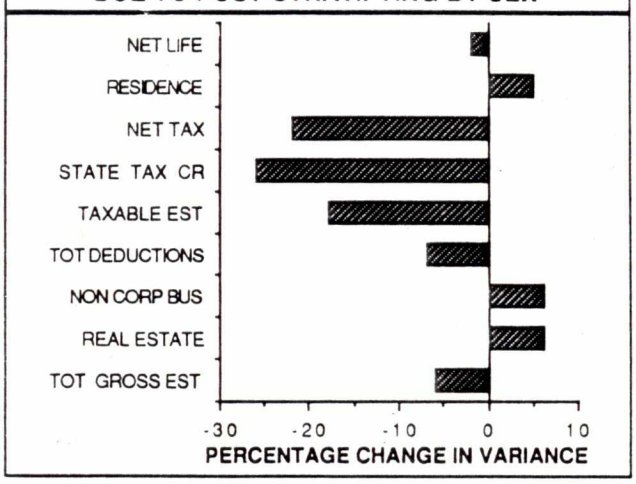
Sex

Because there was no code for sex on the Return Transaction File, it was necessary to assign these codes manually to the whole population based on the decedent's first name. If the first name was not easily classifiable, as in the names "Terry" or "Lee," then a determination was made based on the frequency of appearance and sex assigned to that name on a listing of 1986 estate tax filers for which the sexes were known with certainty. At the completion of this manual task, there were only .6% of the returns for which a SEX could not be determined. The number of unknown returns was later distributed across the SEX categories with probability equal to the observed population proportion of males and females.

A comparison of the resulting sex codes with the sex codes present on the 1987 SOI sample (which had been assigned using the decedent's death certificate) revealed an effective misclassification rate (excluding unknowns) of .2%. This misclassification, as well as any bias introduced by using different methods to assign the sex to the sample and the population, are ignored here, but will be investigated in the future.

Post-stratifying by sex significantly reduced the variance of the estimates, although not as much as seen previously in the tax status case (see Figure 4). Again, the greatest improvements were achieved for the variables related to tax computation. The precision of estimates of total gross estate improved, while those of its components did not. This suggests that while the size of gross estate may be somewhat dependent on the sex of the decedent (it is, on average, larger for male decedents), its components are not.

FIGURE 4
PERCENTAGE CHANGE IN VARIANCE
DUE TO POST-STRATIFYING BY SEX



Region

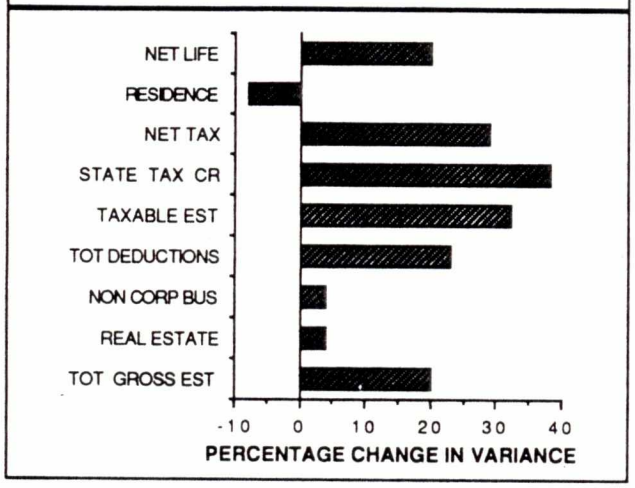
A value for region was determined for the population based on the location of the 10 IRS Service Centers in which the returns were filed. Unfortunately, although most of the areas under the jurisdiction of a service center are geographically related, a few of them are responsible for geographically unrelated areas in an effort to distribute the volume of all returns more equally among the centers. Likewise, some of the regions cover a large geographic area which is relatively sparce in population, while others are responsible for smaller, more densely populated areas. Further, an examination of the sample data revealed that some of the sample sizes within region and original sample strata were quite small. In such cases, it was necessary to collapse post-strata across regions for weighting purposes. All of these factors probably contributed to the poor results obtained here.

Post-stratifying by region failed to achieve any reduction in the variation of the estimates over the sample weight for all but one variable, value of the personal residence (see Figure 5). In fact, using this weight increased the variance of one estimate by almost 30 percent.

V. CONCLUSIONS/FUTURE RESEARCH

Overall, the greatest reductions in the variance of estimates created using post-stratified weights were achieved using tax status as the post-stratifying variable. While weights post-stratified by the decedent's sex did achieve notable results, the cost of obtaining the population counts and the associated uncertainty introduced by the process of determining the sex make it less desirable as a post-stratifying variable. It is also likely that the results obtained were due, in part, to the similarities of these groupings with those obtained when post-stratifying by tax status. Almost 2/3 of nontaxable decedents were male, while female decedents made up the majority of

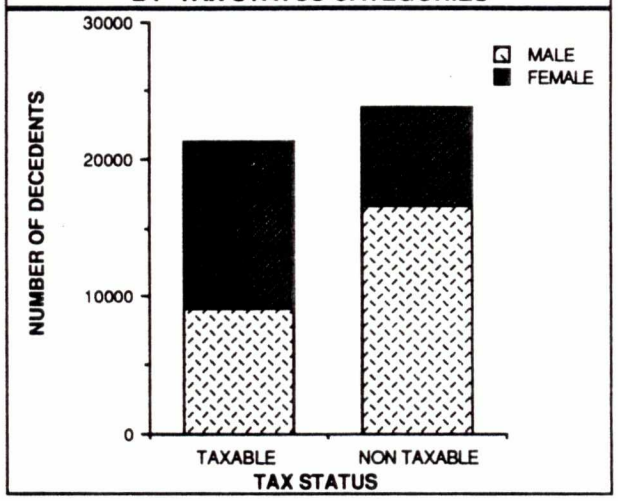
FIGURE 5
PERCENTAGE CHANGE IN VARIANCE DUE TO POST-STRATIFYING BY REGION



taxable decedents (see Figure 6). This is probably due to the large number of married decedents, most of whom took advantage of a provision in the estate tax law which allows for an unlimited tax deduction for bequests to the surviving spouse, which is most often the female partner.

If the sole objective of the estate study were to calculate estimates concerning the estate tax return population, then adding tax status as a stratification variable would suffice. However, the estate tax data are also used to compute wealth estimates of the living population. For this process, post-stratification by sex may prove doubly beneficial. An investigation into the effects of the post-stratified weights on wealth estimates is planned. It may be that a process using raking ratio estimation with both tax status and sex will be best for wealth estimation (Scheuren and Oh, 1978a, 1978b). Further investigation is also needed to determine if the existing strata for age and total gross estate still adequately group the population. It may be that inflation, higher stock and real estate prices, and longer life expectancies, coupled with filing requirement changes, will require the modification or addition of strata for these variables.

FIGURE 6
DISTRIBUTION OF ESTATE TAX POPULATION BY TAX STATUS CATEGORIES



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