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Sampling Errors for SESTAT: 1993, 1995, 1997, and 1999

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I. INTRODUCTION

SESTAT combines information from three surveys sponsored by the National Science Foundation:

- The National Survey of College Graduates (NSCG),
- The Survey of Doctorate Recipients (SDR), and
- The National Survey of Recent College Graduates (NSRCG)

The integrated SESTAT database represents individuals who met the following criteria as of April 15 of the SESTAT survey reference years (1993, 1995, 1997 or 1999):

- U.S. residents
- 75 years of age or less
- noninstitutionalized
- had at least one degree at the bachelor's level or higher in science or engineering

  OR

  had at least one degree at the bachelor's level or higher in a non-science or engineering field, but was working in a science or engineering occupation as of the survey reference date

This report provides information about sampling errors for SESTAT and how users can calculate standard errors for estimates derived from SESTAT.

II. UNDERSTANDING SAMPLING ERRORS

This chapter contains a brief discussion of the types of survey errors and the accuracy of estimates derived from surveys.

A. TYPES OF SURVEY ERRORS

Estimates derived from sample surveys are subject to two types of errors--sampling errors and nonsampling errors. *Nonsampling errors*[1] can be attributed to many sources, such as response differences, definitional difficulties, differing respondent interpretations, and respondent inability to recall information.

Sampling error (the focus of this presentation) occurs when an estimate is derived from a sample rather than a census of the population. The sample used for a particular survey is only one of a large number of possible samples of the same size and design that could have been selected. Even if the same questionnaire and instructions were used, the estimates from each sample would differ from the others. This difference, termed sampling error, occurs by chance, and its variability is measured by the standard error associated with a particular survey estimate. Estimates of the characteristics of scientists and engineers obtained using SESTAT are based on sample surveys and are thus subject to sampling errors. The standard errors and related information provided here indicate the general magnitude of the sampling errors for the three surveys when analyzed separately and when they are combined to create the full SESTAT database.

B. ASSESSING THE ACCURACY OF ESTIMATES

Having estimated a population quantity such as a mean or total, it is desirable to assess the accuracy of the estimate. The customary approach is to construct a *confidence interval* within which one is reasonably sure the true population value lies. The *standard error* of a survey estimate measures the

[1] For a general discussion of nonsampling errors, see *Nonsampling Errors in Surveys* by Judith T. Lessler and William D. Kalsbeek (New York: John Wiley & Sons, 1992). While the full extent of nonsampling errors is usually unknown, a variety of related research has been conducted for the SESTAT surveys. This research has been summarized in the technical notes associated with the SESTAT data elements, accessible through the SESTAT Home Page (http://sestat.nsf.gov) under the "Research Compendium" link.

precision with which an estimate from one sample approximates the true population value, and thus can be used to construct the confidence interval for a survey parameter[2]. Let $\hat{q}$ be an estimator of a parameter of interest q with a standard error $SE\left(\hat{q}\right)$. If the sample size is large, then an approximate (1-α)100% confidence interval for q is $\left\{\hat{q} - z_{\alpha/2}SE\left(\hat{q}\right), \hat{q} + z_{\alpha/2}SE\left(\hat{q}\right)\right\}$, where $z_{\alpha/2}$ is the upper α/2 percentage point of the normal distribution with mean zero and variance one.

If the process of selecting a sample from the population were repeated many times and an estimate and its standard error calculated for each sample, then:

a. Approximately 90% (α = 0.10) of the intervals from 1.645 (=$Z_{.05}$) standard errors below the estimate to 1.645 standard errors above the estimate will include the true population value.

b. Approximately 95% (α = 0.05) of the intervals from 1.96 (=$Z_{.025}$) standard errors below the estimate to 1.96 standard errors above the estimate will include the true population value.

c. Approximately 99% (α = 0.01) of the intervals from 2.575 (=$Z_{.005}$) standard errors below the estimate to 2.575 standard errors above the estimate will include the true population value.

With an estimate of the standard error and these factors (1.645, 1.96, or 2.575), a data user may construct a confidence interval, or range of values, that includes the true population value with the given probability α (=0.10, 0.05, or 0.01).

[2]Another related term is the *variance*, which is the square of the standard error and is sometimes used in standard error calculations.

III. GENERALIZED VARIANCE FUNCTIONS (GVFs): A METHODOLOGY FOR ESTIMATING STANDARD ERRORS

A *generalized variance function* (GVF) is a mathematical model that describes the relationship between a statistic (such as a population total) and its corresponding variance. GVF models are used to approximate standard errors for a wide variety of estimates of characteristics of the target population.[3]

A. GVF MODELING

GVF modeling consists of two steps:

(1) calculating population totals and their variances directly for a small subset of the survey items, and

(2) modeling the relationship between the survey-derived totals and their associated variances.

Step 1—Calculate Population Totals and Their Variances

For direct calculation of the variance (Step 1), a successive differences method or a resampling method such as random groups, balanced repeated replication, or jackknife replication might be used.[4]

Step 2—Model Relationships Between Survey-derived Totals and Sampling Errors

GVF models (Step 2) use regression modeling techniques and hence are subject to the same limitations of model specification, fit, and estimation as any other model. The principal advantage of the GVF method is that approximations of sampling errors are simplified for the large amount of estimates that are normally generated from a demographic survey with many variables. For SESTAT, GVF models are available for the total population and for domains of interest. Analysts can use these models to predict the variance for an estimated total or a percentage by inserting the value of the statistic into the model for the appropriate domain and survey component. The models developed for SESTAT are also described in Chapter IV.

[3]For more information on GVFs, see Chapter 5 of *Introduction to Variance Estimation*, by Kirk Wolter (New York: Springer-Verlag, 1985).

[4]The multi-phase nature of the sample designs for the SESTAT component surveys makes it difficult to use the Taylor series linearization approach to variance estimation.

B. A METHODOLOGY OVERVIEW

Let $\hat{Y}$ denote an estimator of the population total *Y*. GVF models are usually created for the *relative variance* of the estimated total, or $RelVar\left(\hat{Y}\right) = \frac{Var\left(\hat{Y}\right)}{Y^2}$ where $Var\left(\hat{Y}\right)$ is the variance of $\hat{Y}$. The modeling typically begins by assuming that the relative variance of an estimated total is a linear function of the inverse of the total *Y* being estimated, or $RelVar\left(\hat{Y}\right) = b_0 + \frac{b_1}{Y}$.

The parameters of the GVF model, b_0 and b_1, are estimated from a subset of all possible survey-derived totals and their variances by some form of least squares regression estimation. The relative variance of an estimated total $\hat{Y}$ can be predicted by evaluating the appropriate GVF model using the estimated values for Y, b_0 and b_1. Thus, using the GVF model, the standard error of a specific estimated total can be predicted by inserting the value of the estimated total into the following computational equivalent:

$$SE\left(\hat{Y}\right) = \sqrt{\hat{b}_0\hat{Y}^2 + \hat{b}_1\hat{Y}} \qquad \text{(III.1)}$$

where: $SE\left(\hat{Y}\right)$ is the predicted standard error of the estimated total $\hat{Y}$, and

$\hat{b}_0, \hat{b}_1$ are estimates of the regression parameters of b_0 and b_1.

The GVF model can also be adapted to estimate the standard error of a percentage. Using the same parameters, the standard error for a percentage can be predicted with this formula:

$$SE\left(\hat{P}\right) = \sqrt{\frac{\hat{b}_1}{\hat{Y}}\hat{P}(100 - \hat{P})} \qquad \text{(III.2)}$$

where: $SE\left(\hat{P}\right)$ is the predicted standard error for a specific estimated percentage $\hat{P}$, and

$\hat{Y}$ is the estimated number of persons in the base of the percentage.

The b_1 parameter to be used is the one developed for the domain that comprises the denominator of $\hat{Y}$ of the percentage $\hat{P}$.

IV. CALCULATING STANDARD ERRORS FOR SESTAT

This Chapter describes how users can calculate errors based on GVFs provided for SESTAT. This Chapter describes the estimation of these GVFs, including:

(1) the GVF model used,

(2) the method used to obtain directly calculated variance estimators, and

(3) the resulting estimated GVF parameters, displayed as parameter tables.

Parameter tables enable the user to calculate standard errors for a wide range of population totals and percentages. Instead of displaying standard errors, these tables provide parameters that the user inserts into formulas (provided in this Chapter) to calculate standard errors.

Basic Steps to Approximating Standard Errors

The following steps may be followed to approximate the standard error of an estimated total or percentage:

1. Obtain the estimated total or percentage from SESTAT;
2. Determine the most appropriate domain for the estimate from the parameter table(s);
3. Refer to the parameter table to get the parameter estimates for this domain; and
4. Compute the approximate standard error using the equations provided.

Examples showing how to use these tables for SESTAT are provided.

A. GVF MODEL

The Scientists and Engineers Statistical Data System (SESTAT) formed the GVF model for the variance of the estimate as a quadratic function of the total, or:

$$Var\left(\hat{Y}\right) = b_0 Y^2 + b_1 Y$$

where: Y is the population total being estimated,

$VAR\left(\hat{Y}\right)$ is the variance of the estimated total $\hat{Y}$, and

b_0 and b_1 are parameters of the model.

For the SESTAT data, GVF models were specified for the overall population and for subgroups such as gender, race/ethnicity, field of highest degree, occupation, and combinations of these characteristics. Separate models were estimated for 1993, 1997, and 1999. Because of the similarity in the 1993 and 1995 sample designs, a separate model was not estimated for 1995. Users are urged to use the 1993 models when evaluating standard errors for 1995 estimates.

To fit the model, population totals for 60 selected variables were estimated for each domain. Direct estimates of the variances for these domain totals were generated using the method of random groups. Ordinary least squares regression was used to derive estimates of b_0 and b_1 with the estimated domain totals and their directly calculated variances as inputs. The results are presented as a table of generalized variance model parameters which can be used to estimate standard errors.

B. DIRECT VARIANCE ESTIMATES – THE METHOD OF RANDOM GROUPS

The random group technique is appropriate when the sampling structure(s) of the survey(s) is sufficiently complex that analytically-derived variance estimation formulas become unmanageable. In general, variance estimation using the *method of random groups* consists of drawing multiple samples from a target population (or subpopulation) of interest and then constructing separate estimates for each sample. The dispersion of the different population estimates provides the basis for the variance measure. For the SESTAT variance measures, the survey sample was divided into random subsamples, chosen to mimic the sample design procedures for the total sample and weighted appropriately. From the SESTAT component surveys, the observations within each stratum were randomized and separate random group samples[5] were systematically selected without replacement:

NSCG Sampled cases were assigned to random groups within each sampling strata.

SDR Respondent cases were assigned to random groups within each sampling strata.

NSRCG Because of the two-step sample design of the NSRCG, two sets of random groups were selected:

- Responding students from certainty institutions were assigned to random groups within each sampling strata.

[5]For 1993, twenty separate random group samples were selected. Changes to the sample design for 1997 resulted in increased variation of the random group estimates used. Consequently, in 1997 and 1999, fifty groups samples were selected.

- Noncertainty institutions were assigned to random groups. All sampled students from the institution were then assigned to that institution's random group.

The sets of random groups for each survey were combined to create SESTAT random groups, with each group representing a valid sample of the combined SESTAT target population.

C. EXAMPLES: HOW DATA USERS CAN CALCULATE STANDARD ERRORS FOR SESTAT

We offer two methods for obtaining standard errors for SESTAT estimates. Method 1 is easiest but is limited in its application to standard errors for estimated totals. Method 2 can be used to predict standard errors for estimated percentages and totals.

Method 1. Obtaining Standard Errors from the Look-up Tables

The look-up tables provide approximate standard errors for estimated counts of scientists and engineers for the total population and for different segments of the population.

Example A: Total (from Look-up Tables)

For example, assume the 1993 estimate of the number of scientists and engineers employed in S&E occupations was approximately 8 million people. The total column in *Table A-1. Scientists and Engineers in 1993, 1995, 1997, and 1999 (Total Population): Approximate Standard Errors for Specified Demographic Groups* shows a standard error estimate of 57,450 associated with a 1993 estimated count of 8 million. Then the 95% confidence interval is 1.96 (the factor for the 95% confidence interval) times the standard error from the table (57,450), or 1.96 x 57,450 = 112,602. Thus, the 95% confidence interval for the true value is the interval between 7,887,398 and 8,112,602 (8,000,000 ± 112,602).

There are several versions of the Look-up Tables. As a general rule, use the table that is most specific to the domain you are studying and the database being analyzed. Thus, the “total” category is used when more than one degree level is included. In many cases, the exact estimate will not be included in the Look-up Tables. For these standard errors, you may use linear interpolation for intermediate values or you may wish to use *Method 2*.

Method 2. Using the Parameter Tables

The parameter table provides a method for approximating standard errors for estimated counts and percents of scientists and engineers for the total SESTAT population and for different segments of the population.

Example B. Total (from Parameter Tables)

Suppose SESTAT data are used to estimate the total population size of individuals employed in science or engineering occupations in 1993. As the domain for this population is the total science and engineering population, we look in *Table B-1. Scientists and Engineers in 1993, 1995, 1997, and 1999 (Total Population):* b_0 *and* b_1 *Parameters for Specified Demographic Groups* and determine the values for $\hat{b}_0 (= 0.00003)$ and $\hat{b}_1 (= 176.69490)$ from the total column for 1993/1995. Using equation III.1, we estimate the standard error as

$$SE\left(\hat{Y}\right) = \sqrt{(0.00003\hat{Y}^2) + (176.69490\hat{Y})}$$

We substitute the value of $\hat{Y}$ = 8,311,787 and obtain $SE\left(\hat{Y}\right)$ = 59,508. Thus, a 95% confidence interval for the true value for the total number of individuals employed in science or engineering occupations in 1993 would be 8,311,787 ± 116,636, where 116,636 represents 1.96 times the standard error.

Example C: Percentage (from Parameter Tables)

To illustrate the use of the formula for determining standard errors for percentages, suppose that we use SESTAT estimates to determine that 82% of female scientists and engineers in 1993 were participating in the labor forces as of the reference week. The base for this percentage is the number of female scientists and engineers, estimated at 3,867,887.

Obtaining the value for $b_1 (= 270.32836)$ from the "female" column of the appropriate parameter table and using equation III.2:

$$SE\left(\hat{P}\right) = \sqrt{\frac{270.32836}{\hat{Y}}\hat{P}(100 - \hat{P})}$$

Substituting for the values of the base $\hat{Y}(3{,}867{,}887)$ and the percentage $\hat{P}(82)$, we obtain an estimated standard error of 0.32. The 95% confidence interval for the labor force participation rate for females is 82% ± 0.63% (where 0.63 equals 1.96 times the estimated standard error).

APPENDIX A

LOOK-UP TABLES: 1993, 1995, 1997, AND 1999 SESTAT

Table A-1. Scientists and Engineers in 1993, 1995, 1997, and 1999 (Total Population): Approximate Standard Errors for Specified Demographic Groups

	1993/1995					1997					1999				
Estimated Number	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite
100	130	130	160	140	90	160	160	160	170	110	175	168	172	178	132
200	190	180	230	200	130	230	230	230	250	160	248	237	244	251	186
500	300	290	370	320	200	370	360	360	390	250	392	375	385	397	294
750	360	350	450	390	250	450	450	440	480	310	480	460	472	486	360
1,000	420	410	520	450	290	520	520	510	550	350	555	531	545	561	416
2,000	590	580	740	630	410	730	730	720	780	500	784	750	771	794	588
3,000	730	710	900	780	500	900	890	880	950	610	961	919	944	972	721
4,000	840	820	1,040	900	580	1,030	1,030	1,020	1,100	710	1,109	1,061	1,090	1,123	832
5,000	940	910	1,160	1,000	650	1,160	1,150	1,140	1,230	790	1,240	1,186	1,218	1,255	930
10,000	1,330	1,290	1,640	1,420	920	1,640	1,630	1,610	1,740	1,120	1,754	1,677	1,722	1,775	1,314
25,000	2,110	2,040	2,600	2,250	1,480	2,580	2,580	2,540	2,740	1,770	2,771	2,650	2,719	2,804	2,072
50,000	2,980	2,900	3,670	3,180	2,150	3,650	3,640	3,580	3,870	2,490	3,915	3,742	3,836	3,961	2,919
100,000	4,240	4,120	5,190	4,520	3,190	5,160	5,140	5,040	5,470	3,490	5,527	5,278	5,400	5,590	4,092
250,000	6,780	6,600	8,190	7,220	5,690	8,110	8,070	7,840	8,600	5,390	8,690	8,276	8,417	8,781	6,301
500,000	9,780	9,530	11,540	10,380	9,370	11,380	11,280	10,780	12,050	7,300	12,174	11,540	11,612	12,281	8,495
750,000	12,210	11,920	14,080	12,930	12,900	13,820	13,650	12,810	14,610	8,520	14,767	13,930	13,855	14,871	9,869
1,000,000	14,360	14,040	16,190	15,170	--	15,830	15,570	14,330	16,700	9,330	16,885	15,846	15,564	16,973	10,742
2,000,000	21,710	21,360	22,540	22,760	--	21,610	20,930	17,420	22,640	--	22,912	21,003	19,360	22,844	10,725
3,000,000	28,200	27,880	27,170	29,390	--	25,480	24,220	17,140	26,490	--	26,824	23,877	19,942	26,483	--
4,000,000	34,330	34,060	--	35,610	--	28,240	26,230	13,310	29,070	--	29,475	25,258	17,633	28,749	--
5,000,000	40,260	40,060	--	41,590	--	30,200	27,240	--	30,720	--	31,190	25,393	10,698	29,957	--
6,000,000	46,060	45,950	--	47,430	--	31,490	27,380	--	31,580	--	32,117	24,302	--	30,232	--
7,000,000	51,780	51,770	--	53,170	--	32,220	26,640	--	31,720	--	32,326	21,801	--	29,602	--
8,000,000	57,450	--	--	58,850	--	32,400	24,950	--	31,140	--	31,830	17,289	--	28,004	--
9,000,000	63,070	--	--	64,480	-	32,060	--	--	29,800	--	30,595	7,842	--	25,257	--
10,000,000	68,670	--	--	70,060	--	31,170	--	--	27,590	--	28,525	--	--	20,912	--
11,000,000	--	--	--	--	--	29,690	--	--	--	--	25,417	--	--	13,506	--
12,000,000	--	--	--	--	--	27,510	--	--	--	--	20,811	--	--	--	--

NOTE: White category excludes persons of Hispanic origin. Hispanics are included in the Nonwhite category.
SOURCE: National Science Foundation/Division of Science Resources Statistics; Scientists and Engineers Statistical Data System (SESTAT), 1993-1999.

Table A-2. Bachelor's Scientists and Engineers in 1993, 1995, 1997, and 1999: Approximate Standard Errors for Specified Demographic Groups

	1993/1995					1997					1999				
Estimated Number	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite
100	110	120	160	120	90	170	170	180	180	130	186	183	179	191	138
200	150	170	230	170	130	240	240	250	260	180	263	258	254	270	196
500	240	270	360	260	200	380	380	390	410	280	416	409	401	426	309
750	300	330	450	320	250	470	470	480	510	350	509	500	491	522	379
1,000	340	380	520	370	290	540	540	550	580	400	588	578	567	603	437
2,000	490	540	730	530	410	760	760	780	830	570	832	817	802	853	618
3,000	600	660	890	650	500	940	930	960	1,010	700	1,018	1,001	982	1,044	757
4,000	690	760	1,030	750	580	1,080	1,080	1,110	1,170	800	1,176	1,155	1,134	1,206	874
5,000	770	850	1,150	840	650	1,210	1,210	1,240	1,310	900	1,315	1,292	1,268	1,348	977
10,000	1,090	1,200	1,630	1,180	930	1,710	1,700	1,750	1,850	1,270	1,859	1,826	1,792	1,906	1,380
25,000	1,740	1,910	2,580	1,880	1,520	2,700	2,690	2,770	2,920	2,000	2,937	2,885	2,829	3,012	2,177
50,000	2,480	2,720	3,650	2,680	2,250	3,810	3,800	3,900	4,120	2,810	4,150	4,073	3,989	4,254	3,065
100,000	3,570	3,900	5,160	3,860	3,470	5,380	5,360	5,490	5,810	3,930	5,858	5,743	5,610	6,004	4,298
250,000	5,930	6,430	8,170	6,400	6,630	8,470	8,410	8,540	9,120	6,010	9,209	8,998	8,716	9,431	6,615
500,000	9,020	9,690	11,580	9,700	11,590	11,860	11,730	11,740	12,740	7,960	12,898	12,528	11,953	13,192	8,915
750,000	11,770	12,540	14,220	12,620	--	14,390	14,150	13,960	15,410	9,060	15,640	15,098	14,169	15,975	10,351
1,000,000	14,380	15,230	16,450	15,390	--	16,460	16,100	15,610	17,560	9,590	17,878	17,146	15,799	18,235	11,259
2,000,000	24,270	25,310	23,460	25,860	--	22,360	21,320	18,970	23,450	--	24,227	22,545	18,831	24,554	11,169
3,000,000	33,870	35,010	--	35,990	--	26,200	24,220	--	26,940	--	28,320	25,356	17,747	28,481	--
4,000,000	43,370	44,590	--	46,010	--	28,830	25,590	--	28,900	--	31,061	26,418	11,433	30,941	--
5,000,000	52,820	--	--	55,980	--	30,560	--	--	29,640	--	32,791	25,946	--	32,271	--
6,000,000	62,250	--	--	65,920	--	31,530	--	--	29,240	--	33,667	23,851	--	32,609	--
7,000,000	--	--	--	--	--	31,820	--	--	--	--	33,755	19,617	--	31,988	--
8,000,000	--	--	--	--	--	--	--	--	--	--	33,061	11,006	--	30,347	--
9,000,000	--	--	--	--	--	--	--	--	--	--	31,533	--	--	27,506	--
10,000,000	--	--	--	--	--	--	--	--	--	--	29,042	--	--	23,024	--
11,000,000	--	--	--	--	--	--	--	--	--	--	25,302	--	--	15,540	--
12,000,000	--	--	--	--	--	--	--	--	--	--	19,613	--	--	--	--

NOTE: White category excludes persons of Hispanic origin. Hispanics are included in the Nonwhite category.
SOURCE: National Science Foundation/Division of Science Resources Statistics; Scientists and Engineers Statistical Data System (SESTAT), 1993-1999.

Table A-3. Master's Scientists and Engineers in 1993, 1995, 1997, and 1999: Approximate Standard Errors for Specified Demographic Groups

	1993/1995					1997					1999				
Estimated Number	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite
100	140	130	160	150	100	160	160	180	180	110	168	161	179	177	137
200	200	180	220	210	140	230	220	250	250	160	237	228	252	251	193
500	320	290	360	340	230	360	350	400	390	250	375	360	399	396	305
750	400	360	440	410	280	440	430	490	480	300	459	441	489	485	374
1,000	460	410	500	480	320	510	500	560	560	350	530	509	564	560	432
2,000	650	580	710	680	450	720	710	790	790	490	749	720	798	793	610
3,000	790	710	870	830	560	890	860	970	970	600	918	882	977	971	747
4,000	920	820	1,000	960	640	1,020	1,000	1,120	1,110	700	1,060	1,019	1,129	1,121	863
5,000	1,020	920	1,120	1,070	720	1,140	1,120	1,250	1,250	780	1,185	1,139	1,262	1,253	964
10,000	1,450	1,300	1,590	1,510	1,010	1,620	1,580	1,770	1,760	1,100	1,675	1,610	1,783	1,772	1,363
25,000	2,290	2,060	2,500	2,390	1,590	2,560	2,500	2,790	2,790	1,730	2,648	2,543	2,815	2,801	2,149
50,000	3,220	2,900	3,520	3,360	2,230	3,610	3,530	3,940	3,940	2,410	3,741	3,590	3,971	3,959	3,026
100,000	4,540	4,070	4,940	4,730	3,070	5,100	4,980	5,540	5,560	3,330	5,283	5,059	5,587	5,592	4,242
250,000	7,060	6,320	7,600	7,360	--	8,050	7,860	8,610	8,770	4,860	8,316	7,912	8,696	8,813	6,526
500,000	9,720	8,630	10,250	10,120	--	11,330	11,060	11,810	12,360	5,770	11,670	10,983	11,965	12,396	8,786
750,000	11,570	10,190	11,900	12,020	--	13,810	13,480	14,010	15,070	--	14,181	13,194	14,234	15,099	10,188
1,000,000	12,960	11,310	12,950	13,440	--	15,870	15,480	15,630	17,330	--	16,246	14,932	15,937	17,337	11,064
2,000,000	15,860	--	--	16,290	--	22,000	21,460	--	24,080	--	22,228	19,308	19,460	23,962	10,816
3,000,000	15,840	--	--	--	--	26,390	--	--	--	--	26,277	21,201	19,341	28,649	--
4,000,000	--	--	--	--	--	--	--	--	--	--	29,208	21,284	15,497	32,255	--
5,000,000	--	--	--	--	--	--	--	--	--	--	31,336	19,580	--	35,114	--
6,000,000	--	--	--	--	--	--	--	--	--	--	32,817	15,512	--	37,397	--
7,000,000	--	--	--	--	--	--	--	--	--	--	33,738	4,970	--	39,207	--
8,000,000	--	--	--	--	--	--	--	--	--	--	34,144	--	--	40,605	--
9,000,000	--	--	--	--	--	--	--	--	--	--	34,052	--	--	41,634	--
10,000,000	--	--	--	--	--	--	--	--	--	--	33,459	--	--	42,320	--
11,000,000	--	--	--	--	--	--	--	--	--	--	32,337	--	--	42,681	--
12,000,000	--	--	--	--	--	--	--	--	--	--	30,628	--	--	42,723	--

Table A-4. Doctoral Scientists and Engineers in 1993, 1995, 1997, and 1999: Approximate Standard Errors for Specified Demographic Groups

	1993/1995					1997					1999				
Estimated Number	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite
100	80	80	80	80	90	90	90	80	90	80	99	97	94	104	85
200	110	110	110	110	130	120	130	120	130	110	139	137	133	146	121
500	180	170	170	180	210	200	200	190	210	170	220	217	210	232	191
750	220	210	210	220	250	240	240	230	250	210	270	266	258	284	234
1,000	260	250	240	250	290	280	280	270	290	240	312	307	298	327	270
2,000	360	350	350	360	410	390	400	380	410	340	441	434	421	463	381
3,000	440	420	420	440	500	480	490	460	510	410	539	532	515	567	466
4,000	510	490	490	510	580	550	560	530	590	480	623	614	595	655	538
5,000	570	550	540	570	650	620	630	600	650	530	696	686	665	732	601
10,000	810	770	770	800	900	870	890	840	920	750	984	969	939	1,034	845
25,000	1,280	1,220	1,200	1,260	1,350	1,380	1,390	1,330	1,460	1,180	1,554	1,525	1,478	1,631	1,315
50,000	1,800	1,710	1,670	1,780	--	1,940	1,950	1,880	2,050	1,650	2,192	2,141	2,074	2,296	1,807
100,000	2,520	2,390	2,290	2,480	--	2,710	2,700	2,660	2,860	2,260	3,084	2,982	2,890	3,218	2,401
250,000	3,840	3,640	--	3,750	--	4,110	3,990	--	4,330	--	4,799	4,490	4,355	4,950	2,945
500,000	5,110	4,800	--	4,890	--	5,410	4,900	--	5,670	--	6,603	5,780	5,619	6,660	--
750,000	5,830	--	--	--	--	6,080	--	--	--	--	7,856	6,305	6,149	7,718	--
1,000,000	--	--	--	--	--	--	--	--	--	--	8,795	6,259	6,138	8,374	--
2,000,000	--	--	--	--	--	--	--	--	--	--	10,737	--	--	8,120	--
3,000,000	--	--	--	--	--	--	--	--	--	--	10,668	--	--	--	--
4,000,000	--	--	--	--	--	--	--	--	--	--	8,539	--	--	--	--

NOTE: White category excludes persons of Hispanic origin. Hispanics are included in the Nonwhite category.

SOURCE: National Science Foundation/Division of Science Resources Statistics; Scientists and Engineers Statistical Data System (SESTAT), 1993-1999.

APPENDIX B

PARAMETER TABLES: 1993, 1995, 1997, AND 1999 SESTAT

Table B-1. Scientists and Engineers in 1993, 1995, 1997, and 1999 (Total Population):

$\hat{a}_0$ and $\hat{a}_1$ Parameters for Specified Demographic Groups

Field	Parameter	1993/1995					1997					1999				
		Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite
Total Scientists and Engineers																
Total, all individuals	$\hat{a}_0$	0.00003	0.00003	-0.00001	0.00003	0.00019	-0.00002	-0.00002	-0.00005	-0.00002	-0.00004	-0.00002	-0.00003	-0.00005	-0.00003	-0.00006
	$\hat{a}_1$	176.69490	166.31100	270.32836	200.99951	83.18664	267.55681	266.08229	259.10898	301.43571	125.89853	307.74838	281.62859	297.07774	315.22684	173.25637
Field of Highest Degree																
Computer and mathematical sciences	$\hat{a}_0$	0.00029	0.00006	0.00076	0.00021	0.00147	-0.00012	-0.00022	-0.00020	-0.00017	-0.00030	-0.00014	-0.00021	-0.00040	-0.00022	-0.00021
	$\hat{a}_1$	89.80400	130.80748	145.06455	134.71012	108.84321	236.72680	244.64129	202.74606	266.59769	127.85088	238.30346	250.50661	225.56489	281.30536	151.88338
Life sciences	$\hat{a}_0$	0.00008	0.00011	-0.00002	0.00006	0.00033	-0.00011	-0.00011	-0.00025	-0.00014	-0.00026	-0.00010	-0.00019	-0.00030	-0.00013	-0.00029
	$\hat{a}_1$	251.34883	294.31433	196.03116	274.20978	77.23959	252.30016	227.52316	238.40757	275.04771	127.69724	263.04618	276.56190	297.08279	274.29995	162.97016
Physical sciences	$\hat{a}_0$	0.00003	0.00004	0.00032	0.00005	0.00004	-0.00013	-0.00011	-0.00037	-0.00015	-0.00034	-0.00013	-0.00020	-0.00040	-0.00017	-0.00045
	$\hat{a}_1$	170.49243	157.99787	176.99994	177.93209	101.40953	183.41966	179.29663	165.56655	194.88111	105.91051	191.05037	211.65869	171.46532	217.56020	121.16321
Social sciences	$\hat{a}_0$	0.00004	0.00013	-0.00014	0.00004	0.00019	-0.00007	-0.00011	-0.00012	-0.00010	-0.00009	-0.00006	-0.00014	-0.00013	-0.00008	-0.00010
	$\hat{a}_1$	303.60745	265.72307	394.62859	347.42949	82.27349	361.16213	366.52066	312.42873	394.58586	194.79961	391.98517	394.61136	350.07506	410.02192	218.30068
Engineering	$\hat{a}_0$	0.00007	0.00007	-0.00018	0.00007	0.00055	-0.00003	-0.00003	-0.00041	-0.00004	-0.00009	-0.00003	-0.00005	-0.00009	-0.00006	-0.00014
	$\hat{a}_1$	128.77535	114.98185	147.68140	133.65887	84.71114	155.24470	152.46790	130.16610	164.35369	98.65669	173.72197	184.19018	114.07917	205.42315	122.67385
Non-S&E fields	$\hat{a}_0$	-0.00004	0.00000	-0.00003	-0.00005	-0.00003	-0.00004	-0.00006	-0.00014	-0.00006	-0.00014	-0.00002	-0.00007	-0.00003	-0.00002	-0.00019
	$\hat{a}_1$	256.85135	251.53103	242.24599	287.08421	147.34102	391.88372	391.37197	370.40347	464.26096	176.54602	362.78296	349.15063	352.27621	398.80013	229.68120
Occupation																
Computer and mathematical scientists	$\hat{a}_0$	-0.00006	-0.00006	-0.00003	-0.00010	0.00108	-0.00006	-0.00012	-0.00015	0.00000	-0.00012	-0.00001	0.00003	-0.00022	0.00003	-0.00022
	$\hat{a}_1$	221.85065	204.84245	178.91865	238.24613	83.86203	207.12086	201.97914	221.17196	219.47569	112.50829	222.17067	225.58645	263.81063	248.07716	164.28594
Life scientists	$\hat{a}_0$	-0.00001	0.00001	-0.00016	0.00006	-0.00003	-0.00005	-0.00003	0.00010	0.00002	0.00033	0.00002	-0.00011	-0.00003	-0.00004	-0.00005
	$\hat{a}_1$	138.75347	149.30748	154.14534	141.49262	94.85909	171.32426	165.65807	146.85424	184.03261	79.93541	162.64087	152.08679	193.12466	185.56071	97.13051
Physical scientists	$\hat{a}_0$	0.00000	0.00005	-0.00036	-0.00001	0.00268	0.00002	0.00016	-0.00054	-0.00001	0.00000	-0.00006	-0.00006	-0.00018	-0.00007	-0.00030
	$\hat{a}_1$	130.53054	112.34096	168.71025	130.32785	60.75632	131.22180	127.96285	133.87579	147.98803	89.02575	145.22370	136.95987	150.84816	153.65366	103.17917
Social scientists	$\hat{a}_0$	0.00034	0.00037	0.00035	0.00049	0.00277	0.00007	-0.00007	-0.00017	0.00012	0.00088	0.00001	-0.00027	-0.00007	-0.00004	-0.00030
	$\hat{a}_1$	109.84407	108.54372	153.28439	112.45018	54.15554	179.05551	172.83589	181.63405	177.25055	102.25442	189.71994	208.67765	213.72394	191.99128	135.74938
Engineers	$\hat{a}_0$	0.00003	0.00003	-0.00035	0.00001	0.00007	-0.00003	-0.00004	0.00007	-0.00003	-0.00008	0.00002	0.00004	-0.00034	0.00004	-0.00011
	$\hat{a}_1$	96.10207	101.13821	113.82222	110.78920	77.59964	159.87429	167.11702	123.48409	166.91390	95.01412	190.69903	197.17445	156.12924	188.37016	122.96701
Non-S&E occupations	$\hat{a}_0$	0.00001	-0.00001	-0.00007	-0.00001	0.00019	-0.00002	-0.00003	-0.00009	-0.00002	-0.00007	-0.00003	-0.00005	-0.00008	-0.00004	-0.00010
	$\hat{a}_1$	287.16730	291.87926	331.93894	340.29557	86.68441	310.86024	331.01722	304.79958	342.79059	145.95845	372.55391	366.62209	350.48018	388.08396	203.79014

NOTE: White category excludes persons of Hispanic origin. Hispanics are included in the Nonwhite category.

SOURCE: National Science Foundation/Division of Science Resources Statistics; Scientists and Engineers Statistical Data System (SESTAT), 1993-1999.

Table B-2. Bachelor's Scientists and Engineers in 1993, 1995, 1997, and 1999: $\hat{a}_0$ and $\hat{a}_1$ Parameters for Specified Demographic Groups

Field	Parameter	1993/1995					1997					1999				
		Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite
Bachelor's Scientists and Engineers																
Total, all individuals	$\hat{a}_0$	0.00009	0.00009	0.00001	0.00010	0.00037	-0.00002	-0.00003	-0.00006	-0.00003	-0.00007	-0.00003	-0.00004	-0.00007	-0.00003	-0.00006
	$\hat{a}_1$	118.86394	143.42254	266.09738	139.30246	83.05303	292.07203	290.87424	307.66661	341.32119	161.72388	345.76312	333.81569	321.92498	363.55902	191.13484
Field of Highest Degree																
Computer and mathematical sciences	$\hat{a}_0$	0.00042	0.00011	0.00074	0.00029	0.00234	-0.00016	-0.00035	-0.00031	-0.00024	-0.00052	-0.00023	-0.00041	-0.00055	-0.00031	-0.00061
	$\hat{a}_1$	70.13289	127.74573	152.67456	122.24251	101.43949	255.78820	273.24608	233.52033	288.34371	141.39241	277.47804	300.98507	239.70050	294.67208	192.93481
Life sciences	$\hat{a}_0$	0.00004	0.00017	-0.00017	0.00004	0.00053	-0.00017	-0.00024	-0.00033	-0.00020	-0.00056	-0.00017	-0.00034	-0.00045	-0.00022	-0.00050
	$\hat{a}_1$	256.31104	308.56627	194.07835	276.02536	71.41519	292.44341	283.99040	281.89141	308.42797	167.63249	322.31076	339.91860	355.23811	342.76698	198.01218
Physical sciences	$\hat{a}_0$	0.00017	0.00022	0.00048	0.00018	-0.00001	-0.00032	-0.00034	-0.00068	-0.00038	-0.00070	-0.00036	-0.00059	-0.00073	-0.00045	-0.00104
	$\hat{a}_1$	194.58008	208.15287	194.84192	222.70969	95.93459	260.14427	256.65870	205.98793	276.76861	140.41573	270.32685	312.30207	219.66166	291.16354	170.87214
Social sciences	$\hat{a}_0$	0.00009	0.00012	-0.00010	0.00009	0.00019	-0.00009	-0.00019	-0.00018	-0.00013	-0.00015	-0.00008	-0.00020	-0.00015	-0.00010	-0.00017
	$\hat{a}_1$	331.37020	339.14613	389.32146	379.88527	96.43793	401.03246	404.94402	372.99958	442.59272	217.40138	431.44041	465.09638	367.37615	458.98435	238.39416
Engineering	$\hat{a}_0$	0.00006	0.00005	-0.00037	0.00006	0.00096	-0.00005	-0.00005	-0.00065	-0.00006	-0.00017	-0.00007	-0.00009	-0.00027	-0.00010	-0.00040
	$\hat{a}_1$	181.28722	171.15698	166.40808	182.28338	84.00956	171.53962	170.26260	150.87960	174.11792	117.31563	200.65872	214.80459	137.43830	228.21721	158.48280
Non-S&E fields	$\hat{a}_0$	0.00036	0.00030	-0.00008	0.00036	-0.00025	-0.00025	-0.00032	-0.00072	-0.00026	-0.00044	-0.00038	-0.00042	-0.00048	-0.00038	-0.00004
	$\hat{a}_1$	179.64400	190.18533	247.51211	190.88006	138.61525	317.09402	280.01820	350.39384	328.65576	155.98798	356.29880	326.05010	392.44659	377.09712	182.68328
Occupation																
Computer and mathematical scientists	$\hat{a}_0$	0.00004	0.00009	-0.00037	-0.00002	0.00175	-0.00007	-0.00021	-0.00020	-0.00003	-0.00027	0.00006	0.00016	-0.00050	0.00009	-0.00027
	$\hat{a}_1$	176.92090	176.35940	168.35653	196.70627	82.97840	253.37849	258.23402	265.09790	280.50500	133.19109	247.69805	260.97694	299.01424	248.49673	196.36168
Life scientists	$\hat{a}_0$	0.00014	-0.00080	-0.00020	0.00020	0.00090	-0.00055	-0.00045	-0.00055	-0.00047	-0.00238	-0.00041	-0.00064	-0.00053	-0.00033	-0.00423
	$\hat{a}_1$	190.86238	222.78489	192.27569	188.61426	122.43038	247.12505	250.37299	212.01362	259.99524	147.01842	267.62855	282.96504	230.79496	277.87158	200.97213
Physical scientists	$\hat{a}_0$	0.00045	0.00048	-0.00116	0.00043	0.00494	-0.00011	0.00001	-0.00041	-0.00015	0.00022	0.00018	0.00028	-0.00161	0.00009	-0.00214
	$\hat{a}_1$	121.52097	124.81811	154.56167	131.47902	76.41973	194.33324	204.68028	168.13985	211.38832	117.86311	200.91399	220.12543	174.59927	223.17370	172.67648
Social scientists	$\hat{a}_0$	0.00109	-0.00169	0.00352	0.00120	0.00076	-0.00116	-0.00140	-0.00220	-0.00088	-0.00324	-0.00012	0.00028	-0.00209	0.00024	-0.00813
	$\hat{a}_1$	197.35439	247.24193	193.66180	234.77269	105.80722	315.19447	310.60447	275.68941	336.14284	162.55200	391.59005	329.92357	374.54928	409.08087	229.92383
Engineers	$\hat{a}_0$	0.00001	0.00000	-0.00047	-0.00003	0.00067	-0.00006	-0.00008	0.00022	-0.00003	-0.00007	0.00002	0.00003	-0.00089	0.00005	-0.00020
	$\hat{a}_1$	115.17534	119.74258	128.91438	126.97845	79.37610	173.52403	180.21247	123.62580	166.75678	110.98110	212.33234	218.63238	175.40824	199.92285	158.09250
Non-S&E occupations	$\hat{a}_0$	0.00008	0.00003	-0.00002	0.00009	0.00041	-0.00002	-0.00004	-0.00008	-0.00003	-0.00004	-0.00003	-0.00002	-0.00011	-0.00004	-0.00005
	$\hat{a}_1$	260.55657	290.08548	315.02172	316.80330	81.39798	304.87751	361.26565	320.44709	351.01049	163.04403	413.80692	397.18491	351.06926	444.24003	216.79169

NOTE: White category excludes persons of Hispanic origin. Hispanics are included in the Nonwhite category.
SOURCE: National Science Foundation/Division of Science Resources Statistics; Scientists and Engineers Statistical Data System (SESTAT), 1993-1999.

Table B-3. Master's Scientists and Engineers in 1993, 1995, 1997, and 1999:

$\hat{a}_0$ and $\hat{a}_1$ Parameters for Specified Demographic Groups

Field	Parameter	1993/1995					1997					1999				
		Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite
Master's Scientists and Engineers																
Total, all individuals	$\hat{a}_0$	-0.00004	-0.00004	-0.00009	-0.00005	-0.00009	-0.00001	-0.00001	-0.00007	-0.00001	-0.00011	-0.00002	-0.00004	-0.00006	-0.00001	-0.00006
	$\hat{a}_1$	210.06537	170.11517	252.39245	228.74298	103.53543	261.58243	249.27268	313.91704	310.51850	121.87442	280.81808	259.55041	318.64128	314.08432	186.33419
Field of Highest Degree																
Computer and mathematical sciences	$\hat{a}_0$	0.00019	0.00025	-0.00056	0.00018	-0.00097	-0.00039	-0.00062	-0.00080	-0.00068	-0.00021	-0.00051	-0.00066	-0.00180	-0.00108	-0.00023
	$\hat{a}_1$	188.10992	196.74359	209.28052	192.46761	90.39364	169.67067	194.90296	149.49758	217.86625	90.85164	229.98609	225.03016	226.95922	316.13836	102.25294
Life sciences	$\hat{a}_0$	-0.00047	-0.00122	0.00029	-0.00059	-0.00151	-0.00014	-0.00042	-0.00100	-0.00007	-0.00014	-0.00076	-0.00159	-0.00086	-0.00092	-0.00104
	$\hat{a}_1$	211.00732	238.29361	207.13858	219.72587	95.50247	157.90700	205.82272	163.49812	166.49322	98.26611	248.75495	257.14653	170.81826	273.86726	122.38972
Physical sciences	$\hat{a}_0$	-0.00074	-0.00087	-0.00196	-0.00067	-0.00180	-0.00094	-0.00060	-0.00194	-0.00115	-0.00175	-0.00101	-0.00116	-0.00285	-0.00135	-0.00048
	$\hat{a}_1$	192.22280	201.63694	175.23612	193.43460	110.59097	185.81873	159.11787	164.71389	198.69199	103.06367	204.79070	195.57067	197.51872	236.19915	105.83538
Social sciences	$\hat{a}_0$	-0.00005	0.00017	0.00004	0.00007	-0.00012	-0.00028	-0.00056	-0.00038	-0.00032	-0.00018	-0.00017	-0.00041	-0.00030	-0.00022	-0.00053
	$\hat{a}_1$	299.15360	257.60808	261.30818	310.11987	80.37316	265.46726	273.75776	249.76073	287.15449	121.06691	222.66632	253.44483	213.49174	247.12989	127.55022
Engineering	$\hat{a}_0$	0.00005	0.00005	0.00165	0.00000	0.00136	-0.00016	-0.00019	-0.00062	-0.00021	-0.00005	-0.00020	-0.00023	-0.00065	-0.00031	-0.00017
	$\hat{a}_1$	123.14936	134.00632	117.05667	129.90681	68.37829	135.84388	140.79669	92.55089	154.92750	74.67399	155.09404	160.56347	95.92828	192.63307	99.26671
Non-S&E fields	$\hat{a}_0$	-0.00005	0.00015	-0.00014	-0.00006	-0.00010	-0.00002	0.00003	-0.00013	-0.00004	-0.00024	0.00000	0.00000	-0.00010	0.00000	-0.00026
	$\hat{a}_1$	268.59729	197.09808	272.38668	288.32761	97.97493	399.69959	393.11157	402.28213	479.97751	183.80538	327.08060	298.66567	393.91455	382.99428	238.20534
Occupation																
Computer and mathematical scientists	$\hat{a}_0$	0.00000	0.00021	0.00115	-0.00005	0.00131	-0.00016	-0.00021	-0.00057	-0.00009	-0.00027	-0.00026	-0.00017	-0.00066	-0.00032	-0.00022
	$\hat{a}_1$	183.50758	172.44006	170.76234	190.91253	72.02225	184.31767	173.15501	171.50832	217.78539	84.82360	228.95490	191.32276	225.56785	294.06459	124.69842
Life scientists	$\hat{a}_0$	-0.00010	0.00029	-0.00005	-0.00020	-0.00169	-0.00028	-0.00033	-0.00086	-0.00025	0.00169	-0.00093	-0.00255	0.00028	-0.00124	-0.00169
	$\hat{a}_1$	140.38411	157.76687	172.98053	152.41353	80.58550	202.94076	222.39396	173.41956	223.62657	104.79479	217.07815	234.96015	204.61524	263.42916	115.99420
Physical scientists	$\hat{a}_0$	0.00027	0.00033	-0.00240	0.00037	-0.01257	0.00024	0.00057	-0.00051	-0.00006	0.00032	-0.00068	-0.00046	0.00147	-0.00113	-0.00186
	$\hat{a}_1$	169.60795	142.65607	196.48028	159.90545	113.47778	113.76603	107.68848	126.02772	129.32508	83.94158	175.23600	152.43634	198.43957	193.23003	103.11800
Social scientists	$\hat{a}_0$	0.00011	0.00036	0.00026	0.00035	-0.00091	0.00002	0.00017	-0.00045	0.00000	0.00268	-0.00041	-0.00025	-0.00079	-0.00066	-0.00158
	$\hat{a}_1$	212.35286	199.57239	202.90721	220.33454	97.53233	250.73647	221.59452	221.53054	265.80801	105.30327	251.97446	292.67170	236.59249	264.01161	169.67809
Engineers	$\hat{a}_0$	-0.00011	-0.00013	-0.00169	-0.00014	-0.00122	-0.00005	-0.00004	-0.00051	-0.00007	-0.00001	-0.00012	-0.00010	-0.00089	-0.00005	-0.00028
	$\hat{a}_1$	127.04489	141.78455	148.96956	133.62233	71.58530	131.75986	130.25205	152.76231	150.14412	81.25122	148.28276	148.01961	139.50388	164.43166	104.69653
Non-S&E occupations	$\hat{a}_0$	-0.00006	-0.00018	-0.00017	-0.00005	0.00005	-0.00002	-0.00004	-0.00008	-0.00002	-0.00023	-0.00003	-0.00011	-0.00004	-0.00003	-0.00007
	$\hat{a}_1$	261.66292	269.76809	285.51003	279.12185	102.42366	331.71574	319.92437	362.97703	379.77620	168.11034	373.39630	349.62567	374.43773	410.55657	211.50237

Table B-4. Doctoral Scientists and Engineers in 1993, 1995, 1997, and 1999:

$\hat{a}_0$ and $\hat{a}_1$ Parameters for Specified Demographic Groups

Field	Parameter	1993/1995					1997					1999				
		Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite	Total	Male	Female	White	Nonwhite
Doctorate Scientists and Engineers																
Total, all individuals	$\hat{a}_0$	-0.00003	-0.00003	-0.00007	-0.00003	-0.00053	-0.00004	-0.00006	0.00000	-0.00004	-0.00006	-0.00002	-0.00006	-0.00005	-0.00004	-0.00015
	$\hat{a}_1$	66.04422	60.13165	59.68715	64.81466	86.20847	76.87679	79.00613	71.07350	85.88032	57.50323	97.06564	94.44642	88.59845	107.28630	72.96765
Field of Highest Degree																
Computer and mathematical sciences	$\hat{a}_0$	-0.00012	-0.00021	0.00047	-0.00017	0.00523	-0.00049	-0.00054	-0.00319	-0.00051	-0.00091	-0.00028	-0.00037	-0.00179	-0.00052	-0.00077
	$\hat{a}_1$	23.03015	28.86231	24.60627	24.49546	10.40822	27.85892	28.31325	25.67467	29.19178	26.84264	37.62834	41.62299	27.24175	44.38081	32.07953
Life sciences	$\hat{a}_0$	0.00008	0.00011	-0.00041	0.00007	-0.00234	-0.00011	-0.00016	-0.00030	-0.00014	-0.00028	-0.00010	-0.00016	-0.00036	-0.00009	-0.00037
	$\hat{a}_1$	51.10627	45.23408	53.64585	48.05147	67.48826	29.40126	32.14545	25.29687	29.92958	40.33174	32.56587	34.01286	44.64157	31.20354	40.15677
Physical sciences	$\hat{a}_0$	-0.00009	-0.00014	-0.00049	-0.00008	-0.00264	-0.00023	-0.00026	-0.00099	-0.00026	-0.00043	-0.00014	-0.00016	-0.00039	-0.00018	-0.00054
	$\hat{a}_1$	34.17140	37.68962	19.18446	33.34039	27.06988	41.16139	43.06004	25.58420	41.82678	42.55420	33.70681	32.82507	32.26803	36.01126	37.70068
Social sciences	$\hat{a}_0$	0.00000	-0.00004	-0.00028	-0.00007	0.00225	-0.00013	-0.00026	-0.00023	-0.00015	-0.00054	-0.00010	-0.00017	-0.00018	-0.00011	-0.00039
	$\hat{a}_1$	35.66356	37.24070	39.81732	39.61975	19.72706	37.55825	42.11364	36.09506	40.20323	27.27073	29.98008	32.29567	25.01193	29.31617	26.69858
Engineering	$\hat{a}_0$	-0.00022	-0.00021	-0.00182	-0.00029	0.00593	-0.00024	-0.00029	-0.00031	-0.00037	-0.00027	-0.00012	-0.00012	-0.00156	-0.00022	-0.00004
	$\hat{a}_1$	40.32429	39.62296	31.03194	42.33195	34.30108	37.99965	40.07299	19.08347	45.58617	28.11343	28.61567	29.07171	26.60185	32.84335	25.55628
Non-S&E fields	$\hat{a}_0$	-0.00021	-0.00010	-0.00002	-0.00030	-0.00181	-0.00057	-0.00112	-0.00096	-0.00086	-0.00207	-0.00072	-0.00173	-0.00232	-0.00095	-0.00332
	$\hat{a}_1$	147.31955	142.76089	111.78115	146.75252	127.30954	273.97326	299.67667	263.74128	295.38835	189.31996	373.32905	421.22255	303.59259	408.92508	249.95700
Occupation																
Computer and mathematical scientists	$\hat{a}_0$	0.00033	0.00026	-0.00011	0.00019	-0.00247	-0.00019	-0.00012	-0.00350	-0.00018	-0.00111	-0.00024	-0.00046	-0.00115	-0.00030	-0.00060
	$\hat{a}_1$	62.08820	52.35163	87.72871	60.43033	69.39232	58.05557	53.17254	80.21751	54.70380	47.47652	53.37508	58.66742	68.91037	63.31541	36.09954
Life scientists	$\hat{a}_0$	-0.00019	-0.00024	-0.00077	-0.00018	0.00074	-0.00015	-0.00021	-0.00074	-0.00018	-0.00030	-0.00009	-0.00015	0.00008	-0.00009	-0.00031
	$\hat{a}_1$	51.47333	45.57898	49.05549	52.50848	32.18871	38.30114	39.41434	42.07143	42.12946	31.22603	37.65423	37.61122	43.76323	36.29873	36.57734
Physical scientists	$\hat{a}_0$	-0.00006	-0.00008	-0.00162	-0.00001	-0.00331	-0.00019	-0.00022	-0.00102	-0.00021	0.00028	-0.00013	-0.00009	-0.00066	-0.00024	-0.00021
	$\hat{a}_1$	39.01369	38.39904	54.76509	36.74536	34.69140	40.90065	42.22343	27.09699	42.57087	34.25670	36.16038	34.36691	41.93698	38.15836	39.51903
Social scientists	$\hat{a}_0$	-0.00009	0.00001	-0.00028	-0.00009	0.00035	-0.00001	-0.00032	0.00005	-0.00007	-0.00041	0.00010	0.00029	-0.00024	0.00008	-0.00068
	$\hat{a}_1$	44.93976	37.32044	56.38556	49.48828	38.58854	49.83424	58.23314	45.45499	52.32406	39.78532	64.45554	82.28239	51.60141	62.99938	54.08267
Engineers	$\hat{a}_0$	0.00011	0.00020	-0.00077	0.00012	-0.00370	-0.00002	-0.00006	0.00003	-0.00001	-0.00002	-0.00010	-0.00009	-0.00154	-0.00009	0.00008
	$\hat{a}_1$	33.46265	34.34063	18.86432	33.64494	43.22313	35.60274	37.22621	21.37051	40.64325	28.42724	33.29740	34.74466	27.23506	29.48511	34.03765
Non-S&E occupations	$\hat{a}_0$	0.00008	-0.00004	0.00110	0.00011	-0.00258	-0.00012	-0.00020	0.00004	-0.00015	0.00017	-0.00011	-0.00028	-0.00017	-0.00020	-0.00064
	$\hat{a}_1$	101.36944	96.60280	79.17578	96.75472	113.49612	151.70161	162.47312	128.81088	156.41911	101.50266	182.29262	190.08102	166.29516	201.24602	134.47307

NOTE: White category excludes persons of Hispanic origin. Hispanics are included in the Nonwhite category.

SOURCE: National Science Foundation/Division of Science Resources Statistics; Scientists and Engineers Statistical Data System (SESTAT), 1993-1999.