Contract No.: SRS-282-98-0021 (23)
MPR Reference No.: 8797-410

MATHEMATICA
Policy Research, Inc.

Sampling Errors for SESTAT: 1993, 1995, 1997, 1999, and 2001

December 22, 2003

Donsig Jang
David Edson
Esther M. Friedman

Submitted to:

National Science Foundation
Division of Science Resource Studies

4201 Wilson Boulevard, Room 965
Arlington, VA 22230

Project Officer:
Nirmala Kannankutty

Submitted by:

Mathematica Policy Research, Inc.
600 Maryland Avenue, SW
Suite 550
Washington, DC 20024-2512
(202) 484-9220

Project Director:
David Edson

CONTENTS

Chapter **Page**

I INTRODUCTION 1

II UNDERSTANDING SAMPLING ERRORS 3

A. TYPES OF SURVEY ERRORS 3

B. ASSESSING THE ACCURACY OF ESTIMATES 4

III GENERALIZED VARIANCE FUNCTIONS (GVFS): A METHODOLOGY FOR ESTIMATING STANDARD ERRORS 5

A. GVF MODELING 5

1. Step 1: Calculate Population Totals and Their Variances 5
2. Step 2: Model Relationships Between Survey-derived Totals and Sampling Variances 6

B. A METHODOLOGY OVERVIEW 6

IV Calculating Standard Errors 9

A. THE 1993-1999 SCIENTISTS AND ENGINEERS STATISTICAL DATA SYSTEM (SESTAT) 10

1. GVF Model 10
2. Direct Variance Estimates—The Method of Random Groups 11
3. Examples: How Data Users Can Calculate Standard Errors for the 1993, 1995, 1997, and 1999 SESTAT 12

B. THE NATIONAL SURVEY OF COLLEGE GRADUATES (NSCG) 14

1. GVF Model 14
2. Direct Variance Estimates – The Successive Difference Method 15
3. Examples: How Data Users Can Calculate Standard Errors for the 1993, 1995, 1997 and 1999 NSCG 17

Chapter **Page**

IV *(continued)*

C. THE SURVEY OF DOCTORATE RECIPIENTS (SDR) 18

1. GVF Model 18
2. Direct Variance Estimates 20
3. Examples: How Data Users Can Calculate Standard Errors for the 1993, 1995, 1997, 1999 and 2001 SDR 21

D. THE NATIONAL SURVEY OF RECENT COLLEGE GRADUATES (NSRCG) 22

1. GVF Model 22
2. Direct Variance Estimates—The Method of Jackknife Replication 23
3. Examples: How Data Users Can Calculate Standard Errors for the 1993, 1995, 1997, 1999 and 2001 NSRCG 24

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

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

APPENDIX C: PARAMETER TABLES: NATIONAL SURVEY OF COLLEGE GRADUATES

APPENDIX D: PARAMETER TABLES: SURVEY OF DOCTORATE RECIPIENTS

APPENDIX E: PARAMETER TABLES: NATIONAL SURVEY OF RECENT COLLEGE GRADUATES

I. INTRODUCTION

The Scientists and Engineers Statistical Data System (SESTAT) is a comprehensive and integrated data system of information about the employment, educational, and demographic characteristics of scientists and engineers in the United States. It comprises data collected through three surveys sponsored by the National Science Foundation (NSF):

- 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 responding to the these surveys who met the following criteria as of April 15 of the SESTAT survey reference years:

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

The SDR and NSRCG were conducted in 1993, 1995, 1997, 1999, and 2001. The NSCG was conducted in 1993, 1995, 1997, and 1999. The integrated SESTAT database is thus available for 1993, 1995, 1997 and 1999. Since the NSCG was not conducted in 2001, an integrated database does not exist for this year.

This report provides information about sampling errors for the 1993, 1995, 1997, and 1999 SESTAT and how users can calculate standard errors for estimates derived from SESTAT. Moreover, this report provides information about sampling errors for the three SESTAT

component surveys: The National Survey of College Graduates (NSCG) (1993-1999), the Survey of Doctoral Recipients (SDR) (1993-2001) and the National Survey of Recent College Graduates (NSRCG) (1993-2001).

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 report) 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.

[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.

B. ASSESSING THE ACCURACY OF ESTIMATES

Having estimated a population quantity such as a percentage 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*[2] of a survey estimate measures the 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. Let $\hat{\theta}$ be an estimator of a parameter of interest θ with a standard error $SE(\hat{\theta})$. If the sample size is large, then an approximate (1-α) 100% confidence interval for θ is $\left(\hat{\theta} - z_{\alpha/2}SE(\hat{\theta}),\ \hat{\theta} + z_{\alpha/2}SE(\hat{\theta})\right)$, where $z_{\alpha/2}$ is the upper $\alpha/2$ 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% ($\alpha = 0.10$) of the intervals from 1.645 ($= z_{0.05}$) standard errors below the estimate to 1.645 standard errors above the estimate will include the true population value.

b. Approximately 95% ($\alpha = 0.05$) of the intervals from 1.96 ($= z_{0.025}$) standard errors below the estimate to 1.96 standard errors above the estimate will include the true population value.

c. Approximately 99% ($\alpha = 0.01$) of the intervals from 2.575 ($= z_{0.005}$) 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 1-α (= 0.90, 0.95, or 0.99).

[2]Another related term is the *variance*, which is the square of the standard error.

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.

1. Step 1: Calculate Population Totals and Their Variances

Suppose a population attribute is of interest from the population with size N and the observed value from the *i*-th sampled unit of the sample of size n is denoted as y_i. Each sampled unit has the final analysis weight w_i so that the sample can represent the population. With the final analysis weights and observed values from the sample, the population total Y can be estimated with the weighted sum of sampled values:

$$\hat{Y} = \sum_{i=1}^{n} w_i y_i \qquad \text{(III.1)}$$

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

Estimates of totals for a set of attributes can be calculated using this formula (III.1). For direct calculation of the variance, a customary method such as a design-based method or a resampling method may be used. For the design-based method, appropriate design variables, such as stratification and cluster variables must need to be provided along with the final analysis weight. For resampling methods such as jackknife, random group, and balanced repeated replication method, appropriate replicate weights must be provided. Specific variance estimation methods applied to SESTAT component surveys are discussed in Chapter IV below.

2. Step 2: Model Relationships Between Survey-derived Totals and Sampling Variances

A GVF uses a regression model technique and hence is subject to the same limitations of model specification, fit, and estimation as any other regression model. The principal advantage of the GVF method is that approximations of sampling errors are simplified so that they can easily be calculated for the large number of estimates that are normally generated from a demographic survey with many variables. For SESTAT, separate GVF models are available for the total population and for selected 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 the 1993-1999 SESTAT and the three component surveys (1993-2001, as appropriate) are described in Chapter IV.

B. A METHODOLOGY OVERVIEW

Let $\hat{Y}$ denote an estimator of the population total Y. GVF models are usually created for the *relative variance* (*RelVar*) of the estimated total, or

$$RelVar(\hat{Y}) = \frac{\mathrm{Var}(\hat{Y})}{Y^2} \qquad \text{(III.2)}$$

where $\text{Var}(\hat{Y})$ is the variance of $\hat{Y}$. The modeling typically begins by assuming that the *RelVar* of an estimated total is a linear function of the inverse of the total Y being estimated, or

$$RelVar(\hat{Y}) = \beta_0 + \frac{\beta_1}{Y}. \tag{III.3}$$

The parameters of the GVF model, β_0 and β_1, are estimated from a subset of all possible survey-derived totals and their variances by some form of least squares regression estimation. The *RelVar* of an estimated total $\hat{Y}$ can be predicted by evaluating the appropriate GVF model using the estimated values for Y, β_0 and β_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:

$$se(\hat{Y}) = \sqrt{\hat{\beta}_0 \hat{Y}^2 + \hat{\beta}_1 \hat{Y}} \tag{III.4}$$

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

$\hat{\beta}_0$ and $\hat{\beta}_1$ are estimates of the regression parameters of β_0 and β_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:

$$se(\hat{P}) = \sqrt{\frac{\hat{\beta}_1}{\hat{X}} \hat{P}(100 - \hat{P})} \tag{III.5}$$

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

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

The β_1 parameter to be used is the one developed for the domain that comprises the denominator of $\hat{X}$ of the percentage $\hat{P}$.

IV. CALCULATING STANDARD ERRORS

This chapter describes how users can calculate standard errors based on GVFs provided for SESTAT as a whole for 1993-1999 and for the component surveys for 1993-2001. This chapter also details the estimation of these GVFs, including:

(1) The GVF model used,

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

(3) Examples to calculate standard errors from two tables: look-up tables and GVF parameter tables.

Both the look-up tables and parameter tables enable the user to calculate standard errors for a wide range of population totals. Look-up tables display standard errors for several total values in the range so that users may calculate standard errors for any total estimates within the range by interpolation. Parameter tables, on the other hand, provide GVF coefficient parameter estimates that the user inserts into formulas (provided in this chapter) to calculate standard errors.

Basic Steps to Calculate Standard Errors

The following steps may be followed to calculate the standard error of an estimated total or percentage through parameter tables:

1. Obtain the estimated total or percentage from the data;
2. Determine the most appropriate table (whether it is for survey specific or SESTAT as whole) for a characteristic of interest and domain of interest;
3. Determine the most appropriate domain for the estimate from the parameter table(s);
4. Refer to the parameter table to get the parameter estimates for this domain; and
5. Compute the approximate standard error using the equations provided.

Examples demonstrating how to use these tables for 1993-1999 SESTAT and each component survey for 1993-2001 are also provided.

In choosing which parameters to use for GVF variance estimation, users should determine whether they wish to estimate characteristics for subpopulations completely covered by an individual survey component or by more than one components. For instance, if one is interested in individuals earning doctoral degrees, regardless of the location of university from which s/he obtained the degree, parameters for the integrated SESTAT dataset would be most appropriate; however, if one is interested in doctoral recipients from U.S. institutions only, it is better to use parameters from the SDR.

A. THE 1993-1999 SCIENTISTS AND ENGINEERS STATISTICAL DATA SYSTEM (SESTAT)

1. 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:

$$\mathrm{Var}(\hat{Y}) = \beta_0 Y^2 + \beta_1 Y \qquad \text{(IV.1)}$$

where: Y is the population total being estimated,

$\mathrm{Var}(\hat{Y})$ is the variance of the estimated total $\hat{Y}$, and

β_0 and β_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 should 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 β_0 and β_1 with the estimated domain totals and their directly calculated variances as inputs. The results are presented as a table of generalized variance function model parameters, which can be used to estimate standard errors.

2. Direct Variance Estimates—The Method of Random Groups

The random group technique is appropriate when the sampling structure of the survey 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[4] were systematically selected without replacement:

NSCG Respondent 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 stage 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.

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

3. Examples: How Data Users Can Calculate Standard Errors for the 1993, 1995, 1997, and 1999 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.

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

The look-up tables in Appendix A (A.1-A.4), provide approximate standard errors for estimated counts of scientists and engineers for the total population and for different segments of the population when using the SESTAT integrated database.

Example A: Total (from Look-up Tables). 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; or (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*.

b. Method 2: Using the Parameter Tables

The parameter tables in Appendix B (B.1-B.4) provide 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 when using the SESTAT integrated database.

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): β_0 and β_1 Parameters for Specified Demographic Groups* and determine the values for $\hat{\beta}_0 (= 0.00003)$ and $\hat{\beta}_1 (= 176.69490)$ from the total column for 1993/1995. Using equation III.4, we estimate the standard error as

$$se(\hat{Y}) = \sqrt{(0.00003\hat{Y}^2) + (176.69490\hat{Y})}$$

We substitute the value of $\hat{Y}$ = 8,311,787 and obtain $se(\hat{Y})$ = 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 $\beta_1 (= 270.32836)$ from the "female" column of the appropriate parameter table (Table B-1) and using equation III.5:

$$se(\hat{P}) = \sqrt{\frac{270.32836}{\hat{X}} \hat{P}(100 - \hat{P})}$$

Substituting for the values of the base $\hat{X}\,(= 3{,}867{,}887)$ 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).

B. THE NATIONAL SURVEY OF COLLEGE GRADUATES (NSCG)

1. GVF Model

The 1993, 1995, 1997, and 1999 National Survey of College Graduates (NSCG) modified the basic GVF model (see Chapter III) to ensure that negative variances were not predicted. Let T_d represent the population total for a domain d for which a GVF model was desired for the NSCG. The NSCG assumed that:

$$\beta_0 = -\frac{\beta_1}{T_d} \qquad \text{(IV.2)}$$

and fit the following GVF model for totals derived from domain d:

$$RelVar(\hat{Y}) = \beta_1 \left(\frac{1}{Y} - \frac{1}{T_d} \right) \qquad \text{(IV.3)}$$

For the NSCG data, GVF models were specified for the overall population and for separate subgroups such as race/ethnicity, field of education, degree level, and sex. To fit the model, between 37 to 152 different totals were estimated for each domain. Direct estimates of the variances for these domain totals were generated using the successive difference replication method and then converted to relative variances. The estimated domain totals and their directly estimated relative variances were then used to fit the model using weighted least squares with the weight equal to the inverse of the square of the predicted relative variance (after removing outliers)[5]. The results are presented in Appendix C as a table of generalized variance model parameters which can be used to estimate standard errors.

2. Direct Variance Estimates – The Successive Difference Method

Because stratified systematic sampling was used in sample selection, the NSCG chose the successive difference replication method[6] to calculate the direct variance estimates. Replicates in the successive difference replication method were formed in the following way. First, the full sample is sorted by sample design variables. Because the number of replicates determined was 160, the next step was to construct an 160 x 160 Hadamard matrix **H** with all elements equal to either one or negative one. Hadamard matrices are unique in that they satisfy $\mathbf{H}^{\mathbf{T}}\mathbf{H}=R\mathbf{I}$, where **I** is the identity matrix of order R (see Wolter 1985 for the list of Hadamard matrices and references). Next, each sample case was assigned two rows of the Hadamard matrix. The assignment process began with the assignment of rows 2 and 3 of the Hadamard matrix to the first sample case. The remaining row assignments were set up to ensure that consecutive sample

[5] For details of NSCG GVF developments, see "Generalized Variance Parameters for the 1999 National Survey of College Graduates," York, B.L., 2001, U.S. Bureau of Census.

[6] The successive difference method estimator is based on squared differences between neighboring sample cases, and the theoretical basis for this method may be found in Wolter (1984), "An Investigation of Some Estimators of Variance for Systematic Sampling." *Journal of the American Statistical Association*, vol. 79, no. 388, pp.781-790.

cases share one row of the Hadamard matrix. Following this algorithm, rows 3 and 4 were assigned to the second sample case. Once the rows (*R*-1) and *R* were assigned to a sample case, the next row assigned to the next sample case will be row 2. The same row assignment procedure was done until the last sample case was reached. Next, each sample case used assigned rows from the Hadamard matrix to calculate its replicate factor. The *r*-th replicate factor for *i*-th case was calculated as:

$$\mathrm{RF}_{ir} = 1 + 2^{-3/2}(h_{i1,r} - h_{i2,r}) \qquad \text{(IV.4)}$$

where $h_{i1,r}$ and $h_{i2,r}$ are the *r*-th column element of the first and second row assigned to the *i*-th case, respectively, and take values of one or negative one. At the completion of this step, each sample case has 160 replicate factors - one factor for each replicate sample. That is, the *r*-th column can be regarded as the *r*-th replicate with replicate sample weights as the product of the full sample weight and the above replicate factor. All postsample adjustment procedures, such as nonresponse adjustments and poststratification, must also be implemented to obtain a set of *R* final replicate weights.

Given successive difference replicates with appropriate replicate weights, the corresponding successive difference replication variance estimator can be obtained with the following formula:

$$v_{SUD}(\hat{\theta}) = \frac{4}{R}\sum_{r=1}^{R}(\hat{\theta}_r - \hat{\theta})^2 \qquad \text{(IV.5)}$$

where $\hat{\theta}$ is the survey estimate using the full-sample, $\hat{\theta}_r$ is the survey estimate using the replicate weights from the *r*-th replicate, and *R* is 160.

3. Examples: How Data Users Can Calculate Standard Errors for the 1993, 1995, 1997 and 1999 NSCG

The parameter table (C-1) in Appendix C provides a method for approximating standard errors for estimated counts and percents of scientists and engineers for the total NSCG population and for different segments of the population when using the NSCG data alone.

Example A: Total. Suppose data from the 1993 NSCG are used to estimate persons having a bachelor's degree prior to April 1, 1990 in engineering and the corresponding estimate is reported as 1,500,000. As the domain for this population is the total engineering population, we look in Table C-1 to determine the values for

$$\hat{\beta}_0 \text{ (= -0.000006) and } \hat{\beta}_1 \text{ (= 191).}$$

Then, using Equation III.4, the approximate standard error on the estimated number of 1,500,000 persons is:

$$se(\hat{Y}) = \sqrt{(-0.000006 \times 1{,}500{,}000^2) + (191 \times 1{,}500{,}000)} = 16{,}523$$

Thus, a 95% confidence interval for the true value for the total number of persons having a bachelor's degree in engineering would be between 1,467,615 and 1,532,385 (1,500,000 +/- 32,385), where 32,385 represents 1.96 times the standard error.

Example B: Percentage. Suppose the percentage of the persons with a bachelor's degree prior to April 1, 1990 in engineering who are women is 12.0% among 1,500,000 persons. Obtaining the appropriate value of the parameter $\hat{\beta}_1 = 191$ from Table C-1 and using Equation III.5, the approximate standard error on 12.0% is:

$$se(\hat{P}) = \sqrt{\frac{191}{1{,}500{,}000} \times 12(100-12)} = 0.37\%$$

The 95 percent confidence interval for the percentage of the persons with a bachelor's degree in engineering in 1993 who are women is 12% +/- 0.725% (where 0.725 equals 1.96 times the estimated standard error).

C. THE SURVEY OF DOCTORATE RECIPIENTS (SDR)

1. GVF Model

Prior to 1999. The Survey of Doctorate Recipients (SDR) used the basic GVF model or,

$$RelVar(\hat{Y}) = \beta_0 + \frac{\beta_1}{Y}.$$

For the SDR data, GVF models were specified for the scientists and engineers who earned doctoral degrees from U.S. institutions, for groups defined by field, and for selected subgroups of analytic interest.

To estimate the parameters of the model, totals for a number of different characteristics were estimated for each domain. Direct estimates of the variances for these domain totals were generated using the *Balanced Repeated Replication Method* (for 1993 and 1995 SDR) and a design based method (for 1997 SDR), and then converted to relative variances. The estimated domain totals and their relative variances were then used to fit the model through a series of successive iterations of the relative variance function until values of $\hat{\beta}_0$ and $\hat{\beta}_1$ differed negligibly. The final set of $\hat{\beta}_0$ and $\hat{\beta}_1$ estimates were ultimately used to calculate approximate standard errors of totals. The results are presented as a series of tables in Appendix D (Tables D1-D3) of GVF model parameters, which can be used to estimate standard errors.

1999 and 2001 SDR. For 1999 and 2001, the SDR modified the basic GVF model to ensure that negative variances were not predicted. Let T_d represent the population total for a domain *d* for which a GVF model was desired for the SDR. The 1999 and 2001 SDR assumed that:

$$\beta_0 = -\frac{\beta_1}{T_d}$$

and fit the following GVF model for totals derived from domain *d:*

$$\mathrm{Re}lVar(\hat{Y}) = \beta_1\left(\frac{1}{Y} - \frac{1}{T_d}\right)$$

where: Y is the population total being estimated,

$\mathrm{Re}lVar(\hat{Y})$ is the relative variance of the estimated total $\hat{Y}$, and

β_1 is a parameter of the model.

For the SDR data, GVF models were specified for nine demographic subgroups within the overall population and 28 fields of study, for a total of 261 groups. The generalized variance function was then fit independently in each group. To fit the model, population totals were estimated for each domain. Direct estimates of the variances for these domain totals were generated using the method described below. Ordinary least squares regression was used to derive an estimate of β_1 with directly calculated variances as inputs. The results are presented in Appendix Table D-4 and D-5.

2. Direct Variance Estimates

Prior to 1997. The SDR chose the *balanced repeated replication method* (BRR) to calculate their direct variance estimates.[7] To be able to use BRR, the SDR sample designs were to have a two groups per stratum design. One replicate is constructed as a subsample of the original full sample with only one group within each stratum (called half sample). Thus, the replicates are constructed as all possible samples made from combination of these random groups. If the number of strata in the population is L, there are $R = 2^L$ replicates available. However, when L is large, the number of replicates R becomes impractical. Instead a small subset of replicates is formed in a balanced manner, where R usually is chosen as a multiple of four, with $L+1 \le R \le L+4$ (Wolter 1985). SDR used 16 balanced half-samples. Such balance can be achieved from a Hadamard matrix with elements of 1 and -1, where 1 corresponds to assigning the first group into the replicate, and -1 corresponds to assigning the second group into the replicate.

Let $\hat{\theta}_r$ be the estimate of θ calculated from the r-th replicate in the same way as one calculates $\hat{\theta}$ from the full sample. Then the BRR variance estimator of $\hat{\theta}$ can be calculated as:

$$v_{\text{BRR}}(\hat{\theta}) = \frac{1}{R}\sum_{r=1}^{R}\left(\hat{\theta}_r - \hat{\theta}\right)^2, \qquad \text{(IV.6)}$$

where R = 16 for the1993 SDR and 1995 SDR.

1997 SDR. A variance estimate for the estimator of a total from complex survey samples like the 1997 SDR can be obtained from an explicit formula. The 1997 SDR used this method

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

for variance estimation. For example, consider a total estimator $\hat{Y}$ obtained from the 1997 SDR for a population total *Y*. This estimator is then a weighted sum, denoted by

$$\hat{Y} = \sum_{h=1}^{L} \sum_{i=1}^{n_h} w_{hi} y_{hi} , \qquad \text{(IV.7)}$$

where y_{hi} is the observed value of the *i*-th sampled unit of the *h*-th sampling stratum. The corresponding design based variance estimator can be obtained as:

$$v_L(\hat{Y}) = \sum_{h=1}^{L} \frac{1}{n_h} \frac{\sum_{i=1}^{n_h} (n_h w_{hi} y_{hi} - \hat{Y}_h)^2}{n_h - 1} . \qquad \text{(IV.8)}$$

1999 and 2001 SDR. The Census Bureau conducted the 1999 and 2001 SDRs. As with the NSCG, the successive difference replication method was used to calculate the direct variance estimates. Procedures to construct replicate weights are similar to those for NSCGs presented above.

3. Examples: How Data Users Can Calculate Standard Errors for the 1993, 1995, 1997, 1999 and 2001 SDR

The parameter tables in Appendix D provide a method for approximating standard errors for estimated counts and percents of scientists and engineers for the total SDR population and for different segments of the population when using the SDR data alone.

Example A: Total. In 2001, if the number of life sciences Ph.D.s employed in universities and 4-year colleges is reported at 66,900 and one wishes to determine the approximate standard error, one can use values of $\hat{\beta}_0 (= -0.000103)$ and $\hat{\beta}_1 (= 17.4486)$, as determined from Appendix Table D-5. Using Equation III.4, we estimate the standard error as:

$$se\left(\hat{Y}\right) = \sqrt{(-0.000103\hat{Y}^2 + 17.4486\hat{Y})}$$

We substitute the value of $\hat{Y}$ = 66,900 and obtain $se(\hat{Y})$ = 840. Thus, a 95% confidence interval for the true value for the total number of doctorate recipients employed in the life sciences in 2001 would be

$$66{,}900 \pm (1.96 \times 840) = 65{,}253 \text{ to } 68{,}547.$$

This range of 65,253 to 68,547 represents the 95 percent confidence interval of the estimated total of 66,900.

Example B: Percentage. In 2001, suppose the unemployment rate for physical science doctorates was estimated at 2.1% of the 100,660 individuals who are in the labor force. Using the appropriate value $\beta_1 (= 17.0518)$ from the Appendix Table D-5 and using Equation III.5:

$$se\left(\hat{P}\right) = \sqrt{\frac{17.0518}{\hat{X}} \hat{P}(100 - \hat{P})}$$

Substituting for the values of the base $\hat{X}\,(= 100{,}600)$ and the percentage $\hat{P}\,(= 2.1)$, we obtain an estimated standard error of 0.187. The 95 percent confidence interval for the unemployment rate for physical sciences doctorates in 2001 would be

$$2.1 \pm (1.96 \times 0.187) = 1.7 \text{ to } 2.5.$$

This range represents the 95 percent confidence interval for the estimated percentage 2.1.

D. THE NATIONAL SURVEY OF RECENT COLLEGE GRADUATES (NSRCG)

1. GVF Model

The National Survey of Recent College Graduates (NSRCG) used the basic GVF model, or

$$\mathrm{Re}\,lVar\left(\hat{Y}\right) = \beta_0 + \frac{\beta_1}{Y}$$

For the NSRCG data, GVF models were specified separately for bachelor's degree recipients and master's degree recipients. Separate models were specified for each academic year up until the 2001 NSRCG.[8] In addition, the models were specified separately within each of these groups for graduates by gender (male/female), major (science/engineering), occupation (scientist/engineer/other), and race/ethnicity (White/Black/Hispanic/Asian/American Indian).

Direct estimates of the variances for these domain totals were generated using the jackknife replication method and then converted to relative variances. The estimated domain totals and their relative variances were then used to fit the model using ordinary least squares to produce estimates of the parameters of the model. The results are presented as a series of tables in Appendix E which can be used to estimate standard errors.

2. Direct Variance Estimates—The Method of Jackknife Replication

The NSRCG chose the jackknife replication method to calculate their direct variance estimates. Jackknife replication involves constructing a number of subsamples (replicates) from the full sample and computing the statistics of interest for each replicate. To construct the replications, multiple stratified subsamples of the full sample were created. The jackknife replicates were formed by deleting one subsample at a time from the full sample. The variability between the replicate estimates provides an estimate of the variance of the statistic of interest. WesVarPC, a public use computer program developed at Westat and available on the Internet at www.westat.com, was used to calculate direct estimates of standard errors for a number of statistics from the survey using this methodology.

[8] In 2001, the model combined graduates from the 1999 and 2000 academic year cohorts.

3. Examples: How Data Users Can Calculate Standard Errors for the 1993, 1995, 1997, 1999 and 2001 NSRCG

The parameter tables in Appendix E provide a method for approximating standard errors for estimated counts and percents of scientists and engineers for the total NSRCG population and for different segments of the population when using the NSRCG data alone

Example A: Total. Suppose that the number of 1999-2000 bachelor's degree recipients (from the 2001 NSRCG) in engineering currently working in an engineering-related job was 40,000 ($\hat{Y} = 40,000$) in 2001. The most appropriate domain from Table E-5 of Appendix E is engineering majors with bachelors degrees and the parameters are $\hat{\beta}_0 (= -0.000263)$ and $\hat{\beta}_1 (= 83.473)$.

The approximate standard error using the Equation in III.1 is:

$$se\left(\hat{Y}\right) = \sqrt{(-0.000263\hat{Y}^2 + 83.473\hat{Y})} .$$

We substitute the value of $\hat{Y}$ = 40,000 and obtain $se(\hat{Y})$ = 1,708. Thus, a 95 percent confidence interval for the true value for the total number of recent bachelor's degree recipients in engineering working in an engineering-related job in 2001 would be

40,000 ± (1.96 x 1,708) =36,652 to 43,348.

This range of 36,652 to 43,348 represents the 95 percent confidence interval of the estimated total of 40,000.

Example B: Percentage. Now suppose that the percentage of the 1999-2000 bachelor's degree recipients (from the 2001 NSRCG) who are currently working in an engineering-related job was 60% ($\hat{P} = 60$). Using $\beta_1 (= 83.473)$ from Table E-5 and using Equation III.2:

$$se\left(\hat{P}\right)=\sqrt{\frac{83.473}{\hat{X}}\hat{P}(100-\hat{P})}$$

Substituting for the values of the base $\hat{X}\left(=40,000\right)$ and the percentage $\hat{P}\left(=60\right)$, we obtain an estimated standard error of 2.2. The 95 percent confidence interval for bachelor's degree recipients currently working in an engineering-related field is, therefore,

$$60 \pm (1.96 \text{ x } 2.2) = 55.6 \text{ to } 64.4.$$

The range 55.6 to 64.4 represents the 95 percent confidence interval for the estimated percentage 60.

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.

APPENDIX C

PARAMETER TABLES:

NATIONAL SURVEY OF COLLEGE GRADUATES

Table C-1. b_0 and b_1 Parameters for Selected Groups: 1993, 1995, 1997 and 1999 National Survey of College Graduates

Domain	1993		1995		1997		1999	
	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1
Total S&E	-0.000007	222	0.000028	246	0.000024	281	0.000012	359
Female	-0.000015	218	-0.000012	239	-0.000018	261	-0.000027	311
Hispanic	-0.000017	93	0.000002	122	-0.000002	129	-0.000029	170
Black	-0.000016	112	0.000153	138	0.000150	144	0.000119	189
Asian	-0.000003	96	0.000007	122	-0.000004	139	-0.000027	176
Ph.D. Recipients	-0.000004	127	0.000031	212	0.000030	227	0.000018	297
Biological Scientists	-0.000008	263	0.000028	236	0.000027	259	0.000016	324
Female	-0.000015	229	-0.000006	213	-0.000011	232	-0.000014	259
Hispanic	-0.000018	98	0.000005	117	0.000002	123	-0.000028	168
Black	-0.000017	123	0.000149	148	0.000144	156	0.000117	194
Asian	-0.000003	105	0.000006	123	0.000003	128	-0.000025	173
Ph.D. Recipients	-0.000005	169	0.000033	187	0.000032	208	0.000024	238
Physical Scientists	-0.000006	208	0.000034	179	0.000032	206	0.000025	233
Female	-0.000016	207	0.000005	165	-0.000001	198	-0.000005	223
Hispanic	-0.000017	97	0.000011	107	0.000000	126	-0.000022	159
Black	-0.000015	110	0.000164	117	0.000158	130	0.000130	166
Asian	-0.000003	106	0.000011	115	0.000001	132	-0.000016	158
Ph.D. Recipients	-0.000004	123	0.000038	130	0.000039	146	0.000031	166
Math/Computer	-0.000007	228	0.000032	194	0.000033	204	0.000025	234
Female	-0.000014	208	0.000001	182	-0.000002	199	-0.000007	232
Hispanic	-0.000016	91	0.000010	109	0.000008	115	-0.000018	153
Black	-0.000016	113	0.000156	132	0.000151	142	0.000127	173
Asian	-0.000003	99	0.000010	117	0.000007	123	-0.000020	164
Ph.D. Recipients	-0.000004	129	0.000034	173	0.000035	185	0.000026	217
Engineers	-0.000006	191	0.000033	189	0.000032	210	0.000023	251
Female	-0.000010	153	0.000013	132	0.000011	151	0.000009	167
Hispanic	-0.000016	92	0.000010	109	0.000004	120	-0.000020	155
Black	-0.000014	101	0.000163	118	0.000153	138	0.000129	168
Asian	-0.000003	92	0.000016	105	0.000007	123	-0.000015	156
Ph.D. Recipients	-0.000004	134	0.000037	145	0.000036	175	0.000030	175
Social Scientists	-0.000009	296	0.000021	319	0.000018	344	0.000006	423
Female	-0.000017	260	-0.000020	275	-0.000027	294	-0.000038	355
Hispanic	-0.000019	107	-0.000014	148	-0.000026	162	-0.000062	221
Black	-0.000019	133	0.000138	171	0.000127	187	0.000086	256
Asian	-0.000004	119	-0.000016	162	-0.000033	182	-0.000062	236
Ph.D. Recipients	-0.000004	142	0.000025	275	0.000023	293	0.000009	395

SOURCE: National Science Foundation/SRS, 1993/95/97 National Survey of College Graduates

APPENDIX D

PARAMETER TABLES:

SURVEY OF DOCTORATE RECIPIENTS

Table D-1: b_0 and b_1 parameters for selected demographic groups in science and engineering fields: 1993 Survey of Doctorate Recipients

Field of doctorate	Para-meter	All	Female	White	Asian	Black	Native American	Hispanic	1991-92 Cohort	Foreign
Total	β_0	-0.000026	-0.000087	-0.000031	0.000023	-0.000584	-0.001682	-0.000321	-0.000243	-0.000268
	β_1	13.480000	9.450000	14.760000	11.480000	11.320000	19.590000	12.820000	11.240000	13.660000
Sciences	β_0	-0.000030	-0.000092	-0.000035	0.000109	-0.000611	-0.002595	-0.000392	-0.000310	-0.000317
	β_1	13.120000	9.620000	14.280000	10.580000	10.760000	20.840000	12.700000	11.570000	12.770000
Computer and mathematical sciences	β_0	-0.000030	-0.000092	-0.000035	0.000109	-0.000611	-0.002595	-0.000392	-0.000310	-0.003802
	β_1	14.770000	8.480000	15.540000	15.810000	3.320000	20.840000	17.520000	12.790000	16.370000
Computer and information sciences	β_0	-0.001287	-0.010720	-0.000928	-0.002154	0.026504	-0.002590	0.066164	-0.006365	-0.009285
	β_1	7.370000	9.040000	55.535000	11.790000	3.320000	20.840000	-0.100000	9.980000	15.550000
Mathematical sciences	β_0	-0.000592	-0.002761	-0.000711	-0.000249	0.031535	-0.002595	-0.019405	-0.008632	-0.005853
	β_1	16.557000	8.880000	17.290000	17.880000	2.900000	20.840000	19.260000	15.670000	16.240000
Life and related sciences	β_0	-0.000068	-0.000210	-0.000070	-0.000333	-0.001365	0.023396	-0.003245	-0.000733	-0.001060
	β_1	10.500000	7.770000	10.250000	8.360000	6.740000	6.640000	10.920000	9.230000	10.840000
Agricultural and food sciences	β_0	-0.000965	-0.008273	-0.000881	-0.006030	0.013928	0.023396	0.058986	-0.008613	-0.007744
	β_1	18.910000	18.565000	16.940000	14.150000	11.100000	6.640000	3.230000	15.500000	11.390000
Biological and health sciences	β_0	-0.000082	-0.000224	-0.000096	-0.000139	-0.000888	0.033779	-0.003999	-0.000792	-0.001167
	β_1	9.730000	7.680000	10.210000	6.640000	5.130000	5.290000	10.280000	8.620000	9.760000
Environmental sciences	β_0	-0.000825	0.066940	0.000183	-0.039187	-0.001365	0.023396	-0.003245	0.039506	-0.001060
	β_1	13.270000	8.570000	13.150000	8.320000	6.730000	6.640000	10.920000	4.130000	10.840000
Physical and related sciences	β_0	-0.000105	-0.000733	-0.000116	0.000509	-0.002337	0.075976	0.044566	-0.001722	-0.001565
	β_1	11.960000	10.050000	11.970000	12.360000	11.330000	1.930000	-0.300000	15.420000	15.820000
Chemistry, except biochemistry	β_0	-0.000233	-0.001095	-0.000274	0.000399	0.002105	0.117198	0.060822	-0.004239	-0.003472
	β_1	14.160000	10.330000	14.450000	18.150000	9.590000	1.420000	-0.420000	19.870000	18.110000
Geology and oceanography	β_0	-0.000117	-0.003137	0.000055	0.021301	-0.002337	0.075976	0.001711	-0.001840	-0.011668
	β_1	5.200000	8.790000	5.200000	10.020000	11.330000	1.930000	7.800000	7.660000	9.590000
Physics and astronomy	β_0	-0.000260	-0.002154	-0.000224	0.002000	-0.036344	0.075976	0.021624	-0.004709	-0.004833
	β_1	9.740000	7.290000	7.730000	7.580000	13.510000	1.930000	12.750000	12.680000	18.450000
Other physical sciences (inc. earth)	β_0	-0.010099	-0.024718	-0.013421	0.000509	-0.002337	0.075976	0.044566	-0.001722	-0.001565
	β_1	15.670000	11.820000	16.790000	12.360000	11.330000	1.930000	-0.300000	15.420000	15.830000

See explanatory information and SOURCE at end of table.

Table D-1: b_0 and b_1 parameters for selected demographic groups in science and engineering fields: 1993 Survey of Doctorate Recipients

Field of doctorate	Para-meter	All	Female	White	Asian	Black	Native American	Hispanic	1991-92 Cohort	Foreign
Social and related sciences	β_0	-0.000106	-0.000211	-0.000126	0.002951	-0.001747	-0.010340	0.002030	-0.000963	-0.000310
	β_1	17.130000	10.790000	19.840000	8.760000	13.990000	28.450000	8.030000	12.010000	11.380000
Economics	β_0	0.000155	-0.002650	0.000256	-0.003223	0.007075	-0.010340	0.018067	0.017476	-0.019238
	β_1	5.560000	9.170000	6.100000	13.010000	10.510000	28.450000	17.310000	13.890000	14.300000
Political and related sciences	β_0	0.000203	-0.001252	-0.000219	0.021517	-0.013924	-0.010340	0.018067	0.017476	-0.019238
	β_1	21.690000	7.890000	24.350000	7.160000	12.910000	28.450000	9.450000	18.170000	17.480000
Psychology	β_0	-0.000248	-0.000398	-0.000305	-0.006483	-0.005128	-0.043994	0.006116	-0.001529	-0.007936
	β_1	19.430000	12.660000	23.160000	12.050000	16.060000	21.890000	9.090000	10.300000	12.620000
Sociology and anthropology	β_0	-0.000434	-0.000914	-0.000337	-0.000588	-0.004615	0.237751	0.008481	-0.010177	-0.009831
	β_1	10.810000	7.760000	10.900000	9.860000	7.320000	2.250000	5.130000	16.810000	10.090000
Other social sciences	β_0	-0.001757	-0.003642	-0.002411	0.033866	0.011698	-0.010340	-0.021878	0.007272	-0.002515
	β_1	34.230000	19.780000	36.680000	5.540000	8.500000	28.450000	15.650000	10.750000	12.660000
Engineering	β_0	-0.000168	-0.001140	-0.000247	-0.000131	-0.000369	0.053005	-0.003625	-0.001113	-0.001088
	β_1	15.450000	5.900000	17.950000	12.970000	12.930000	5.860000	15.560000	10.120000	15.160000
Aerospace/aeronautical	β_0	0.003337	-0.001140	0.006919	0.014224	-0.000369	0.053005	-0.003625	-0.045483	0.019269
	β_1	21.500000	5.900000	15.850000	21.210000	12.630000	5.860000	15.560000	18.760000	28.870000
Chemical	β_0	-0.001168	0.009568	-0.001098	0.007662	-0.036776	0.053005	-0.054127	0.009251	-0.002974
	β_1	16.100000	6.540000	14.490000	10.420000	7.870000	5.860000	21.860000	12.650000	5.850000
Civil	β_0	0.023625	0.100001	0.035403	0.011251	0.415796	0.053005	-0.054127	0.009251	-0.002974
	β_1	6.660000	-1.500000	9.570000	7.880000	1.220000	5.860000	5.690000	11.670000	18.950000
Electrical/computer	β_0	-0.000705	-0.004224	-0.001047	-0.001236	-0.033401	0.053005	0.027241	-0.003072	-0.002218
	β_1	15.910000	6.700000	16.030000	11.270000	17.580000	5.860000	12.780000	10.500000	10.690000
Industrial	β_0	-0.005265	0.006136	-0.010131	0.029049	-0.000369	0.053005	-0.003625	0.040079	0.001834
	β_1	18.260000	9.380000	22.540000	11.790000	12.630000	5.860000	15.560000	13.390000	4.450000
Mechanical	β_0	-0.000772	-0.006733	0.001164	-0.005297	0.151036	0.053005	0.064669	-0.001254	-0.003204
	β_1	12.990000	6.430000	14.260000	18.190000	1.870000	5.860000	5.440000	10.700000	6.130000
Other engineering	β_0	0.001212	-0.006641	0.001562	0.005771	0.023358	0.053005	-0.032770	-0.000695	-0.002171
	β_1	12.420000	10.600000	14.810000	11.630000	8.650000	5.860000	14.300000	7.450000	21.820000

SOURCE: National Science Foundation/SRS, 1993 Survey of Doctorate Recipients

Table D-2: b_0 and b_1 parameters for selected demographic groups in science and engineering fields: 1995 Survey of Doctorate Recipients

Field of doctorate	Para-meter	All	Female	White	Asian	Black	Native American	Hispanic	1993-94 Cohort	Foreign
Total	β_0	-0.000023	0.000021	-0.000040	-0.000008	-0.000489	-0.000259	0.000299	-0.000277	-0.000316
	β_1	18.5899	13.0050	20.4266	12.7529	12.4291	17.1888	12.2297	17.4728	19.4170
Sciences	β_0	-0.000044	0.000034	-0.000054	-0.000301	-0.000591	0.001656	0.000504	-0.000367	-0.000515
	β_1	21.6561	12.5028	22.4212	16.0783	12.6927	17.1112	11.5813	18.1395	21.1058
Computer and mathematical sciences	β_0	-0.000853	-0.000015	-0.002698	-0.002373	-0.004981	-0.150946	0.018700	-0.002501	-0.000185
	β_1	28.0454	5.4012	42.0849	16.1405	12.7974	9.6391	8.6377	17.1318	11.4903
Computer and information sciences	β_0	-0.000885	-0.001217	0.000614	-0.006329	-0.019370	0.014536	0.003246	-0.003694	0.018624
	β_1	9.9392	2.3555	3.9946	15.0334	15.0256	-0.0976	10.0460	14.3085	0.8335
Mathematical sciences	β_0	-0.000540	0.000046	0.001772	-0.004289	-0.005817	-0.098259	0.030161	-0.000516	-0.001747
	β_1	25.5222	5.4909	16.5930	18.5153	12.1190	6.3232	6.7742	13.4704	7.1415
Life and related sciences	β_0	-0.000171	-0.000366	-0.000200	0.000106	0.002809	0.042462	-0.005573	-0.000787	-0.001571
	β_1	21.4545	17.6003	20.7956	12.1302	4.9851	3.5054	15.4796	14.1837	18.0885
Agricultural and food sciences	β_0	0.000163	-0.006782	0.001017	-0.006930	-0.001434	0.042462	-0.012383	0.024752	-0.025676
	β_1	10.6019	20.2661	7.9515	16.2664	8.1511	3.5054	8.5916	3.9799	19.1821
Biological and health sciences	β_0	-0.000224	-0.000376	-0.000213	0.000466	0.003153	0.049573	-0.005760	-0.000905	-0.001462
	β_1	21.8288	16.7396	20.7474	11.4164	4.9506	3.4480	15.4556	13.6868	15.0375
Environmental sciences	β_0	-0.001686	0.074768	-0.006754	-0.001703	0.589446	0.012913	0.292197	0.058142	-0.020755
	β_1	16.1779	5.2488	20.0928	5.4797	-5.2662	-0.0800	-2.4694	10.9223	6.3131
Physical and related sciences	β_0	0.000114	0.001052	0.000150	-0.000646	-0.007952	-0.007954	0.008160	-0.001299	-0.000207
	β_1	10.8529	4.6941	11.9211	11.7896	14.6432	11.6577	7.6114	13.1661	8.7183
Chemistry, except biochemistry	β_0	0.000223	0.000755	0.000128	-0.000721	-0.012689	0.027039	0.009031	-0.005039	-0.002139
	β_1	15.3418	6.0265	18.4545	11.0773	15.5033	3.6410	8.5310	21.1786	13.0193
Geology and oceanography	β_0	-0.000973	0.002054	-0.000910	-0.005124	0.474362	0.162483	0.046690	0.007492	-0.004373
	β_1	17.0479	3.3279	14.7055	17.6009	-2.0383	1.8659	8.9725	5.0869	6.4656
Physics and astronomy	β_0	0.000261	-0.005085	0.000689	-0.001293	0.001091	0.202934	0.021614	-0.004297	-0.004409
	β_1	5.1938	9.1354	1.5439	8.5745	3.9319	-0.1961	2.8557	13.7771	17.7154
Other physical sciences (Incl. earth)	β_0	0.001490	0.060666	0.018634	0.042892	0.293921	-0.007954	0.142239	0.371915	0.214456
	β_1	8.1617	5.8244	2.3477	7.3602	0.7987	11.6577	1.7752	-0.7142	-4.6815

See explanatory information and SOURCE at end of table.

Table D-2: b_0 and b_1 parameters for selected demographic groups in science and engineering fields: 1995 Survey of Doctorate Recipients

Field of doctorate	Para-meter	All	Female	White	Asian	Black	Native American	Hispanic	1993-94 Cohort	Foreign
Social and related sciences	β_0	-0.000066	0.000006	-0.000087	0.003467	-0.000784	0.055318	0.002348	-0.002276	0.002341
	β_1	24.1827	19.6173	26.2486	12.9711	14.0330	2.5704	8.8686	31.1131	11.8954
Economics	β_0	-0.001860	-0.002993	-0.009160	0.017416	0.018669	-0.195509	0.049109	-0.013244	0.008330
	β_1	50.0002	11.6143	45.5894	8.7259	16.8857	12.8549	6.8511	24.1809	8.6854
Political and related sciences	β_0	-0.000925	0.004913	-0.000972	-0.007520	0.034105	0.155827	0.054803	-0.011663	0.004232
	β_1	25.0215	4.1086	21.3615	11.0090	-0.5418	-17.4856	-3.9270	11.2798	14.4068
Psychology	β_0	0.000101	-0.000059	0.000096	-0.014189	-0.003263	0.093760	-0.005823	-0.003076	0.004409
	β_1	18.3531	24.0757	19.6472	21.6614	15.1217	5.0968	17.5394	25.2727	15.2624
Sociology and anthropology	β_0	-0.000641	-0.000753	-0.000650	-0.000186	0.001082	0.066320	0.005582	-0.013473	-0.010160
	β_1	17.4264	8.0744	15.9666	5.6019	3.8273	-0.2871	4.6923	15.0009	10.6842
Other social sciences	β_0	-0.000633	-0.000549	-0.000424	-0.004979	0.015130	0.026521	0.000459	-0.000846	0.016087
	β_1	19.1413	11.9950	15.8947	26.7948	6.5850	1.0566	7.0809	11.5407	14.5094
Engineering	β_0	-0.000135	-0.006390	0.000044	-0.000428	0.006469	-0.038454	-0.001188	0.004499	-0.001033
	β_1	14.6994	23.6020	8.1550	17.1424	5.2421	17.3361	13.3388	13.4102	19.4301
Aerospace/aeronautical	β_0	-0.007795	-0.097285	-0.012822	-0.066937	0.151322	-0.038454	-0.034138	-0.029052	0.004493
	β_1	15.7897	4.6514	13.8309	22.8680	-1.1424	17.3361	2.4502	12.7274	-0.1321
Chemical	β_0	0.001101	-0.001088	-0.000637	0.000236	0.112882	-0.038454	-0.028280	-0.002367	0.000898
	β_1	5.4395	3.9492	11.0768	6.2993	4.0044	17.3361	14.6285	9.1778	1.8737
Civil	β_0	-0.017836	-0.001847	-0.001201	0.002871	-0.009567	0.517931	0.048866	-0.012088	-0.009090
	β_1	39.3848	6.2769	9.2613	3.2557	11.2200	-2.1553	6.4519	16.6786	16.7293
Electrical/computer	β_0	-0.000520	-0.004639	0.002209	0.006563	0.039620	0.218413	-0.010227	-0.002568	-0.002608
	β_1	16.4161	7.4492	2.9594	6.4722	-0.1783	4.5607	10.2778	10.1329	12.9309
Industrial	β_0	-0.003107	0.041131	0.024767	0.004322	-0.047322	-0.038454	-0.149059	0.132530	-0.050017
	β_1	15.0343	4.8166	-1.6111	4.2404	10.7387	17.3361	16.1463	-3.5348	11.4787
Mechanical	β_0	0.000322	-0.026791	-0.007779	-0.004174	-0.045343	-0.038454	-0.074873	-0.000142	0.001539
	β_1	7.0706	10.4604	20.7584	12.6009	10.4651	17.3361	15.7967	3.3455	3.3271
Other engineering	β_0	0.000353	-0.015372	0.000582	-0.000662	0.021109	-0.050146	0.076911	-0.001470	0.006189
	β_1	10.6413	18.9641	6.4912	13.8365	9.0236	2.6865	-0.4487	24.4974	9.7376

SOURCE: National Science Foundation/SRS, 1995 Survey of Doctorate Recipients

Table D-3: b_0 and b_1 parameters for selected demographic groups in science and engineering fields: 1997 Survey of Doctorate Recipients

Field of doctorate	Para-meter	All	Female	White	Asian	Black	Native American	Hispanic	1995-96 Cohort	Foreign
Total	β_0	-0.000024	-0.000094	-0.000027	-0.000095	-0.000079	0.001763	0.000196	-0.000025	-0.000196
	β_1	20.232903	15.149944	20.721270	18.686566	12.705895	14.155590	12.995122	9.614203	21.030685
Sciences	β_0	-0.000030	-0.000099	-0.000033	-0.000139	-0.000022	0.001844	0.000144	-0.000023	-0.000292
	β_1	19.663329	15.262763	20.145051	17.969387	11.757938	14.982789	13.199846	9.636961	21.478287
Computer and mathematical sciences	β_0	-0.000464	-0.002212	-0.000500	-0.001425	0.026547	0.283845	0.008215	-0.000843	-0.002350
	β_1	20.091003	12.827339	19.824503	21.521454	4.835119	-0.007300	13.169017	11.806712	24.495633
Computer and information sciences	β_0	-0.001845	-0.004028	-0.001664	-0.002922	0.129749	-0.034000	0.214927	-0.001863	-0.006645
	β_1	20.713524	7.130760	19.100579	21.198310	2.254268	0.770419	0.968027	12.085238	26.658114
Mathematical sciences	β_0	-0.000624	-0.003706	-0.000677	-0.002091	0.054928	0.393259	0.003389	-0.000885	-0.003264
	β_1	20.058239	15.140621	19.983911	20.342138	0.858148	-0.102790	12.380153	10.535876	22.587272
Life and related sciences	β_0	-0.000070	-0.000214	-0.000077	-0.000345	0.000145	0.010391	0.000345	-0.000034	-0.000800
	β_1	15.281118	11.871579	15.616633	14.531558	9.258944	4.096479	8.480597	7.014069	17.517255
Agricultural and food sciences	β_0	-0.000872	-0.005658	-0.000949	-0.003377	0.012182	0.280027	0.017791	-0.001045	-0.006407
	β_1	19.276192	16.364908	19.567888	17.516577	6.783573	0.911722	6.230076	8.528777	17.899706
Biological and health sciences	β_0	-0.000079	-0.000224	-0.000086	-0.000386	0.000039	0.013465	0.000113	-0.000033	-0.000946
	β_1	14.837110	11.652207	15.180441	13.972145	9.026595	3.902157	8.715575	6.871224	17.416621
Environmental sciences	β_0	-0.002929	-0.017896	-0.003228	0.045602	0.429290	0.196741	0.281755	0.001106	-0.015137
	β_1	18.232159	13.266102	18.402555	11.201389	0.398229	0.480885	1.320654	7.223846	17.937842
Physical and related sciences	β_0	-0.000145	-0.000997	-0.000156	-0.000581	0.007352	0.044670	-0.000627	-0.000213	-0.001084
	β_1	21.945816	17.410416	22.015460	21.304705	9.986558	13.687949	19.212837	11.469419	24.848397
Chemistry, except biochemistry	β_0	-0.000296	-0.001635	-0.000331	-0.001065	0.012744	0.102262	0.001770	-0.000244	-0.002220
	β_1	24.295076	18.794640	24.810838	21.723233	8.647245	13.402229	16.996885	11.816135	26.398445
Geology and oceanography	β_0	-0.000995	-0.007282	-0.001009	-0.003614	-0.073678	0.155894	-0.003477	-0.000481	-0.009553
	β_1	18.283583	15.452059	18.244082	15.526740	2.375153	0.664785	17.574747	9.293523	20.294082
Physics and astronomy	β_0	-0.000429	-0.004623	-0.000461	-0.001505	0.053159	0.273376	-0.000450	-0.001074	-0.002734
	β_1	20.645565	14.595172	20.473608	20.914248	3.339270	0.287338	18.951945	11.958860	24.264742
Other physical sciences (Incl. earth)	β_0	-0.009866	-0.014956	-0.010663	0.094785	0.771164	0.745162	0.538820	-0.010718	0.298198
	β_1	19.374057	15.821797	17.517231	14.022327	0.448199	0.781607	0.704011	8.852852	2.444919

See explanatory information and SOURCE at end of table.

Table D-3: b_0 and b_1 parameters for selected demographic groups in science and engineering fields: 1997 Survey of Doctorate Recipients

Field of doctorate	Para-meter	All	Female	White	Asian	Black	Native American	Hispanic	1995-96 Cohort	Foreign
Social and related sciences	β_0	-0.000105	-0.000254	-0.000113	-0.000371	-0.000746	0.012824	0.001185	-0.000022	-0.001464
	β_1	23.642372	18.419134	24.427464	18.182615	13.637331	10.694843	11.741858	11.021691	22.888345
Economics	β_0	-0.000813	-0.002897	-0.000776	-0.001443	0.022294	0.208880	0.079184	0.000168	-0.004901
	β_1	27.901272	13.756899	27.852654	20.563610	12.936106	2.025526	1.972540	10.661175	26.112712
Political and related sciences	β_0	-0.001265	-0.004448	-0.001388	0.007285	0.008958	0.620476	0.028923	0.003355	-0.010464
	β_1	30.740477	18.628215	32.054004	15.339387	10.537346	0.710545	6.213745	11.744591	24.626077
Psychology	β_0	-0.000197	-0.000441	-0.000211	-0.000912	-0.003485	0.015737	-0.001443	-0.000168	-0.004031
	β_1	22.029115	19.765020	22.706156	11.403181	14.992655	8.687126	12.367131	10.814714	17.004236
Sociology and anthropology	β_0	-0.000669	-0.001374	-0.000771	0.001165	0.000719	0.150139	0.013216	-0.006010	-0.001964
	β_1	21.807267	16.808106	23.301466	9.610278	6.542606	1.312996	4.193325	10.258593	14.645076
Other social sciences	β_0	-0.001357	-0.002782	-0.001443	0.002559	0.003794	0.255084	0.114433	0.000149	-0.002857
	β_1	27.673657	18.946937	28.560680	19.543130	10.357035	0.096308	2.018867	11.836137	19.245046
Engineering	β_0	-0.000135	-0.001877	-0.000143	-0.000307	-0.000731	0.065553	0.003143	-0.000259	-0.000630
	β_1	23.911762	13.316046	25.099797	20.346603	16.648171	1.100106	12.775474	9.673781	20.645608
Aerospace/aeronautical	β_0	-0.002378	-0.152869	-0.001488	-0.006436	-0.072240	0.470717	0.301029	-0.003160	-0.017505
	β_1	23.914850	9.210093	24.332356	20.137258	4.032171	1.096085	4.999338	9.814938	25.997467
Chemical	β_0	-0.000877	-0.012176	-0.000851	-0.002339	0.109680	0.534780	0.054738	-0.002085	-0.006151
	β_1	24.052324	13.049035	24.968387	20.355464	2.474990	1.000000	6.510081	10.466707	22.250030
Civil	β_0	-0.001091	-0.012471	-0.000699	-0.000756	0.086622	0.050728	0.071480	-0.000692	-0.005031
	β_1	22.153612	11.297929	21.640210	20.339110	8.579907	1.254839	7.228125	9.226534	21.253607
Electrical/computer	β_0	-0.000637	-0.003844	-0.000730	-0.000795	0.035405	-0.001001	0.027452	-0.000953	-0.001902
	β_1	26.441873	6.569228	28.524050	18.133374	3.212409	10.744708	11.771131	9.857609	20.760058
Industrial	β_0	-0.004714	-0.029746	-0.004580	-0.016285	0.117949	0.708563	-0.054803	-0.006022	-0.018049
	β_1	19.925106	18.755381	18.190220	25.128298	2.430541	0.298271	4.305273	9.934907	17.534647
Mechanical	β_0	-0.000848	-0.018552	-0.000524	-0.002179	0.199099	0.120580	0.018237	-0.001000	-0.003753
	β_1	21.041164	16.148224	19.980719	20.415118	4.493056	1.945219	9.218450	8.910516	18.736915
Other engineering	β_0	-0.000490	-0.005883	-0.000472	-0.001405	0.020606	0.076290	0.022310	-0.001268	-0.002573
	β_1	26.676798	15.329220	27.101252	23.669797	14.917233	1.893646	8.104554	10.685531	21.695164

SOURCE: National Science Foundation/SRS, 1997 Survey of Doctorate Recipients

Table D-4: b_0 and b_1 parameters for selected demographic groups in science and engineering fields: 1999 Survey of Doctorate Recipients

Field of doctorate	Para-meter	All	Female	White	Asian	Black	Native American	Hispanic	1997-98 Cohort	Foreign
Total	β_0	-0.000029	-0.000111	-0.000031	-0.000124	-0.000078	-0.000077	-0.000091	-0.000318	-0.000143
	β_1	19.194400	17.159400	19.134800	19.008100	12.043700	11.241100	13.774700	16.656000	20.615700
Sciences	β_0	-0.000034	-0.000107	-0.000033	-0.000114	-0.000077	-0.000076	-0.000080	-0.000296	-0.000116
	β_1	18.666900	16.534500	17.724300	17.419900	11.813700	11.039600	12.217400	15.502400	16.745000
Computer and mathematical sciences	β_0	-0.000387	-0.000216	-0.000377	-0.000373	-0.000243	-0.000070	-0.000291	-0.000293	-0.000326
	β_1	16.119700	9.016900	15.725200	15.557200	10.111400	2.936300	12.119000	12.202700	13.597300
Computer and information sciences	β_0	-0.001488	-0.000556	-0.001353	-0.001276	-0.000930	-0.000103	-0.000775	-0.000968	-0.001080
	β_1	17.307400	6.466400	15.745300	14.846300	10.825000	1.194400	9.017500	11.266400	12.567400
Mathematical sciences	β_0	-0.000621	-0.000365	-0.000596	-0.000570	-0.000312	-0.000152	-0.000414	-0.000448	-0.000523
	β_1	18.641000	10.974200	17.891200	17.108900	9.373800	4.554800	12.443000	13.448700	15.700200
Life and related sciences	β_0	-0.000092	-0.000085	-0.000092	-0.000108	-0.000073	-0.000065	-0.000077	-0.000268	-0.000107
	β_1	16.803100	13.063100	16.766700	16.548600	11.299700	9.538600	11.727300	14.043000	15.502500
Agricultural and food sciences	β_0	-0.000647	-0.000407	-0.000642	-0.000549	-0.000588	-0.000384	-0.000383	-0.000575	-0.000617
	β_1	18.959700	11.926400	18.798000	16.091500	17.232200	11.248700	11.235500	16.851600	18.080000
Biological and health sciences	β_0	-0.000122	-0.000085	-0.000116	-0.000106	-0.000065	-0.000070	-0.000073	-0.000246	-0.000098
	β_1	18.780500	13.033000	17.888000	16.256500	9.921600	10.200800	11.061300	12.849100	14.179800
Environmental sciences	β_0	-0.000320	-0.000268	-0.000324	-0.000310	-0.000101	-0.000025	-0.000340	-0.000266	-0.000345
	β_1	18.499400	15.487200	18.706600	17.933000	5.839500	1.427900	19.628100	13.903300	19.918600
Physical and related sciences	β_0	-0.000122	-0.000085	-0.000115	-0.000123	-0.000071	-0.000074	-0.000081	-0.000251	-0.000110
	β_1	16.222700	11.272200	15.388500	16.333300	9.526500	9.924800	10.817000	13.144800	14.662900
Chemistry, except biochemistry	β_0	-0.000270	-0.000175	-0.000246	-0.000254	-0.000193	-0.000190	-0.000171	-0.000263	-0.000234
	β_1	18.626000	12.102700	16.976600	17.526300	13.323600	13.082700	11.830800	13.738100	16.132200
Geology and oceanography	β_0	-0.000911	-0.000558	-0.000907	-0.000638	-0.000093	-0.000164	-0.000466	-0.000628	-0.000605
	β_1	17.184400	10.521100	17.124400	12.042600	1.751000	3.094800	8.785000	11.850600	11.421600
Physics and astronomy	β_0	-0.000416	-0.000219	-0.000396	-0.000399	-0.000153	-0.000208	-0.000265	-0.000306	-0.000356
	β_1	18.901900	9.939600	17.969400	18.129900	6.953900	9.431200	12.040800	13.905500	16.152000
Other physical sciences (Incl. earth)	β_0	-0.000271	-0.000229	-0.000261	-0.000306	-0.000189	-0.000060	-0.000038	-0.000362	-0.000281
	β_1	17.424500	14.732800	16.783700	19.672600	12.146400	3.886900	2.441600	18.934600	18.074400

See explanatory information and SOURCE at end of table.

Table D-4: b_0 and b_1 parameters for selected demographic groups in science and engineering fields: 1999 Survey of Doctorate Recipients

Field of doctorate	Para-meter	All	Female	White	Asian	Black	Native American	Hispanic	1997-98 Cohort	Foreign
Social and related sciences	β_0	-0.000097	-0.000088	-0.000099	-0.000097	-0.000076	-0.000073	-0.000071	-0.000261	-0.000098
	β_1	17.795600	13.645800	18.067500	14.776800	11.674800	10.596900	10.757400	13.655400	14.122300
Economics	β_0	-0.001001	-0.000431	-0.001008	-0.000693	-0.000510	-0.000492	-0.000516	-0.000558	-0.000665
	β_1	23.607900	10.174600	23.776000	16.333700	12.038000	11.591300	12.169400	13.157800	15.673500
Political and related sciences	β_0	-0.000649	-0.000416	-0.000641	-0.000462	-0.000378	-0.000088	-0.000312	-0.000411	-0.000500
	β_1	24.462900	15.700400	24.183000	17.410500	14.259300	3.326300	11.762800	15.482400	18.865000
Psychology	β_0	-0.000207	-0.000154	-0.000198	-0.000154	-0.000150	-0.000117	-0.000127	-0.000274	-0.000148
	β_1	19.788800	14.733800	18.937800	14.676200	14.372700	11.150000	12.138200	14.355900	14.179200
Sociology and anthropology	β_0	-0.000731	-0.000419	-0.000743	-0.000346	-0.000245	-0.000318	-0.000273	-0.000389	-0.000365
	β_1	19.214600	11.016500	19.507000	9.085700	6.443000	8.348800	7.183200	10.219500	9.580900
Other social sciences	β_0	-0.000660	-0.000433	-0.000703	-0.000527	-0.000340	-0.000439	-0.000283	-0.000442	-0.000478
	β_1	24.901900	16.327300	26.526300	19.858300	12.830300	16.540300	10.684000	16.659300	18.012500
Engineering	β_0	-0.000201	-0.000121	-0.000185	-0.000197	-0.000106	-0.000060	-0.000141	-0.000275	-0.000186
	β_1	22.187000	13.411600	20.459000	21.724500	11.720200	6.670200	15.595500	14.363700	20.551100
Aerospace/aeronautical	β_0	-0.000273	-0.000167	-0.000282	-0.000298	-0.000154	-0.000041	-0.000162	-0.000310	-0.000307
	β_1	22.858900	14.024900	23.597300	24.923500	12.867300	3.444800	13.584300	16.219000	25.684500
Chemical	β_0	-0.000270	-0.000172	-0.000264	-0.000289	-0.000102	-0.000020	-0.000185	-0.000315	-0.000281
	β_1	22.582000	14.375800	22.123100	24.197200	8.538200	1.637700	15.519400	16.457600	23.501500
Civil	β_0	-0.000281	-0.000223	-0.000266	-0.000320	-0.000180	-0.000030	-0.000244	-0.000343	-0.000303
	β_1	23.494100	18.645900	22.259300	26.776100	15.096300	2.527600	20.400700	17.939600	25.385100
Electrical/computer	β_0	-0.000824	-0.000287	-0.000754	-0.000653	-0.000280	-0.000307	-0.000518	-0.000437	-0.000653
	β_1	22.044700	7.685700	20.188900	17.473500	7.483700	8.213400	13.853700	11.682600	17.468000
Industrial	β_0	-0.000264	-0.000176	-0.000272	-0.000306	-0.000046	-0.000133	-0.000054	-0.000304	-0.000292
	β_1	22.118500	14.708800	22.797600	25.613400	3.813000	11.141600	4.507900	15.917100	24.479300
Mechanical	β_0	-0.000280	-0.000187	-0.000267	-0.000267	-0.000156	-0.000065	-0.000225	-0.000304	-0.000269
	β_1	23.464500	15.682600	22.340900	22.394500	13.031100	5.459200	18.840100	15.884400	22.528400
Other engineering	β_0	-0.000268	-0.000195	-0.000254	-0.000277	-0.000173	-0.000133	-0.000208	-0.000300	-0.000269
	β_1	22.474300	16.332800	21.289400	23.214500	14.485200	11.157300	17.381100	15.692800	22.531700

SOURCE: National Science Foundation/SRS, 1999 Survey of Doctorate Recipients

Table D-5: b_0 and b_1 parameters for selected demographic groups in science and engineering fields: 2001 Survey of Doctorate Recipients

Field of doctorate	Para-meter	All	Female	White	Asian	Black	Native American	Hispanic	1999-2000 Cohort	Foreign
Total	β_0	-0.000028	-0.000099	-0.000030	-0.000130	-0.000077	-0.000072	-0.000087	-0.000309	-0.000132
	β_1	19.12830	17.09560	19.48570	21.95660	12.87820	11.58270	14.47680	15.46880	21.01290
Sciences	β_0	*-0.000034*	-0.000094	-0.000034	-0.000115	-0.000078	-0.000076	-0.000080	-0.000287	-0.000103
	β_1	*19.48290*	16.14530	19.23780	19.46940	13.05150	12.18030	13.32790	14.35460	16.36420
Computer and mathematical sciences	β_0	*-0.000381*	-0.000222	-0.000389	-0.000383	-0.000253	-0.000018	-0.000288	-0.000232	-0.000310
	β_1	*16.87310*	9.81840	17.25200	16.96940	11.22020	0.81240	12.73570	10.28290	13.73850
Computer and information sciences	β_0	*-0.001247*	-0.000474	-0.001223	-0.001033	-0.000752	-0.000051	-0.000862	-0.000732	-0.000862
	β_1	*16.37040*	6.22760	16.06660	13.56870	9.87190	0.67260	11.32610	9.61640	11.32570
Mathematical sciences	β_0	*-0.000597*	-0.000385	-0.000610	-0.000622	-0.000369	-0.000029	-0.000428	-0.000364	-0.000492
	β_1	*18.61140*	12.01130	19.02000	19.38350	11.49290	0.91060	13.33630	11.34300	15.33650
Life and related sciences	β_0	*-0.000103*	-0.000078	-0.000101	-0.000104	-0.000070	-0.000057	-0.000080	-0.000257	-0.000099
	β_1	*17.44860*	13.26200	17.21350	17.61260	11.72440	9.16970	13.30730	12.87980	15.64760
Agricultural and food sciences	β_0	*-0.000672*	-0.000420	-0.000649	-0.000659	-0.000551	-0.000460	-0.000408	-0.000413	-0.000523
	β_1	*20.31850*	12.68430	19.60190	19.90460	16.65900	13.89810	12.33030	12.47060	15.79520
Biological and health sciences	β_0	*-0.000135*	-0.000097	-0.000129	-0.000120	-0.000081	-0.000065	-0.000090	-0.000273	-0.000112
	β_1	*18.91250*	13.52910	17.97320	16.79080	11.25350	9.06750	12.63470	13.65000	15.71060
Environmental sciences	β_0	*-0.000690*	-0.000473	-0.000716	-0.000556	-0.000215	-0.000051	-0.000541	-0.000489	-0.000642
	β_1	*20.85350*	14.28790	21.65100	16.81090	6.48710	1.54860	16.35190	14.78110	19.41400
Health sciences	β_0	*-0.000694*	-0.000512	-0.000682	-0.000473	-0.000297	-0.000363	-0.000327	-0.000402	-0.000424
	β_1	*16.99430*	12.53850	16.70080	11.58910	7.27470	8.90130	7.99850	9.85660	10.38660
Physical and related sciences	β_0	*-0.000124*	-0.000089	-0.000122	-0.000122	-0.000077	-0.000063	-0.000088	-0.000233	-0.000108
	β_1	*17.05180*	12.24660	16.76790	16.81230	10.55440	8.70830	12.01580	11.68010	14.85650
Chemistry, except biochemistry	β_0	*-0.000290*	-0.000171	-0.000263	-0.000254	-0.000167	-0.000167	-0.000171	-0.000239	-0.000237
	β_1	*20.50910*	12.10860	18.62590	17.99420	11.86040	11.84710	12.12240	11.95090	16.77490
Geology and oceanography	β_0	*-0.000895*	-0.000549	-0.000908	-0.000715	-0.000271	-0.000153	-0.000460	-0.000556	-0.000549
	β_1	*17.64890*	10.83610	17.92230	14.11130	5.35170	3.01890	9.06550	10.95940	10.83700
Physics and astronomy	β_0	*-0.000449*	-0.000250	-0.000419	-0.000429	-0.000157	-0.000232	-0.000312	-0.000297	-0.000373
	β_1	*21.00590*	11.68700	19.58680	20.06840	7.33420	10.85950	14.58810	13.89640	17.45320
Other physical sciences (Incl. earth)	β_0	*-0.000298*	-0.000228	-0.000321	-0.000275	-0.000300	-0.000045	-0.000037	-0.000287	-0.000241
	β_1	*19.77660*	15.16970	21.36060	18.25080	19.96720	2.96340	2.44690	14.36330	16.02980

See explanatory information and SOURCE at end of table.

Table D-5: b_0 and b_1 parameters for selected demographic groups in science and engineering fields: 2001 Survey of Doctorate Recipients

Field of doctorate	Para-meter	All	Female	White	Asian	Black	Native American	Hispanic	1999-2000 Cohort	Foreign
Social and related sciences	β_0	*-0.000094*	-0.000081	-0.000097	-0.000093	-0.000076	-0.000079	-0.000069	-0.000253	-0.000091
	β_1	*17.89180*	13.88650	18.54090	15.67010	12.82120	12.59290	11.49600	12.65200	14.52440
Economics	β_0	*-0.000935*	-0.000464	-0.000975	-0.000713	-0.000550	-0.000341	-0.000480	-0.000501	-0.000632
	β_1	*22.48790*	11.15070	23.43610	17.15340	13.23210	8.19620	11.54070	12.05260	15.19160
Political and related sciences	β_0	*-0.000596*	-0.000392	-0.000634	-0.000480	-0.000345	-0.000526	-0.000325	-0.000357	-0.000489
	β_1	*23.58660*	15.54140	25.09780	18.99400	13.64370	20.82400	12.88170	14.14630	19.35550
Psychology	β_0	*-0.000219*	-0.000152	-0.000196	-0.000148	-0.000147	-0.000103	-0.000129	-0.000270	-0.000151
	β_1	*21.98040*	15.23720	19.69640	14.85870	14.75800	10.33370	12.98880	13.49210	15.14020
Sociology and anthropology	β_0	*-0.000668*	-0.000432	-0.000689	-0.000346	-0.000279	-0.000221	-0.000289	-0.000363	-0.000395
	β_1	*18.29440*	11.82490	18.85510	9.47000	7.63350	6.05530	7.92340	9.93240	10.80370
Other social sciences	β_0	*-0.000586*	-0.000435	-0.000636	-0.000494	-0.000368	-0.000382	-0.000328	-0.000366	-0.000470
	β_1	*23.19570*	17.23520	25.20400	19.54340	14.58270	15.11320	12.96980	14.47580	18.60490
Engineering	β_0	*-0.000187*	-0.000116	-0.000175	-0.000180	-0.000098	-0.000056	-0.000123	-0.000266	-0.000175
	β_1	*22.07850*	13.68230	20.63930	21.15820	11.53780	6.56190	14.50210	13.32890	20.65000
Aerospace/aeronautical	β_0	*-0.000284*	-0.000194	-0.000290	-0.000269	-0.000118	-0.000045	-0.000140	-0.000319	-0.000267
	β_1	*25.30950*	17.31860	25.81160	23.96230	10.54100	4.05270	12.51970	15.95110	23.78980
Chemical	β_0	*-0.000258*	-0.000171	-0.000256	-0.000262	-0.000150	-0.000018	-0.000178	-0.000308	-0.000266
	β_1	*23.03020*	15.21480	22.78630	23.38590	13.40780	1.63250	15.85590	15.40900	23.67000
Civil	β_0	*-0.000248*	-0.000168	-0.000241	-0.000284	-0.000178	-0.000030	-0.000185	-0.000317	-0.000279
	β_1	*22.09180*	14.97490	21.45170	25.31700	15.89120	2.66370	16.47070	15.88660	24.84590
Electrical/computer	β_0	*-0.000851*	-0.000249	-0.000752	-0.000655	-0.000300	-0.000261	-0.000466	-0.000397	-0.000613
	β_1	*24.39350*	7.13860	21.54790	18.75610	8.60360	7.47560	13.35590	11.38580	17.57330
Industrial	β_0	*-0.000286*	-0.000198	-0.000268	-0.000264	-0.000142	-0.000085	-0.000170	-0.000319	-0.000276
	β_1	*25.49990*	17.67620	23.92680	23.51840	12.66670	7.54530	15.16350	15.98350	24.57790
Mechanical	β_0	*-0.000265*	-0.000211	-0.000249	-0.000285	-0.000128	-0.000050	-0.000214	-0.000321	-0.000290
	β_1	*23.58740*	18.77040	22.17110	25.38980	11.42400	4.46440	19.09510	16.05450	25.87990
Other engineering	β_0	*-0.000251*	-0.000156	-0.000244	-0.000267	-0.000119	-0.000099	-0.000160	-0.000286	-0.000256
	β_1	*22.38980*	13.86870	21.77770	23.82030	10.57790	8.78070	14.26370	14.33630	22.77390

NOTE: Parameter domains differ somewhat from those used in previous years: The *Life and Related Sciences* group now excludes the health sciences; the *Biological Sciences* group now excludes the health sciences; *Health Sciences* has been added as a separate group; *Metallurgical/Materials Engineering* has been added as a separate group; the *Industrial Engineering* has been removed; and the *Other Engineering* group has been revised to include industrial engineers and exclude metallurgical/materials engineers.

SOURCE: National Science Foundation/SRS, 2001 Survey of Doctorate Recipients

APPENDIX E

PARAMETER TABLES:

NATIONAL SURVEY OF RECENT COLLEGE GRADUATES

Table E-1. 1993 National Survey of Recent College Graduates: b_0 and b_1 Parameters for 1991 and 1992 Graduates

Domain	Bachelors		Masters	
	β_0	β_1	β_0	β_1
1991 Graduates				
All Graduates	0.000116	132.515	0.013208	11.064
Male	0.001079	94.871	0.000354	38.915
Female	-0.000010	178.568	0.001214	37.876
Science Majors	0.000411	178.903	0.002822	26.086
Engineering Majors	0.000818	80.969	-0.001952	41.629
Scientists	-0.000872	131.591	0.003328	27.255
Engineers	-0.000045	82.807	-0.000006	27.478
Other Occupations	0.000451	195.981	-0.000500	41.688
White	0.000718	120.830	0.001287	37.517
Black	0.032007	82.327	0.019705	43.892
Hispanic	0.006942	141.348	0.000230	26.526
Asian	0.001170	124.246	0.002644	33.742
1992 Graduates				
All Graduates	0.00653	68.747	0.014906	9.977
Male	0.000731	83.675	-0.000229	42.863
Female	0.000494	166.358	-0.000665	42.195
Science Majors	0.000566	150.333	-0.001252	68.013
Engineering Majors	-0.000971	72.909	-0.000408	28.939
Scientists	-0.000565	171.386	-0.000062	39.428
Engineers	-0.001254	73.203	0.000029	27.23
Other Occupations	0.000117	188.939	0.000463	41.454
White	0.000746	88.749	-0.000806	55.473
Black	0.026867	128.155	0.01508	32.573
Hispanic	0.006141	121.118	-0.001975	25.648
Asian	0.004119	106.541	0.001693	29.712

SOURCE: National Science Foundation/SRS, 1993 National Survey of Recent College Graduates

Table E-2. 1995 National Survey of Recent College Graduates: b_0 and b_1 Parameters for 1993 and 1994 Graduates

Domain	Bachelors		Masters	
	β_0	β_1	β_0	β_1
1993 Graduates				
All Graduates	0.007695	21.661	0.007682	17.111
Male	0.000037	108.600	0.001648	36.908
Female	0.001615	78.105	0.002994	26.467
Science Majors	0.000163	59.031	0.002302	37.582
Engineering Majors	0.006357	19.377	0.001178	35.455
Scientists	0.000782	86.156	0.000775	40.336
Engineers	-0.000410	81.531	0.002812	21.540
Other Occupations	0.001656	54.644	0.001259	27.151
White	0.000903	100.226	0.001550	35.905
Black	0.012871	23.608	0.037290	10.130
Hispanic	0.002875	63.179	0.012692	16.748
Asian	-0.005320	139.512	0.002848	36.229
1994 Graduates				
All Graduates	0.005197	36.643	0.006248	15.649
Male	-0.000390	127.704	0.000715	46.800
Female	0.001733	76.624	0.002574	25.781
Science Majors	0.001402	73.153	0.001913	36.324
Engineering Majors	0.005601	31.693	0.006826	16.731
Scientists	0.001379	85.395	0.001551	36.276
Engineers	-0.001320	89.808	0.003521	28.574
Other Occupations	0.001506	54.044	0.002610	24.271
White	0.000873	104.618	0.001459	30.064
Black	0.008010	44.028	0.026034	8.269
Hispanic	0.003739	51.617	0.009851	14.013
Asian	0.001166	85.471	0.004934	25.061

SOURCE: National Science Foundation/SRS, 1995 National Survey of Recent College Graduates

Table E-3. 1997 National Survey of Recent College Graduates: b_0 and b_1 Parameters for 1995 and 1996 Graduates

Domain	Bachelors		Masters	
	β_0	β_1	β_0	β_1
1995 Graduates				
All Graduates	0.000073	132.546	0.000323	76.410
Male	0.000073	129.242	-0.000007	67.101
Female	0.000463	146.776	0.002307	61.534
Science Majors	0.000273	140.369	0.001121	76.497
Engineering Majors	0.001377	71.464	-0.000205	57.181
Scientists	0.000548	119.521	0.001300	56.181
Engineers	0.001161	79.275	-0.000773	59.125
Other Occupations	0.000222	133.195	0.001239	67.953
White	0.000167	144.508	0.001086	64.411
Black	0.007062	63.168	-0.003100	41.127
Hispanic	0.002413	66.442	0.003209	36.210
Asian	0.002315	127.900	0.000332	61.901
1996 Graduates				
All Graduates	0.000277	142.671	0.000474	75.413
Male	0.000336	116.715	0.000238	61.922
Female	0.000340	175.795	0.001432	78.436
Science Majors	0.000640	147.156	0.001992	65.608
Engineering Majors	0.001446	68.115	0.000421	47.444
Scientists	-0.000038	122.765	0.001515	65.234
Engineers	0.001189	78.696	0.000181	47.614
Other Occupations	0.000462	168.633	0.003501	57.424
White	0.000398	169.388	0.000629	71.656
Black	0.007336	62.826	0.000826	48.648
Hispanic	0.001271	96.859	0.001409	39.791
Asian	-0.000210	136.221	0.002409	52.955

SOURCE: National Science Foundation/SRS, 1997 National Survey of Recent College Graduates

Table E-4. 1999 National Survey of Recent College Graduates: b_0 and b_1 Parameters for 1997 and 1998 Graduates

Domain	Bachelors		Masters	
	β_0	β_1	β_0	β_1
1997 Graduates				
All Graduates	0.000362	178.959	0.000100	104.491
Male	0.000448	140.253	-0.000221	82.248
Female	0.001020	188.494	0.001120	90.087
Science Majors	0.000617	205.101	0.000741	108.037
Engineering Majors	0.001360	73.981	0.000706	41.883
Scientists	0.000391	141.597	-0.000553	84.331
Engineers	0.001170	92.632	0.000194	51.631
Other Occupations	0.000451	199.042	0.003460	81.213
White	0.000613	211.962	0.000461	85.972
Black	0.008760	74.712	0.011640	32.210
Hispanic	0.001300	84.322	0.016630	27.721
Asian	0.000185	146.232	-0.000450	70.206
1998 Graduates				
All Graduates	0.000535	124.854	0.000143	79.164
Male	0.000187	133.510	0.000065	67.217
Female	0.001340	173.468	0.001640	70.395
Science Majors	0.001020	125.447	0.000872	74.059
Engineering Majors	0.000570	71.556	-0.000748	50.652
Scientists	0.001550	117.499	0.000008	67.588
Engineers	0.001030	69.092	0.000348	44.580
Other Occupations	0.001020	141.673	0.002040	63.025
White	0.000611	178.402	-0.000118	80.561
Black	0.006360	72.222	0.003180	42.757
Hispanic	0.000439	102.653	-0.002300	46.015
Asian	-0.000159	166.926	-0.000384	65.071

SOURCE: National Science Foundation/SRS, 1999 National Survey of Recent College Graduates

Table E-5. 2001 National Survey of Recent College Graduates: $\hat{a}_0$ and $\hat{a}_1$ Parameters for 1999 and 2000 Graduates

Domain	Bachelor's Recipients Parameter Estimates		Master's Recipients Parameter Estimates	
	$\hat{a}_0$	$\hat{a}_1$	$\hat{a}_0$	$\hat{a}_1$
All graduates	0.000012	196.577	0.000488	89.726
Sex				
Male	0.000085	146.758	-0.000398	86.421
Female	0.000179	205.268	0.001770	81.031
Major				
Science	0.000084	216.345	0.001340	90.822
Engineering	-0.000263	83.473	-0.000368	48.357
Occupation				
Scientists	0.000016	158.701	0.000386	79.817
Engineers	-0.000104	70.250	-0.000537	48.996
Other	0.000059	221.846	0.002810	61.565
Race/Ethnicity				
White, non-Hispanic	0.000093	198.565	0.000867	91.155
Black, non-Hispanic	0.002670	64.945	0.003510	29.633
Hispanic	-0.000277	109.805	0.000124	49.669
Asian/Pacific Islanders	0.000159	152.473	-0.000809	92.410
American Indian/Alaskan Natives	0.002190	129.822	0.082410	24.713

SOURCE: National Science Foundation/Division of Science Resources Statistics, National Survey of Recent College Graduates, 2001.