# Analysis of Census 2000 Long Form Variances

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**Abstract**

The Census 2000 Long Form consisted of approximately a 15 percent systematic sample of persons. Some 60,000 weighting areas were formed and final weights were calculated using an iterative proportional fitting (raking) procedure. Both the systematic sample and the raking are designed to reduce variance. A successive difference replication (SDR) methodology was developed to estimate the variances in order to properly reflect the variance gains of the systematic sample. Due to operational constraints, the replicate weights did not fully reflect the raking used for estimation. The replicates reflected only the effect of controlling on total population. Thus, the reduction in variances due to raking was not reflected in the variance estimates which, as a result, should overestimate the true variance. Standard errors were estimated for a large number of subtotals in each weighting area, outliers were removed, and generalized design factors were calculated. This paper examines the consequences of not raking to reweight each replicate by comparing variance estimates with or without the replication of the raking procedure for the SDR method and for a simple jackknife method.

**Key Words:** Successive Differences, Jackknife, Raking

## 1. Introduction

### 1.1 Purpose

This paper evaluates the methodology used for estimating standard errors and design factors for the Census 2000 long form sample. Successive difference replication (SDR) was used for the first time instead of the random group methods used in 1980 and 1990. SDR is designed to reflect the variance gains from the use of systematic sample (see Fay and Train, 1995). Although it was originally planned for Census 2000 to reweight the sample for each SDR replicate by the full sample iterative proportional fitting (raking) procedure, this approach was not implemented due to time and resource constraints. This paper compares the results of a simple Jackknife (JK) with the SDR methodology crossed by the option of reweighting or not reweighting each replicate by raking.

### 1.2. Background

Variances for the 1980 and 1990 Censuses were estimated using the random groups method with 24 random groups in 1980 and 25 random groups in 1990. The research before the 1980 Census based on 1970 data examined other methods and found that, although linearization methods might be preferable, the computing time involved was not available (see Fan et al, 1981). Other methods examined included the Jackknife and Balanced Repeated Replications (BRR).

Fan et al reweighted each replicate for each weighting area (a collection of block groups in a single county with at least 400 persons in the long form sample) for the Jackknife and BRR approaches and for two random groups. For more than two random groups the additional collapsing of the weighting matrix required by the smaller sample sizes confounded the results.

Linearization produced the lowest mean square errors of estimates from long form data. The random group approach without reweighting each replicate with 20 or more random groups had MSEs about 20 percent higher. The errors for the Jackknife were even higher although the magnitude is not given. Based on other statistics in Fan et al (1981) it appears that the Jackknife standard errors with reweighting each replicate were about 10 to 20 percent higher than the random groups estimates.

### 1.3 Census 2000

The Census 2000 Long Form Sample was selected using a systematic sample with four different sampling rates (1-in-2, 1-in-4, 1-in-6, and 1-in-8) depending on local area size. Overall about 17 percent of the housing units in the country were sampled and about 16 percent provided long form data. Sample weights were estimated by iterative proportional fitting or raking to control the weighted subtotals of sample persons to the census subtotals for all persons within over 60,000 weighting areas. The observed sampling rates were used as initial weights in the raking. The raking method, as applied to

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person data, controlled the estimated sample totals for race/origin/age/sex, family type, sampling rate, and householder/nonhouseholder groups to the corresponding census counts. There was some collapsing of groups to provide minimum sample sizes and to limit maximum weights. Within weighting areas, large race/origin, family type and householder/nonhouseholder groups were often maintained. Age/sex groups and smaller race/origin groups usually required collapsing, sometimes extensive collapsing.

Standard errors were calculated by the successive difference replication method for 4,000 subtotals for persons, families, households, and housing units in each weighting area. Direct estimates of design factors were calculated by dividing the direct estimate of the standard error by the standard error that would be expected from a simple random 1-in-6 sample. These design factors were averaged, or generalized, over weighting areas with limited outlier removal to calculate 12,240 generalized design factors for the fifty states and the District of Columbia crossed by four observed sampling rates crossed by sixty data categories[1]. Thus, the generalized design factors account for the sample design, the observed sampling rates, and the variability of the particular type of estimate. Data users are instructed to calculate standard errors for estimates from the Census 2000 Long Form by multiplying the generalized design factor by the standard error based on a 1-in-6 simple random sample.

The systematic long form sample was designed to reduce variances by spreading the sample uniformly over the entire population. The SDR process was designed to reflect this variance reduction by mimicking the systematic sample design. Alternative approaches, such as a Jackknife, would not capture the variance gains of the systematic sample and would be expected to overestimate the true variance. The raking procedure was designed to reduce variance by holding certain subtotals fixed. Not raking each replicate results in failure to capture this variance reduction so the variance estimates overestimate the true variance. As is discussed below, not raking each replicate would, as expected, not reflect variance reduction due to raking but also would not reflect the variance reduction due to the systematic sample.

For Census 2000, the design and implementation of the entire variance system required a large investment of statistical design time, systems design and programming time, and computer run time. It was estimated that the computer time required to rake for each replicate was not available. Therefore, instead of raking for each replicate, a simple ratio adjustment was implemented to control the 52 replicate estimates for persons, housing units, and families for each weighting area to the corresponding census totals. It was accepted that this adjustment would overestimate the variance, but the magnitude of the overestimation was not known.

For this study, started after the Census 2000 production was complete, the programs were modified to rake the person data weighting matrix for each replicate using either Jackknife initial weights or SDR initial weights. Estimates of standard errors and design factors were generalized by averaging without removing outliers.

## 2. Methodology

### 2.1 Basic Long Form Methodology

The long form weighting methodology implemented for Census 2000 consisted of the following steps:

- Tabulation block groups were combined to form weighting areas, each with at least 400 sample persons in one county and satisfying several other conditions. Small counties with fewer than 800 sample persons could have only one weighting area.
- Initial weights were calculated by geographic and demographic subgroups within weighting areas to reflect the observed sampling rates.
- The initially weighted sample data were placed into a four-dimensional raking matrix, which was then collapsed to eliminate small sample sizes and large average weights for the marginal totals.
- The collapsed matrix was raked to the census counts at the margins of the matrix for a fixed number of iterations.
- Integer-valued final weights were calculated from the final raking matrix. If the maximum weights exceeded certain limits, additional collapsing was implemented and the raking and weighting steps were repeated.
- Additional information is available in Hefter (2002).

The Census 2000 production standard error estimation methodology consisted of the following steps:

- Define a Hadamard matrix of size 52.
- Define weighting factors for all 52 replicates for each person and housing unit. These factors average out to approximately 1.0.
- Calculate approximately 4,000 estimates for each replicate for each weighting area using the replicate

factors. For each person, household, or housing unit use the full-sample integer weight multiplied by the replicate factor. As a result, the totals and subtotals on the margins of the raking matrix which were controlled to fixed census totals during the raking process for the full sample were not controlled to for each replicate. Ratio adjustment to the weighting area census totals was implemented for each weighting area. A variance formula for SDR estimated the standard error:

$$SE_{SDR} = \sqrt{\frac{4}{52}\sum_{r=1}^{52}(EST_{SDR,r} - EST_0)^2}$$

where, for any item, $EST_{SDR,r}$ is the estimate for the $r^{th}$ SDR replicate and $EST_0$ is the estimate for the full sample.

- Design factors comparing the estimated standard errors to simple random sampling standard errors based on a 1-in-6 sample were calculated.
- Additional information on the production direct variance estimation is available in Fairchild (2004).

The variance generalization process consisted of the following steps:

- All design factors were capped at 5.0. This step removed most outliers.
- A model-based outlier down weighting process was implemented to reduce the impact of any remaining estimates with exceptionally high or low direct standard error estimates.
- The design factors were averaged to produce 240 design factors for each state for four observed sampling rates (0-14.9 percent, 15-24.9 percent, 25-34.9 percent, 35 percent and over) for 60 categories of estimates (34 for persons, 4 for households, and 22 for housing units).
- Additional information is available in Davis and Shores (2004).

### 2.2 Jackknife Estimates

During the initial processing Jackknife estimates were also calculated for the approximately 2,200 person estimates in each weighting area but not for the family, household, and housing unit estimates. Housing units and their residents (or, separately, group quarters persons) were assigned sequentially to 52 replicate groups. To estimate standard errors, replicate estimates were calculated using the weights from the raking process and dropping one replicate group. The replicate totals were ratio adjusted to the census totals. The Jackknife standard error is given by:

$$SE_{JK} = \sqrt{\frac{51}{52}\sum_{r=1}^{52}(EST_{JK,r} - EST_0)^2}$$

For the SDR and Jackknife (JK) methods, standard errors and design factors were also calculated for the same 2,200 person-level estimates at the state and county levels, using the weights calculated at the weighting area level. Simple weighted averages of the design factors were estimated for the SDR and JK methods for weighting areas, counties, and states.

### 2.3 Raking each Replicate

When resources became available to evaluate the impact of not raking the weights for each replicate, the additional steps were:

- Rake the person weighting matrix (without changing the full-sample collapse pattern) for each replicate for each weighting area using the SDR factors or a Jackknife to adjust the initial weights. Use the integer-valued weights generated for the replicates to estimate the approximately 2,200 person data items.
- Combine the replicate totals to estimate standard errors for the raked SDR (RakeSDR) and raked Jackknife (RakeJK) methods. Calculate the simple random sample standard errors and the design factors.
- There was no outlier control procedure.

Five sets of standard error estimates were available for analysis: Production (PROD) with the full outlier treatment, SDR, JK, RakeSDR, and Rake JK. Table 1 summarizes the differences which affect the standard error estimates for the five designs being examined. Except for outlier removal during the generalization process, PROD and SDR are equivalent.

**Table 1:** Design Characteristics

| | PROD | JK | SDR | Rake JK | Rake SDR |
|---|---|---|---|---|---|
| SAMPLING : Reflect variance reduction due to systematic sample | YES | NO | YES | NO | YES |
| ESTIMATION : Reflect variance reduction due to controlling estimates to census counts | Yes, but only for total population | | | Yes, for many subpopulation groups | |
| GENERALIZATION: Outlier Treatment | YES | NO | | | |

Since the RakeSDR approach reflects the variance gains of both the systematic sample design and the controls from the raking, these estimates should be our best estimate of the true standard errors or design factors. For PROD, SDR and JK, it should be expected that the standard error and design factor estimates overestimate the true standard errors because the variance reduction inherent in the raking procedure which reflects the estimation design is not obtained. Similarly, for JK and RakeJK, it should be expected that the standard error and design factor estimates overestimate the true standard errors because the variance reduction inherent in the systematic design is not reflected in the replicates.

The system to rake each replicate is designed to:

- Rake each replicate for SDR initial weights.
- Rake each replicate for JK initial weights.
- Calculate 2,200 item level design factors for PROD, SDR, JK, RakeJK, and RakeSDR for each weighting area.
- Calculate generalized standard error design factors for the five methods for 33 item groups, for 4 observed sampling rates, for the state based on the weighting area level estimates, the county level estimates, or the state level estimates.

It is now possible to compare the generalized standard errors from PROD, SDR, JK, RakeJK, and RakeSDR with the direct standard error from RakeSDR for each item.

### 2.4 Processing

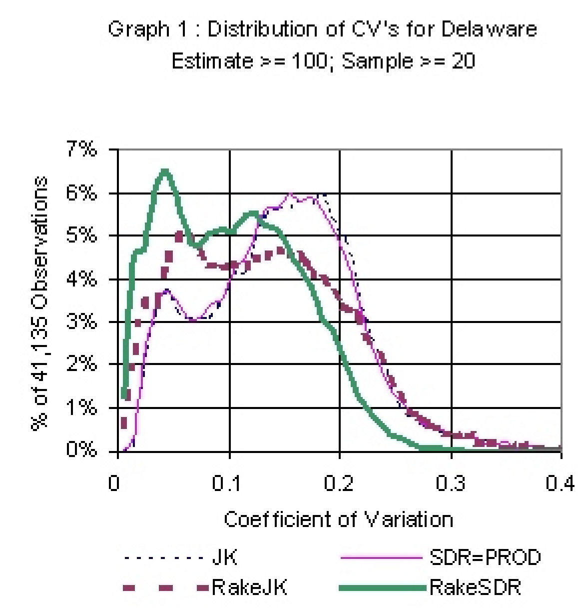
Wyoming was chosen as the first state in order to keep run time short while the system was being written and tested. The run time for Wyoming is about four hours. Run time is a function of the number of weighting areas in a state which is a function of population. Similar estimates for all states required about 2,000 hours of computer time which was much less than the original estimates. Several states can be run simultaneously. In a production mode, the time would be approximately halved because it would not be necessary to run both RakeJK and RakeSDR, but it would be doubled back to 2,000 hours because it would be necessary to run similar estimates for households and housing units, and doubled again if 100 percent verification were required. This is more than could have been comfortably handled in the production time frame.

An attempt was made to define weighting areas as all places with populations above certain cutoffs and all rest-of-counties. A new more efficient program was written to perform the weighting and raking. With these often much larger weighting areas, the results were disappointing when calculating tract-level estimates and they are not presented in this paper. However, the new system ran about four times faster per weighting area than the system for the original weighting area definition. In hindsight, this improved efficiency meant that raking each replicate for the original weighting areas might have been completed in a manageable time frame.

## 3. Results

### 3.1 Estimates of Coefficients of Variation

Many millions of estimates were run and it is not possible to analyze all of their standard errors. Many of the estimates are small with only one or two sample persons, so their error estimates are very erratic. When comparing error estimates it is usually preferable to compare the coefficients of variation (CV), the standard error divided by the estimate, to normalize the estimates. In Delaware there were 41,135 estimates greater than or equal to 100 with at least 20 sample persons. The distributions of their CVs for the four error estimation alternatives is given in Graph 1.




Approximately 94 percent of the RakeSDR CVs are less than 0.20 compared with only about 80 percent for the other methods. JK and SDR and PROD (SDR and PROD are equal at this point before outlier treatment) track together with a median CV at about 0.14, compared to about 0.10 for RakeSDR and 0.12 for Rake JK. These relative positions will be seen throughout this paper.

### 3.2 Estimates of the Design Factors

A comparison of the estimated design factors for the 33 person categories[2] for the four sampling rates shows the difference between the approaches. Some of these categories such as race and age are for the sample estimates of 100 percent data. For these estimates, census counts are available and were often exactly those used in the raking matrix. Other categories are for sample data estimates, such as poverty status, education, or employment status. Weighted averages are calculated by using the number of census persons in each of the 2,200 person-level estimates as the weights, so some persons are counted multiple times within a single design factor. Table 2 at the end of the paper shows that the average weighted design factors for PROD, SDR, and JK tend to be about the same, with SDR a little higher than PROD (because outliers were not reduced or down weighted), and JK usually a little higher than SDR. However, raking each replicate for RakeJK results in decreases for most design factors, and raking each replicate for RakeSDR leads to even greater decreases. Since RakeSDR reflects both the systematic sample design and the raking estimation design, it should provide the best estimates of the true variance; therefore, these "decreases" indicate that the production and other variance estimators overestimate the actual design factors and standard errors. The decreases are greater for those data categories that are controlled for by the raking or correlated with data categories controlled for by the raking. Race, Hispanic origin, and household type are good examples of the former type. Language spoken at home is correlated with Hispanic origin, so there is also a large decrease here. An interesting case is the age category. Many of the items are for single year of age but the raking matrix uses five-year categories and then collapses some of those. As a result there is a smaller reduction in the RakeSDR design factors for age than for race or Hispanic origin. However, there is a large reduction in the RakeSDR design factors for school enrollment which approximately measures the number of 5 to 18 year olds plus a sizeable fraction of the 19 to 22 year olds. The sample data categories related to labor force characteristics which were not controlled to by the raking show little gain.

Table 3 shows the weighted average of design factors for all studied characteristics, both long form and short form, and for the long form characteristics only. There is little advantage to the SDR method compared to PROD or JK. There are advantages to RakeSDR over RakeJK in capturing the gains of the systematic sample. RakeJK achieves some of the gains of RakeSDR but only for the low sampling rates. For the highest observed sampling rates, RakeJK yields the highest estimated design factors.

**Table 3 :** Average Weighted National Design Factors

| | Prod | JK | SDR | Rake JK | Rake SDR |
|---|---|---|---|---|---|
| All Data | 1.35 | 1.39 | 1.37 | 1.19 | 0.92 |
| Sample Data | 1.33 | 1.37 | 1.34 | 1.23 | 0.95 |
| SamRate<15% | 1.47 | 1.53 | 1.49 | 1.27 | 0.99 |
| 15-24.9% | 1.22 | 1.26 | 1.23 | 1.09 | 0.83 |
| 25-34.9% | 0.96 | 0.96 | 0.97 | 0.94 | 0.65 |
| ≥35% | 0.62 | 0.64 | 0.63 | 0.77 | 0.51 |
| State level | n/a | 1.39 | 1.38 | 1.18 | 0.93 |

### 3.3 Using the Design Factors

Instead of just comparing design factors, it is at least as important to consider the accuracy of the standard error estimates derived from the generalized design factors in estimating the true standard error for the particular items. After all, the published design factors are used to approximate the true standard errors. Since RakeSDR reflects both the sample design and the raking design, it should provide direct estimates of the standard errors for individual items that are closest to the true standard errors.

For each RakeSDR direct estimate of standard error, we have five possible generalized estimates of standard error based on the five sets of design factors: PROD, SDR, JK, RakeJK, and RakeSDR. Table 4 shows a weighted distribution of the generalized standard errors over the RakeSDR direct standard error. As should be expected, the RakeSDR generalized standard errors do a good job of reflecting the RakeSDR direct standard errors. For the RakeSDR about 33 percent of the weighted generalized standard errors are within 10 percent of the direct estimates (not shown in the table) and an additional 25 percent are within 20 percent. Less that 5 percent of the generalized estimates are more than twice the direct estimate. The other methods do not reflect the direct RakeSDR standard errors. The "bell shaped curves" are shifted about 0.25 to the right. Only about 10 percent of the generalized estimates are less than the corresponding direct estimates. Over 20 percent of the PROD, SDR, and JK generalized estimates are greater than twice the RakeSDR direct estimate. RakeJK has a smaller tail, about 12 percent, showing that its main advantage over PROD, JK, and SDR is that it reduces the most extreme cases but does little for most generalized estimates.

**Table 4 :** Distribution of Direct and Generalized SEs

| *GenSE* / *RakeSDR* | Method for Generalized SE | | | | |
|---|---|---|---|---|---|
| | PROD | JK | SDR | Rake JK | Rake SDR |
| 0.0 - 0.5 | 0.96% | 0.96% | 0.96% | 0.99% | 0.99% |
| 0.5 - 0.8 | 1.32% | 0.91% | 1.10% | 3.08% | 14.39% |
| 0.8 - 1.0 | 9.31% | 7.28% | 8.48% | 10.29% | 30.59% |
| 1.0 - 1.2 | 20.47% | 18.89% | 20.02% | 21.95% | 27.30% |
| 1.2 - 1.5 | 27.32% | 28.18% | 27.76% | 32.26% | 15.37% |
| 1.5 - 2.0 | 19.51% | 21.06% | 19.96% | 20.40% | 6.63% |
| 2 - 3 | 13.06% | 13.88% | 13.34% | 8.24% | 3.20% |
| 3 - 4 | 4.41% | 4.80% | 4.58% | 1.98% | 0.78% |
| 4 - 5 | 1.79% | 1.97% | 1.86% | 0.70% | 0.31% |
| > 5 | 2.79% | 3.03% | 2.87% | 0.99% | 0.48% |

### 3.4 Results for States

Table 5 shows the average of the weighting area design factors for the 33 data categories for the 50 states and the District of Columbia for all data, for long form characteristics, and for the short form (100%) characteristics. Raking for each replicate has a greater effect on the hundred percent characteristics because race, Hispanic origin, age, and household type are generally controlled for by the raking. The patterns for all states are about the same as the national pattern.

Estimates and design factors were also calculated at the state level from the weights calculated at the weighting area level. These estimates were averaged over the 33 data categories. The average weighted state level design factors shown at the bottom of Table 3. are 1.39 for JK, 1.38 for SDR, 1.18 for RakeJK, and 0.93 for RakeSDR, very close to the weighting area level factors. The average weighted differences between the design factors calculated at the weighting area level and design factors calculated at the state level are 0.024 for Jackknife, 0.001 for SDR, 0.023 for RakeJK, and 0.001 for RakeSDR. It can be concluded that the use of the averaged weighting area level design factors for estimates for larger areas is appropriate.

### 3.5 Comparison with 1990 Data

The estimates of design factors from Census 2000 can be compared with those from the 1990 Census. Because the ranges of observed sampling rate changed between 1990 and 2000, the most appropriate comparison is for weighting areas with an observed sampling rate less than 15 percent. It appears that the 1990 Census estimates are consistent with the Census 2000 estimates. The random groups method used in the 1990 Census did not capture the gains of the systematic sample. The raking and weighting was not replicated for each random group for each weighting area. Therefore, it seems reasonable that the 1990 design factors were probably also overestimates of the standard errors of the magnitude observed in 2000.

**Table 6 :** Comparison of Estimated Design Factors with 1990 Data

| | Method | all | Sam Rate < 15% | |
|---|---|---|---|---|
| | | weighted | weighted | unweighted |
| 2000 : | PROD | 1.35 | 1.47 | 1.40 |
| | JK | 1.39 | 1.53 | 1.48 |
| | SDR | 1.37 | 1.49 | 1.45 |
| | RakeJK | 1.19 | 1.27 | 1.31 |
| | RakeSDR | 0.92 | 0.99 | 1.04 |
| 1990 : | Random Groups | | | 1.42 |

## 4. Conclusion

### 4.1 Conclusions

Based in the observed results of this empirical study we are able to draw the following conclusions:

- RakeSDR is able to capture both the benefits of the systematic sample with the successive difference replication and the benefits of the raking. This option, which best reflects the sample design and which should therefore give the best estimates of standard errors, produces design factors lower than any of the other options. Thus, we conclude that the other options overestimate the long form standard errors.
- Raking the Jackknife initial weights for each replicate provides some of the advantages of RakeSDR compared to PROD, SDR, and JK, especially in controlling the worst overestimates involved in not raking for each replicate. However, raking for the Jackknife replicates is generally the worst option for areas with high sampling rates.
- The three approaches without raking for each replicate give about the same results. As should be expected, PROD does slightly better because the individual design factors are capped at 5.0 and controlled for outliers and the systematic design is reflected. SDR which captures the systematic design but does not control extreme design factors comes next, followed by JK which does neither.
- This paper shows that reflecting the estimation design in a variance system can be at least as

important as reflecting the sample design.

### 4.2 Limitations

Like all empirical studies, this one is also subject to limitations. Some of the limitations of this study are:

- The raking matrix used the same collapse pattern for all replicates. This could cause an underestimate of the standard errors. Most collapsing was implemented to assure a minimum sample size and successive difference replication changes the weights but not the sample size. Since different collapse patterns and potentially large increases in standard errors would have occurred only for the minority of instances where the replicate initially weighted sample differed from the full sample initially weighted sample across a specific threshold, the overall effect should not be too large.
- There was no outlier reduction or down weighting process for SDR, JK, RakeJK, or RakeSDR. A comparison of the PROD and SDR design factors gives an indication that this effect is small.
- No adjustment is made for imputed data in any of the estimates. For most data items, nonresponse is relatively low, but it is of concern for those items related to income or poverty status.
- Only the person-based estimates have been examined.
- There has been no testing of statistical significance of differences between the estimates of variance obtained by the five methods.

### 4.3 Further Research

The American Community Survey (ACS) is replacing the traditional long form estimates. However, these result results might be useful for developing the future research plans for the ACS or other Census Bureau programs.

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## Endnotes

1. The design factors for housing unit and household data were not calculated. The design factors for Group Quarters Type were calculated but not released. They are included in the estimates given in this paper. The design factors for urban/rural make little sense for most weighting areas. They are usually omitted. The observed sampling rate categories were less than 15 percent, 15 to 24.9 percent, 25 to 34.9 percent, and 35 percent and over.
2. Unfortunately, the income categories are household based and are produced in the housing unit portion of the systems. Thus, they are not available.
3. The weighted averages are calculated by using the number of census persons in each of the 2,200 estimates as the weights. Some persons are counted multiple times within a single design factor.

**Table 2 :** Weighted Average Design Factors for Sampling Rate less than 15 Percent

| Type | Original Weighting Areas | | | | |
|---|---|---|---|---|---|
| *Italics indicate sample data* | Prod | Jack-knife | Succ Diff | Rake JK | Rake SDR |
| All SamRate<15% | 1.47 | 1.53 | 1.49 | 1.27 | 0.99 |
| Age | 1.29 | 1.32 | 1.30 | 1.14 | 0.95 |
| Sex | 1.26 | 1.28 | 1.26 | 1.13 | 0.94 |
| Race | 2.16 | 2.24 | 2.17 | 1.08 | 0.74 |
| Hispanic Origin | 2.16 | 2.25 | 2.18 | 0.94 | 0.64 |
| *Marital Status* | 1.08 | 1.12 | 1.10 | 1.06 | 0.88 |
| Relationship | 1.13 | 1.18 | 1.15 | 1.05 | 0.84 |
| *Disability* | 1.37 | 1.41 | 1.38 | 1.46 | 1.22 |
| *Ancestry* | 1.84 | 1.89 | 1.86 | 1.86 | 1.36 |
| *Birth Place* | 1.48 | 1.54 | 1.51 | 1.37 | 1.08 |
| *Citizenship* | 1.64 | 1.70 | 1.66 | 1.70 | 1.30 |
| *1995 Res* | 1.98 | 2.04 | 1.98 | 2.03 | 1.43 |
| *Year of Entry* | 1.70 | 1.78 | 1.74 | 1.85 | 1.35 |
| *Language* | 1.53 | 1.59 | 1.55 | 1.06 | 0.79 |
| *Education* | 1.24 | 1.27 | 1.25 | 1.33 | 1.15 |
| *School Enroll* | 1.46 | 1.52 | 1.48 | 1.02 | 0.82 |
| HH Type | 1.13 | 1.18 | 1.15 | 1.05 | 0.84 |
| Family Type | 2.22 | 2.28 | 2.23 | 1.55 | 0.94 |
| GQ Type | 0.90 | 1.14 | 0.92 | 0.62 | 0.56 |
| Subfamily | 1.30 | 1.35 | 1.33 | 1.53 | 1.24 |
| *Employment Status* | 1.21 | 1.25 | 1.22 | 1.08 | 0.89 |
| *Industry* | 1.33 | 1.36 | 1.34 | 1.47 | 1.26 |
| *Occupation* | 1.28 | 1.30 | 1.28 | 1.42 | 1.23 |
| *Class Worker* | 1.35 | 1.38 | 1.35 | 1.38 | 1.16 |
| *Hours/Week* | 1.20 | 1.23 | 1.20 | 1.23 | 1.04 |
| *Workers/Family* | 1.27 | 1.28 | 1.26 | 1.34 | 1.19 |
| *Work Location* | 1.33 | 1.37 | 1.34 | 1.31 | 1.10 |
| *Transportation* | 1.36 | 1.40 | 1.37 | 1.35 | 1.12 |
| *Travel Time* | 1.31 | 1.37 | 1.34 | 1.49 | 1.27 |
| *Time Lv toWrk* | 1.30 | 1.35 | 1.32 | 1.48 | 1.26 |
| *Carpool* | 1.36 | 1.40 | 1.37 | 1.35 | 1.12 |
| *Person Poverty* | 1.54 | 1.63 | 1.60 | 1.26 | 0.93 |
| *Veteran Status* | 1.17 | 1.20 | 1.17 | 0.87 | 0.69 |
| *Grandparent Status* | 1.44 | 1.49 | 1.45 | 0.78 | 0.57 |

**Table 5** : Weighted Average Design Factors for States

| | All Data | | | | | Sample data | 100% data |
|---|---|---|---|---|---|---|---|
| | Prod | JK | SDR | Rake JK | Rake SDR | Rake SDR | Rake SDR |
| US | 1.35 | 1.39 | 1.37 | 1.19 | 0.92 | 0.95 | 0.80 |
| AL | 1.32 | 1.37 | 1.34 | 1.16 | 0.89 | 0.94 | 0.75 |
| AK | 1.17 | 1.22 | 1.19 | 1.08 | 0.83 | 0.86 | 0.71 |
| AZ | 1.46 | 1.50 | 1.47 | 1.26 | 0.98 | 1.02 | 0.84 |
| AR | 1.22 | 1.26 | 1.24 | 1.11 | 0.83 | 0.87 | 0.72 |
| CA | 1.49 | 1.54 | 1.50 | 1.31 | 1.00 | 1.04 | 0.88 |
| CO | 1.34 | 1.39 | 1.36 | 1.18 | 0.91 | 0.96 | 0.78 |
| CT | 1.35 | 1.40 | 1.36 | 1.17 | 0.91 | 0.95 | 0.80 |
| DE | 1.39 | 1.44 | 1.41 | 1.20 | 0.92 | 0.97 | 0.79 |
| DC | 1.44 | 1.49 | 1.46 | 1.29 | 0.99 | 1.03 | 0.87 |
| FL | 1.48 | 1.52 | 1.49 | 1.28 | 1.00 | 1.04 | 0.87 |
| GA | 1.44 | 1.50 | 1.46 | 1.25 | 0.96 | 1.01 | 0.81 |
| HI | 1.40 | 1.44 | 1.41 | 1.31 | 0.98 | 1.00 | 0.92 |
| ID | 1.27 | 1.30 | 1.28 | 1.13 | 0.87 | 0.91 | 0.75 |
| IL | 1.36 | 1.41 | 1.38 | 1.20 | 0.92 | 0.95 | 0.81 |
| IN | 1.35 | 1.39 | 1.36 | 1.18 | 0.92 | 0.95 | 0.81 |
| IA | 1.13 | 1.17 | 1.15 | 1.04 | 0.79 | 0.81 | 0.70 |
| KS | 1.24 | 1.27 | 1.24 | 1.10 | 0.84 | 0.87 | 0.74 |
| KY | 1.26 | 1.29 | 1.27 | 1.13 | 0.87 | 0.91 | 0.76 |
| LA | 1.33 | 1.37 | 1.34 | 1.17 | 0.90 | 0.94 | 0.77 |
| ME | 1.10 | 1.13 | 1.11 | 1.04 | 0.81 | 0.83 | 0.74 |
| MD | 1.41 | 1.46 | 1.43 | 1.23 | 0.95 | 0.99 | 0.83 |
| MA | 1.38 | 1.43 | 1.40 | 1.19 | 0.93 | 0.97 | 0.81 |
| MI | 1.23 | 1.26 | 1.24 | 1.10 | 0.85 | 0.87 | 0.76 |
| MN | 1.12 | 1.16 | 1.14 | 1.03 | 0.78 | 0.80 | 0.70 |
| MS | 1.31 | 1.36 | 1.32 | 1.16 | 0.88 | 0.93 | 0.74 |
| MO | 1.24 | 1.26 | 1.24 | 1.10 | 0.85 | 0.88 | 0.75 |
| MT | 1.10 | 1.13 | 1.12 | 1.03 | 0.78 | 0.81 | 0.69 |
| NE | 1.13 | 1.16 | 1.14 | 1.03 | 0.78 | 0.81 | 0.69 |
| NV | 1.52 | 1.57 | 1.54 | 1.31 | 1.02 | 1.07 | 0.88 |
| NH | 1.23 | 1.27 | 1.24 | 1.12 | 0.88 | 0.90 | 0.79 |
| NJ | 1.39 | 1.44 | 1.41 | 1.22 | 0.94 | 0.98 | 0.82 |
| NM | 1.38 | 1.42 | 1.39 | 1.23 | 0.95 | 0.99 | 0.83 |
| NY | 1.39 | 1.43 | 1.40 | 1.24 | 0.95 | 0.99 | 0.84 |
| NC | 1.34 | 1.39 | 1.36 | 1.17 | 0.90 | 0.94 | 0.75 |
| ND | 1.03 | 1.06 | 1.04 | 0.97 | 0.74 | 0.76 | 0.65 |
| OH | 1.27 | 1.31 | 1.29 | 1.12 | 0.87 | 0.90 | 0.77 |
| OK | 1.17 | 1.21 | 1.19 | 1.07 | 0.80 | 0.84 | 0.68 |
| OR | 1.34 | 1.39 | 1.37 | 1.18 | 0.91 | 0.95 | 0.78 |
| PA | 1.24 | 1.28 | 1.25 | 1.11 | 0.85 | 0.88 | 0.76 |
| RI | 1.39 | 1.45 | 1.42 | 1.22 | 0.96 | 1.00 | 0.84 |
| SC | 1.35 | 1.41 | 1.37 | 1.18 | 0.91 | 0.96 | 0.75 |
| SD | 1.06 | 1.10 | 1.08 | 1.00 | 0.75 | 0.78 | 0.66 |
| TN | 1.35 | 1.39 | 1.37 | 1.18 | 0.92 | 0.96 | 0.79 |
| TX | 1.40 | 1.45 | 1.42 | 1.23 | 0.94 | 0.98 | 0.81 |
| UT | 1.35 | 1.40 | 1.37 | 1.20 | 0.92 | 0.95 | 0.81 |
| VT | 0.99 | 1.01 | 0.99 | 0.98 | 0.73 | 0.75 | 0.67 |
| VA | 1.36 | 1.42 | 1.39 | 1.19 | 0.92 | 0.97 | 0.78 |
| WA | 1.37 | 1.42 | 1.39 | 1.20 | 0.94 | 0.98 | 0.80 |
| WV | 1.21 | 1.24 | 1.22 | 1.11 | 0.85 | 0.88 | 0.76 |
| WI | 1.13 | 1.17 | 1.15 | 1.04 | 0.79 | 0.81 | 0.71 |
| WY | 1.21 | 1.24 | 1.22 | 1.10 | 0.84 | 0.87 | 0.74 |