# AN ANALYSIS OF THE EFFECT OF INCOME ROUNDING IN THE CURRENT POPULATION SURVEY

by

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This paper analyzes a form of income reporting bias caused by income sample survey respondents reporting income in rounded or approximate amounts.

This paper makes 7 major points:

1. An income rounding bias exists.
2. Responses from "proxy" respondents show more bias than responses from persons who report their own income to the interviewer.
3. The propensity to round is directly related to income.
4. Female persons have more tendency to round income data than male persons.
5. The bias is found at all levels of income aggregation with respect to persons income.
6. The bias may affect the usefulness of the CPS income data for some very specialized uses.
7. There are several changes in procedures which will reduce the bias.

## Income Rounding Bias

It is well known that in any sample survey involving voluntary responses, such as the CPS, respondents do not always report exact income data. In fact, interviewers are specifically instructed to accept a reasonable estimate rather than report the income item as a non-response or "NA" (not available). This estimation bias has never been to my knowledge specifically quantified, although its presence has been recognized by many researchers. As a result of this bias, when income is tabulated by intervals which are less than $1,000 wide, the interval containing an exact thousand dollar amount or an exact $500 amount shows on extraordinarily high reporting frequency. This bias is most easily illustrated by a bar graph by $100 intervals. (see graph 1) this rather peculiar distribution is at variance with any of the usual income size distribution models (normal, lognormal, log-log).

## Proxy vs Self Reporting

In the CPS interview process interviewers are not required to interview every member of the household, but may accept information from a responsible and knowledgeable "proxy" respondent. There were 40,046 proxy respondents or 43.0 percent of the 93,193 persons 14 years old and over who responded to the March, 1970 CPS survey. As the horizontal percentages in table 1 show, over half of the responses for male persons were provided by proxy respondents, but only about 30 percent of the responses for females persons were made by proxy respondents.

The percent of total persons reporting income in the $n,000 - $n,099 (n=1 to .14) intervals who had proxy respondents is higher in all 14 income intervals than the percent reporting for themselves who reported in that interval. Above $4,000, the percent is higher than 25 percent in all intervals tabulated (see table 2).

## Propensity to Round Income Amounts

The propensity to round income amounts is in general directly related to the amount of income in the $1,000 to $15,000 range. As table 2 shows, the propensity to report income in the lowest $100 interval containing the exact thousand dollar amount increases as income increases. The tendency to round is very pronounced in the $10,000, $11,000, and $12,000 intervals. In several of the $1,000 intervals over 50 percent of the units reported the $n,000 to $n,099 interval (see table 2).

## Reporting by Male vs Female Persons

In general, female self respondents have more of a tendency to report in the $n,000 - $n,099 than male self respondents. In only 4 out of the 14 intervals are the percent of male higher or equal to the percent reporting in the lowest $100 of the $1,000 interval. (see table 2).

## Levels of Aggregation

The income rounding bias is present at all levels of aggregation, from a single type of income for a person to total family income. As Table 3 shows, the percent of persons reporting in the lowest $100 of an income class is higher for the individual income types than for total money income. This is true for both male and female respondents. The presence of the bias in total family income has been reported by this author in another paper. 1/

The degree in which the bias is present in persons total money income for persons and for total family income is the surprising aspect of the bias. It had been the assumption of this author and other researchers that as the eight individual income types were aggregated to total persons income and as persons income was aggregated to total family income, that the effect of the income bias would be greatly reduced if not elimated. However, it seem clear that the degree of the income bias exceeds

the expected amount.

Impact of the Rounding Bias

In general the rounding bias does not affect the March income data greatly. The March income supplement to the CPS is designed to collect general statistics on the National level. In this sense, I doubt if the cost of collecting more precise data would be justified by the benefit derived. However, for some specialized researchers, this may not be the case. More and more the March CPS file is being used as a microdata file and for these users the rounding bias may case problems. The possible impact of the income rounding bias on the analysis of the low income population and on econometric modeling is pointed out below. Also the impact on income interval means and interpolation is discussed.

Economic Models

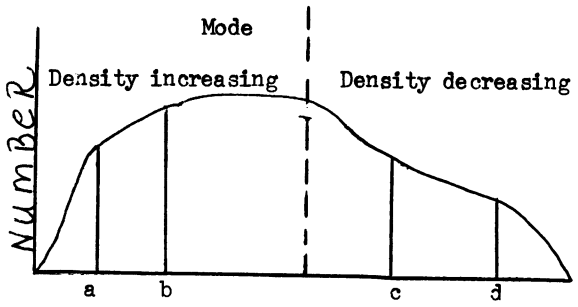
One use of the CPS March file is as input to economic models to evaluate the cost of effects of various programs. This is usually done by assigning different elegibility is dependent on income, the income reporting bias could be reflected by unexpected jumps in the number of eligibles as the qualification income threshold level is increases to include these discontinuous "Lumps" at thousand and five hundred dollar levels. I doubt that the income reporting bias would seriously effect the overall conclusion, but for specialized types of analysis it may.

Possible Impact on the Analysing Low Income Population

Since the low income thresholds are adjusted by the Consumer Price Index (CPI) each year, the rounding bias could cause abberations in the numbers of families classified as low income. For example, an increase in a low income threshold from 3,899 to 3,999 will increase the number of low income families less than an increase from 3,999 to 4,099. However, this aspect of the income rounding bias requires more analysis before its effect on changing the number of lower income families can be understood.

Income Interval Means

Another consequence of rounding reported income values is that the income class interval means are depressed. It is the "usual" practice to tabulate income in $1,000 or $500 intervals expect for high income values. For the intervals close to the class containing the mode income value, one can assume that the actual income values are distributed in the manner shown below. For the income class intervals below the mode (class ab for example), it is expected that the class means would fall above the midpoint $(\overline{ab} < \frac{b+2}{2})$. For the income class intervals above the mode (cd for example), it is expected that the class mean would fall below the midpoint $(\overline{cd} > \frac{c+d}{2})$.




However, this is not the case for class interval below the mode. As table 4 clearly shows the class intervals below the median (assumed to be close to the mode) the tabulated class falls well below the midpoint in the March Current Population Survey (CPS) income data. The Internal Revenue Service class means (table 4) falls slightly below the class midpoint but are much closer to the expected value than the CPS. The IRS data may also indicate some slight tendency for money to be paid in round amounts.

Interpolation for Median Income

It is standard practice to assume a linear distribution within a income class for the computations of the median income value. As can be seen from the $100 interval bar graph this appears to be wrong assumption (see graph 1-3). A negative exponentialfunction ($y = 1n\ e\ -x$) would be a better fit for the observed $100 interval values within a $1000 income class. However, since I believe the observed reporting pattern to be the result of a rounding bias, the assumption of a linear distribution may more closely conform with the true income distribution in the real world.

Reduction of the Income Bias

The income rounding bias could be reduced by several modifications in the instructions covering the field work on collecting the data. These are:

1. To the extent possible, interview the respondent personally.

2. To the extent possible, encourage the respondent to consult records for exact amounts rather than relying on memory.

3. Interviewers should be less willing to accept estimates.

While these modifications will reduce the income rounding bias they will also increase cost of field work and probably increase the income nonresponse rate. These tradeoffs would have to be considered implementing the proposed modifications.

Tabulation Modification

The importance of the bias can be reduced by tabulating data in $1000 intervals which start

with the $500 level. For example, under $500, $500 to $1499, $1500 to $2499, $2500 to $3499, etc. Also it must be recognized that tabulation by intervals less than $1000 in size will result in some distortion of the data.

## Conclusions

The data presented in this paper clearly show the presence of an income rounding bias. The hypothesis that the bias is caused by respondents reporting in exact thousand dollar amount and to a lesser extent in exact five hundred dollar amount has been established but not proven. Further investigation of this subject is being planned. This will require tabulation of persons reporting exactly an exact thousand dollar amount and file hundred dollar amount.

1/ "The Index of Income Concentration in the 1970 Census of Population and Housing", Joseph J. Knott, ASA Proceedings of the Social Science Section 1971.

Table 1.--Respondents 14 Years Old and Over by Sex and Self vs. Proxy Reporting Status in 1969

| | Total | Self | Proxy |
|---|---|---|---|
| Total | 93,192 | 53,146 | 40,046 |
| Male | 42,619 | 17,614 | 25,005 |
| Female | 50,573 | 35,532 | 15,041 |
| Horizontal Percent | | | |
| Total | 100.0 | 57.0 | 43.0 |
| Male | 100.0 | 41.3 | 58.7 |
| Female | 100.0 | 70.3 | 29.7 |
| Vertical Percent | | | |
| Total | 100.0 | 100.0 | 100.0 |
| Male | 45.7 | 33.1 | 62.4 |
| Female | 54.3 | 66.9 | 37.6 |

Table 2.--Number of Units Reporting Total Money in the $n,000 - $n,099 Interval as a Percent of the Units in the $n,000 - $n,099 Interval by Self and Proxy

| Total Money Income | Percent of Units in $n,000 - $n,099 Intervals | | | | | |
|---|---|---|---|---|---|---|
| | Total | | Male | | Female | |
| | Self | Proxy | Self | Proxy | Self | Proxy |
| $1,000 - $1,999 | 14.0 | 16.1 | 11.6 | 15.1 | 15.1 | 18.4 |
| $2,000 - $2,999 | 16.8 | 20.1 | 14.3 | 18.7 | 18.1 | 22.2 |
| $3,000 - $3,999 | 18.7 | 20.7 | 17.4 | 19.3 | 19.4 | 22.7 |
| $4,000 - $4,999 | 20.2 | 22.0 | 18.9 | 20.7 | 20.9 | 24.1 |
| $5,000 - $5,999 | 22.1 | 25.3 | 21.1 | 22.9 | 23.0 | 31.3 |
| $6,000 - $6,999 | 23.6 | 26.1 | 21.7 | 24.7 | 25.7 | 32.8 |
| $7,000 - $7,999 | 18.9 | 24.2 | 19.0 | 22.8 | 18.7 | 35.1 |
| $8,000 - $8,999 | 24.0 | 27.7 | 23.4 | 27.1 | 25.6 | 35.2 |
| $9,000 - $9,999 | 22.7 | 28.5 | 22.5 | 27.9 | 23.8 | 40.7 |
| $10,000 - $10,999 | 29.8 | 35.3 | 29.8 | 35.4 | 29.8 | 54.2 |
| $11,000 - $11,999 | 27.5 | 31.1 | 28.3 | 30.7 | 23.2 | 42.4 |
| $12,000 - $12,999 | 32.7 | 40.3 | 32.1 | 39.9 | 36.2 | 52.0 |
| $13,000 - $13,999 | 26.6 | 31.6 | 26.0 | 30.9 | 31.2 | 58.3 |
| $14,000 - $14,999 | 26.7 | 28.5 | 27.0 | 28.4 | 24.3 | 40.0 |

NOTE: See Table 3 for details.

TABLE 3.-- Percent of Persons 14 Years Old or Over who Reported Income of the Specified Type and Reported in the Lowest $100 of the Specified $1000 Interval in 1969 by Sex and Reporting Status (Self vs. Proxy)

| Income Level $n,000 | Percent of Units In the $n,000 - $n,099 Interval | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SELF | | | | | | | | | PROXY | | | | | | | |
| | Total Money Income | Wages and Salaries | Nonfarm Self-Employed | Farm Self-Employed | Social Security & Railroad Retirement | Dividends Interest Net Rent ect | Public Assistance | Public Transfers | Private Pensions, Annuities, Alimony, ect | Total Money Income | Wages and Salaries | Nonfarm Self-Employed | Farm Self-Employed | Social Security & Railroad Retirement | Dividends Interest Net Rent ect | Public Assistance | Public Transfers | Private Pensions Annuities |
| MALE | | | | | | | | | | | | | | | | | |
| 1000 - 1999 | 11.6 | 12.8 | 25.6 | 22.0 | 8.1 | 24.3 | 25.6 | 24.6 | 14.6 | 15.1 | 17.1 | 37.1 | 30.4 | 9.8 | 24.3 | 29.9 | 16.9 | 18.1 |
| 2000 - 2999 | 14.3 | 22.1 | 38.3 | 37.4 | 12.4 | 29.1 | 13.3 | 10.2 | 13.3 | 18.7 | 22.9 | 38.1 | 35.8 | 14.6 | 24.9 | 11.1 | 12.7 | 18.2 |
| 3000 - 3999 | 17.4 | 21.9 | 40.0 | 37.5 | 20.3 | 42.3 | 17.6 | 15.1 | 26.9 | 19.3 | 20.8 | 54.4 | 43.1 | 12.5 | 39.0 | 9.1 | 28.3 | 40.6 |
| 4000 - 4999 | 18.9 | 23.4 | 42.1 | 50.0 | 20.0 | 37.2 | 16.7 | 20.3 | 25.0 | 20.7 | 23.3 | 38.0 | 48.9 | 7.7 | 37.7 | 20.1 | 15.4 | 42.1 |
| 5000 - 5999 | 21.1 | 24.1 | 61.1 | 44.6 | (B) | 52.3 | - | 15.0 | 45.2 | 22.9 | 26.5 | 48.1 | 40.0 | (B) | 50.0 | (B) | 20.0 | 44.4 |
| 6000 - 6999 | 21.7 | 23.9 | 62.0 | 40.5 | (B) | 54.5 | (B) | 36.4 | 36.4 | 24.7 | 27.6 | 56.6 | 36.7 | (B) | 40.0 | (B) | 33.3 | (B) |
| 7000 - 7999 | 19.0 | 21.4 | 43.8 | 65.2 | (B) | 28.6 | - | 22.2 | 33.3 | 22.8 | 25.2 | 49.3 | 51.9 | - | 25.0 | (B) | 28.6 | (B) |
| 8000 - 8999 | 23.4 | 27.3 | 55.8 | 45.8 | - | 40.0 | (B) | 37.5 | 40.0 | 27.1 | 32.7 | 69.4 | 36.8 | - | 37.5 | - | 14.3 | (B) |
| 9000 - 9999 | 22.5 | 28.7 | 62.2 | 50.0 | (B) | 46.7 | - | 36.4 | (B) | 27.9 | 32.0 | 61.5 | 66.7 | - | 14.3 | - | 57.1 | (B) |
| 10000 - 10999 | 29.8 | 39.2 | 75.7 | 72.7 | - | 68.4 | - | (B) | 40.0 | 35.4 | 43.3 | 83.8 | 76.5 | - | 56.3 | - | (B) | (B) |
| 11000 - 11999 | 28.3 | 42.3 | 72.7 | 83.3 | - | 57.1 | - | (B) | (B) | 30.7 | 41.3 | 54.5 | 50.0 | - | (B) | - | - | - |
| 12000 - 12999 | 32.1 | 52.4 | 84.6 | 77.8 | - | 50.0 | - | 40.0 | (B) | 39.9 | 54.9 | 76.8 | 83.3 | - | (B) | - | (B) | - |
| 13000 - 13999 | 26.0 | 45.5 | 72.2 | 60.0 | - | 33.0 | - | - | (B) | 30.9 | 42.5 | 46.2 | (B) | - | (B) | - | (B) | (B) |
| 14000 - 14999 | 27.0 | 39.0 | 70.0 | 33.3 | - | (B) | - | - | - | 28.4 | 38.6 | 75.0 | (B) | - | 0.0 | - | - | (B) |
| FEMALE | | | | | | | | | | | | | | | | | | |
| 1000 - 1999 | 15.1 | 16.9 | 24.4 | 25.7 | 16.5 | 22.3 | 22.2 | 17.0 | 14.1 | 18.4 | 18.2 | 31.8 | (B) | 21.8 | 24.6 | 26.4 | 21.1 | 20.2 |
| 2000 - 2999 | 18.1 | 19.9 | 37.7 | 30.0 | 13.4 | 27.1 | 14.8 | 20.5 | 17.5 | 22.2 | 22.5 | 29.4 | (B) | 36.4 | 32.4 | 21.4 | 11.1 | 22.2 |
| 3000 - 3999 | 19.4 | 21.0 | 32.6 | 28.6 | 13.2 | 30.3 | 15.8 | 14.3 | 24.5 | 22.7 | 23.7 | 46.2 | (B) | (B) | 25.0 | 0.0 | (B) | 66.7 |
| 4000 - 4999 | 20.9 | 23.6 | 41.4 | (B) | 26.5 | 28.1 | 8.0 | 29.2 | 19.5 | 24.1 | 25.6 | 12.5 | - | (B) | 33.3 | (B) | (B) | 33.3 |
| 5000 - 5999 | 23.0 | 26.1 | 47.2 | 42.9 | (B) | 37.9 | (B) | 30.0 | 29.4 | 31.3 | 32.9 | (B) | - | - | 66.7 | (B) | (B) | - |
| 6000 - 6999 | 25.7 | 27.9 | 45.5 | 33.3 | (B) | 37.5 | (B) | (B) | 50.0 | 32.8 | 34.2 | (B) | (B) | - | (B) | - | (B) | (B) |
| 7000 - 7999 | 18.7 | 19.8 | 38.5 | - | (B) | 30.8 | (B) | (B) | 0.0 | 35.1 | 37.7 | - | - | - | 62.5 | - | - | (B) |
| 8000 - 8999 | 25.6 | 31.0 | 40.0 | - | - | 69.2 | - | (B) | (B) | 35.2 | 37.0 | (B) | - | (B) | (B) | - | - | - |
| 9000 - 9999 | 23.8 | 30.6 | (B) | - | (B) | 36.4 | - | (B) | 40.0 | 40.7 | 37.9 | (B) | - | (B) | (B) | - | (B) | (B) |
| 10000 - 10999 | 29.8 | 33.3 | 63.6 | (B) | - | 81.8 | - | - | (B) | 54.2 | 57.1 | (B) | - | - | (B) | - | - | (B) |
| 11000 - 11999 | 23.2 | 36.9 | (B) | - | - | 40.0 | - | (B) | (B) | 42.4 | 57.7 | (B) | - | - | (B) | - | - | - |
| 12000 - 12999 | 36.2 | 49.3 | (B) | - | - | 80.0 | - | - | (B) | 52.0 | 55.6 | (B) | - | - | (B) | - | - | - |
| 13000 - 13999 | 31.2 | 51.7 | (B) | - | - | 16.7 | - | - | (B) | 58.3 | 60.0 | (B) | - | - | - | - | - | - |
| 14000 - 14999 | 24.3 | 35.0 | (B) | - | - | - | - | - | - | 40.0 | 66.7 | - | - | - | - | - | - | - |

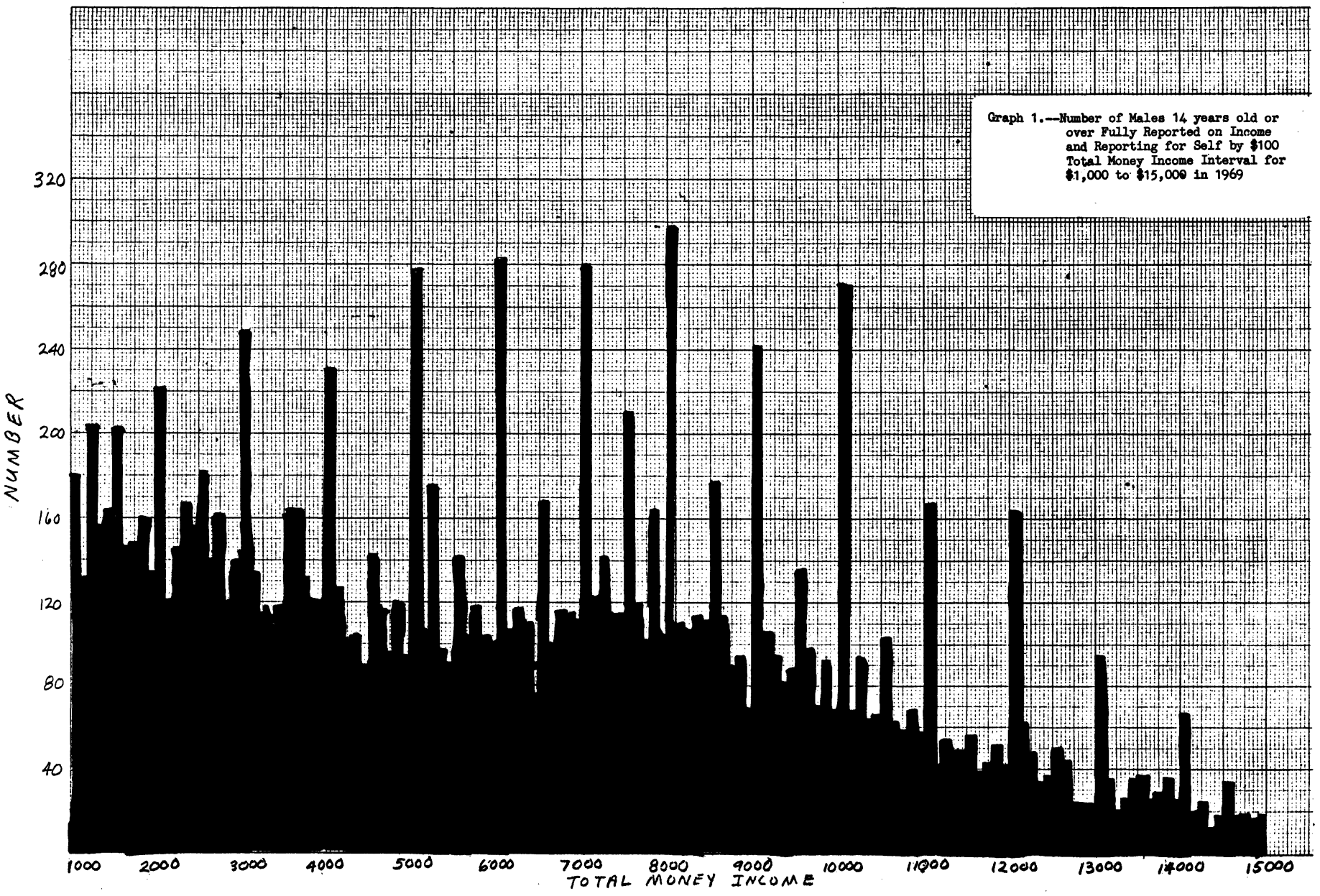
(B) - Base less than 5 - NONE

$$\text{Percent} = \frac{\text{number } \$n,000 - \$n,099}{\text{number } \$n,000 - \$n,999} \times 100$$

TABLE A.--Mean Income of Specified Type by Size Class for Males 14 years Old and Over Reporting for Self in 1969 and All Individual Income Tax Returns in 1968

| Income of Specified Type | Mean Income of Specified Type: CPS Males Reporting for Self with Specified Type of Income: Total | Wages and Salaries | Nonfarm Self-Employed | Farm Self-Employed | Social Security Railroad Retirement | Dividends Interest Net Rent Oct. | Public Assistance | Public Transfers | Private Pensions, Annuities Ect. | All Returns with Specified Type of Income: Adjusted Gross Income | Wages and Salaries | Business or Profession Net Profit | Farm Net Profit | Dividends | Interest |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL | NA | NA | NA | NA | NA | NA | NA | NA | NA | $ 8,783 | $6,839 | $6403 | $2993 | $1355 | $540 |
| Under $1000 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 938 | 502 | 449 | 413 | 191 | 196 |
| $1000 to 1999 | $ 1475 | $ 1438 | $ 1393 | $ 1378 | $ 1486 | $ 1332 | $ 1373 | $ 1331 | $ 1436 | 1483 | 1472 | 1462 | 1434 | 1402 | 1408 |
| 2000 to 2999 | 2465 | 2403 | 2324 | 2313 | 2395 | 2330 | 2470 | 2476 | 2416 | 2492 | 2486 | 2473 | 2468 | 2446 | 2433 |
| 3000 to 3999 | 3452 | 3424 | 3296 | 3325 | 3395 | 3283 | 3364 | 3451 | 3416 | 3502 | 3498 | 3478 | 3464 | 3450 | 3433 |
| 4000 to 4999 | 4433 | 4426 | 4287 | 4273 | 4402 | 4315 | 4216 | 4457 | 4401 | 4497 | 4493 | 4474 | 4484 | 4483 | 4437 |
| 5000 to 5999 | 5410 | 5386 | 5180 | 5248 | (B) | 5234 | - | 5392 | 5230 | 5500 | 5493 | 5471 | 5483 | | |
| 6000 to 6999 | 6424 | 6408 | 6204 | 6354 | (B) | 6256 | (B) | 6341 | 6367 | 6500 | 6493 | 6476 | 6504 | | |
| 7000 to 7999 | 7432 | 7410 | 7277 | 7185 | - | 7391 | - | 7391 | 7375 | 7500 | 7508 | 7479 | 7490 | 6921 | 6647 |
| 8000 to 8999 | 8390 | 8366 | 8210 | 8282 | (B) | 8313 | (B) | 8356 | 8434 | 8489 | 8495 | 8476 | 8447 | | |
| 9000 to 9999 | 9401 | 9367 | 9195 | 9295 | - | 9260 | - | 9366 | (B) | 9489 | 9489 | 9475 | 9478 | | |
| 10000 to 10999 | 10358 | 10295 | 10105 | 10109 | - | 10142 | - | (B) | 10360 | | | | | | |
| 11000 to 11999 | 11376 | 11279 | 11104 | 11033 | - | 11257 | - | (B) | (B) | | | | | | |
| 12000 to 12999 | 12315 | 12217 | 12071 | 12113 | - | 12210 | - | 12220 | (B) | | | | | | |
| 13000 to 13999 | 13393 | 13279 | 13122 | 13160 | - | 13266 | - | - | (B) | 16836 | 14,690 | 22,427 | 16,185 | 31,971 | 19,003 |
| 14000 to 14999 | 14386 | 14301 | 14090 | (B) | - | (B) | - | - | (B) | | | | | | |
| 15000 and over | NA | NA | NA | NA | NA | NA | NA | NA | NA | | | | | | |

NA- Not Available (B) - Base less than 5




Graph 1.--Number of Males 14 years old or over Fully Reported on Income and Reporting for Self by $100 Total Money Income Interval for $1,000 to $15,000 in 1969