THE EVOLUTION OF ROTATION GROUP BIAS: WILL THE REAL UNEMPLOYMENT RATE PLEASE STAND UP?

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Abstract—We document that rotation group bias—the tendency for the unemployment rate to vary systematically by month in sample—in the Current Population Survey (CPS) has worsened over time. Estimated unemployment rates for earlier rotation groups have grown sharply relative to later rotation groups; both should be nationally representative samples. This bias increased discretely after the 1994 CPS redesign, and rising nonresponse rates are likely a significant contributor. Survey nonresponse increased after the redesign, mirroring the evolution of rotation group bias. Consistent with this explanation, rotation group bias for households that responded in all eight interviews remained stable over time.

I. Introduction

MANY countries' labor force surveys use a rotating panel structure to improve the precision of estimated changes in labor force statistics. In these surveys, households selected into the sample are interviewed several times. In the Current Population Survey (CPS), households are interviewed for four consecutive months, not interviewed for the next eight months, and then interviewed for an additional four months. In any given month, there are eight rotation groups, depending on the month in which their dwelling was first selected into the sample. Each rotation group should form a representative sample of the population, with the same labor force characteristics, apart from sampling errors. This is not the case, however. In 2014, for example, the unemployment rate for the first and last rotation groups in the CPS were 7.0% and 5.8%, respectively.[1] The official unemployment rate for this period was 6.2%. These differences raise the obvious question: What was the unemployment rate in 2014? Why does the unemployment rate vary across rotation groups?

A systematic tendency for differences in estimates across rotation groups is referred to as rotation group bias. Bailar (1975) was among the first to document rotation group bias in the CPS. Using data from 1968 to 1972, she found that the unemployment rate estimated from different rotation groups in the same time period were systematically different. These differences came from the margin of out of the labor force rather than employment. She documented a tilted W-shaped pattern, with the first and fifth rotation groups having the highest unemployment rates and slight upticks in the fourth and eighth rotation groups. In this paper, we estimate the magnitude of rotation group bias in the CPS from 1976 to 2014. We find that the magnitude and shape of this bias have evolved and grown significantly over time.

Figure 1A shows the annual average unemployment rate for each rotation group, and figure 1B shows the same data with the official unemployment rate subtracted from each measure. It is clear that there is a secular trend, with the unemployment rate calculated for households in their first interview (first rotation group) rising relative to the official measure, and the unemployment rate calculated for households in their final interview (eighth rotation group) falling relative to the official rate. A symmetric 95% confidence interval for the mean unemployment rate of the eight rotation groups each year is shown in figure 1C under the maintained assumption that the rotation groups have a common mean each year; it indicates a small rise in the width of the confidence interval after the 1994 CPS redesign (see the online appendix figure B1 for the width of the confidence interval). The growing divergence between the first and eighth rotation groups, however, does not support the assumption of a common mean.[2] The differential secular patterns are a vivid motivation for trying to understand the source of the evolving pattern of rotation group bias in the CPS.

Although the presence of rotation group bias is not necessarily informative about the bias of the estimated unemployment rate—and all eight rotation groups could each provide a biased estimate—the rising discrepancies over time suggest possible problems with the survey design. We find that the magnitude of rotation group bias jumped after 1993 and increased thereafter faster than the preexisting trend. Evidence presented here suggests that the 1994 CPS redesign played an important role in the increase in rotation group bias. The 1994 redesign included expanded use of computer-assisted telephone interviewing, introduction of dependent interviewing, and changes in the phrasing and skip logic of some labor force questions; it coincided with a discrete rise in nonresponse rates. The redesign could have changed the

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[1] All estimates in this study use the final weights from the CPS unless otherwise noted.

[2] Under the assumption that eight estimators from different rotation groups are independent and normally distributed with a common mean and possibly different variances, a standard t-test with 7 degrees of freedom based on the eight estimates from different rotation groups provides valid and efficient inference for scalar parameters (Ibragimov & Müller, 2010). Using that result, we find that the range of the 95% confidence interval for the annual unemployment rate increased from under 0.4 percentage points prior to the early 1990s to over 0.6 percentage points in recent years (figure B1). Of course, estimates from different rotation groups may have different means. We reject the hypothesis that the estimates from rotation groups 1 and 8 have the same mean at the 5% level using data from 2005 to 2014 and the test proposed by Ibragimov and Müller (2016). We thank an anonymous referee for this suggestion.

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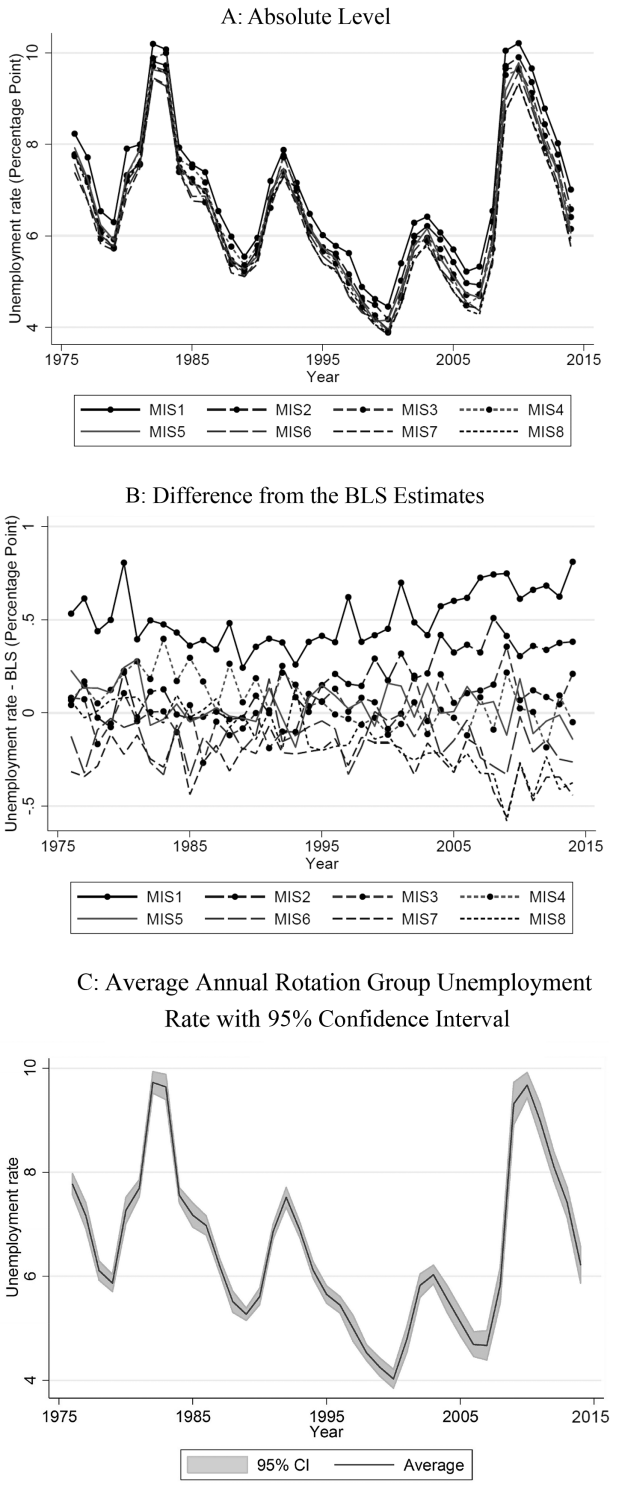
FIGURE 1.—UNEMPLOYMENT RATE BY ROTATION GROUP AND YEAR, 1976–2014



The estimates are based on the CPS monthly files from January 1976 to December 2014. (A) The unemployment rate by MIS and year. (B) The difference between the annual unemployment rate by MIS and the annual unemployment rate published by the BLS. (C) The annual average unemployment rate with 95% confidence interval for the mean of the eight rotation groups.

pattern of rotation group bias through at least two channels: (a) increased survey nonresponse, which changed the composition of respondents across months in sample, and (b) a changed response pattern due to the introduction of dependent interviewing and a new questionnaire and interview format. We conclude that rising nonresponse is likely a significant contributor to the change in rotation group bias.

II. Data

The CPS is a monthly survey of the labor force in the United States with about 60,000 households interviewed for each survey. It is based on a sample of physical addresses with eight panels in a 4-8-4 rotation scheme. For each monthly survey, eight groups of respondents are identified by the month in sample (MIS) of their residences.

This study uses the CPS basic monthly surveys collected between January 1976 and December 2014. The CPS underwent a major redesign in 1994. The most important change was a shift from a paper-based to a computer-based questionnaire.[3] New phrasing and skip logic were also introduced for some labor force questions. In particular, the shift to a computer-based questionnaire permitted dependent interviewing, which uses information from a previous interview (often combined with answers to other questions) to update information for the current interview. The use of information from other sources reduced respondent burden and allowed the inclusion of additional questions.

We analyze the pattern in the Bureau of Labor Statistics (BLS) recoded labor force status across MIS. Observations are weighted by final weights. Additional details of our sample are available in online appendix A.

III. The Evolution of Rotation Group Bias in the CPS

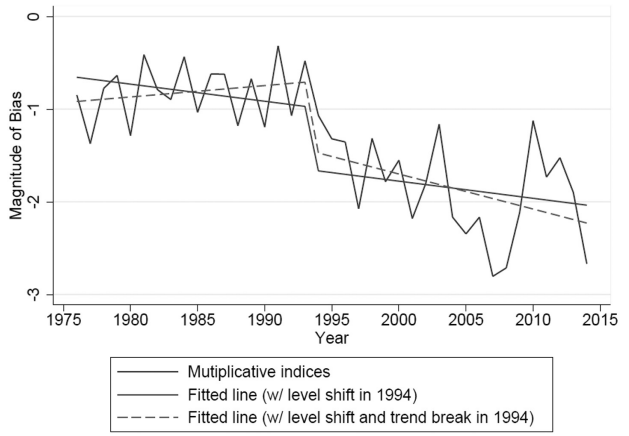
Following Solon (1986), we focus on a multiplicative model to estimate rotation group bias.[4] The multiplicative index for a rotation group is computed by dividing the estimate for that rotation group by the average estimate over all eight rotation groups in the relevant time period and multiplying by 100. If there is no rotation group bias, the multiplicative index should be 100 for all rotation groups.

We use the slope of the fitted line through multiplicative indices with respect to MIS as an approximate summary measure of the magnitude of rotation group bias. Specifically, we regress the multiplicative indices on a variable running from 1 to 8 representing the rotation group. Figure 2 plots these slopes for the unemployment rate by year. In all years from 1976 to 2014, the slope is negative, implying

[3] Prior to the 1994 redesign, interviews in MIS1 and MIS5 were conducted in person. In other months, a majority of the interviews were conducted over the phone. Most of the interviews were conducted with a paper-based questionnaire; only about 9% of the data were collected by computer-assisted telephone interviewing (CATI) facilities (Polivka & Miller, 1998). After the redesign, the new questionnaire was designed solely for computer-assisted interviewing, and an increasing number of interviews have been conducted by CATI.

[4] Bailar (1975) argued that the estimates of month-to-month changes are unbiased if the rotation group effects are constant over time and the effects are additive. Solon (1986) showed that the estimates of changes would be biased if the rotation group effects are multiplicative. Solon also provided empirical evidence that rejects the assumption of additive rotation group effects.

FIGURE 2.—MAGNITUDE OF ROTATION GROUP BIAS IN UNEMPLOYMENT RATE OVER TIME, 1976–2014



The estimates are based on the CPS monthly files from January 1976 to December 2014. The figure plots the magnitude of rotation group bias by year. The multiplicative index is estimated by dividing the estimate in a given rotation group by the average estimate over all eight rotation groups and multiplying by 100. The slope, or the magnitude of rotation group bias, is the linear slope of multiplicative indices with respect to MIS. The solid line is the fitted line of the magnitude of bias allowing for a linear time trend and a level shift between 1993 and 1994. The dashed line is the fitted line of the magnitude of bias allowing for a linear time trend, a level shift between 1993 and 1994, and a trend break between 1993 and 1994.

that the estimated unemployment rates generally decrease with MIS.[5] The magnitude of the bias measure can be interpreted as the percent change in the labor force statistic from an incremental interview month. For example, the value of −1 in 1994 implies that, on average, every incremental MIS was associated with a decline in the measured unemployment rate by 1%.[6]

Figure 2 shows that the magnitude of the bias for the unemployment rate increased over time and almost doubled in absolute value following the 1994 CPS redesign. To assess the significance of this increase, we fit the slope measure of bias to a linear time trend, a post-1993 dummy (solid line) and, in a second specification, their interaction (dashed line). These regressions are shown in the first two columns of table 1, and the fitted values are displayed in figure 2.[7] The results show statistical evidence of a level shift in 1994, with the post-1993 dummy statistically significant in both specifications.[8] The time-post-93 interaction

TABLE 1.—MAGNITUDE OF ROTATION GROUP BIAS IN UNEMPLOYMENT RATE AND TYPE A NONINTERVIEW OVER TIME, 1976 –2014

	(1)	(2)	(3)
Time	−0.018	0.012	0.006
	(0.012)	(0.019)	(0.017)
Post-93	−0.678**	−0.727**	−0.428
	(0.280)	(0.269)	(0.299)
Time×Post-93		−0.050**	
		(0.024)	
Type A			−0.208*
			(0.108)
Constant	−0.968***	−0.707***	0.150
	(0.148)	(0.190)	(0.598)
N	39	39	39
R^2	0.611	0.653	0.648

The estimates are based on the CPS monthly files from January 1976 to December 2014. The unit of observation is calendar year. The dependent variable is the magnitude of rotation group bias in unemployment rate as described in the notes to figure 2. "Time" is a linear time trend. "Post-93" is an indicator variable for years after 1993. "Time × Post-93" is the interaction of "Time" and "Post-93." "Type A" is the number of type A noninterview households divided by the sum of interviewed households and type A noninterview households. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

indicates that the magnitude of rotation group bias also gradually increased over time after 1993.

The shape of the rotation group pattern with respect to MIS also evolved over time. Table 2 presents average multiplicative indices of several labor force statistics for the 1976–1993 and 1994–2014 periods. Prior to the 1994 redesign, the index of the unemployment rate exhibits a mildly tilted W shape: it decreases after MIS1 and MIS5, with upticks in MIS4 and MIS8, consistent with Bailar's (1975) findings. Since 1994, the index of the unemployment rate decreases monotonically with MIS, with a small uptick in MIS5. The index for the number of unemployed workers shows a similar pattern to that of the unemployment rate.

Table 2 also shows that rotation group bias is small for the number of employed persons. This finding suggests that rotation group bias in the unemployment rate is not driven by whether respondents are classified as being employed (see also the results for "not working last week" in table 3). Instead, rotation group bias in unemployment results from the margin between being classified as unemployed and out of the labor force.[9]

Table 3 explores how the response to labor force questions changed after the 1994 redesign and whether the increased rotation group bias may be explained by bias in the different components of the definition of unemployment by the BLS. We compute the fraction of respondents who stated they are on layoff, were not employed in the previous week, looked for a job in the previous four weeks, and are available for work. The denominator for these rates is the number of people in the population. For these measures, we report multiplicative indices, as with the unemployment rate.

Consistent with the results in table 2, we observe only a small change in the rotation group pattern on the employ-

[5] Figure B2 presents rotation group indices of the unemployment rate by MIS and year, along with the slope of the fitted line. Other measures of rotation group bias, including the slope of additive indices (figure B3), coefficient of variation, and variance of the logarithm of multiplicative indices, yield similar rotation group patterns over time.

[6] Note that the rotation groups are balanced each year. The number of individuals in their first month of interview is roughly the same across calendar months, as is the number of individuals in other months of interview. Seasonality does not play a role in explaining the pattern of rotation group bias.

[7] Formally, this can be viewed as a method of moments approach. We find qualitatively similar results if we estimate an MA(2) model to account for possible autocorrelation in the errors across years due to the rotation group design of the CPS. For example, the coefficient and standard error for the Post-93 dummy variable in column 1 is −.604 (.332).

[8] We also used the Bai and Perron (1998) test to identify structural breaks in the time series of rotation group bias. The test identifies the third quarter of 1996 as the last period prior to the structural break, and we cannot reject that the structural break occurred in 1994. A 90% confidence interval runs from the second quarter of 1993 to the third quarter of 1997.

[9] The individual weights in CPS are adjusted to account for nonresponses. The unweighted estimates have a very similar magnitude and pattern of rotation group bias over time. Thus, individual characteristics used for weighting adjustment could not explain the rotation group bias or its variation over time.

TABLE 2.—MULTIPLICATIVE INDICES OF ROTATION GROUP BIAS IN LABOR FORCE STATISTICS, 1976–2014

	1	2	3	4	5	6	7	8	Mean	Slope	SE
1976–1993											
Number unemployed	107.5	100.3	98.5	102.2	100.1	96.8	95.3	99.4	12,036	−1.05	0.047
Number employed	101.1	100.2	99.9	100.2	99.9	99.5	99.4	99.8	159,438	−0.18	0.013
Unemployment rate	105.8	100.1	98.7	101.8	100.2	97.6	96.2	99.6	7.0	−0.81	0.046
1994–2014											
Number unemployed	110.9	105.0	101.3	99.0	99.7	95.9	93.9	94.3	13,440	−2.22	0.052
Number employed	101.0	100.6	100.4	100.2	99.7	99.2	99.3	99.6	206,487	−0.25	0.012
Unemployment rate	109.2	104.1	100.8	98.9	100.1	96.9	94.9	95.1	6.1	−1.85	0.050

The estimates are based on the CPS monthly files from January 1976 to December 2014. The estimation of multiplicative indices is described in the notes to figure 2. The table presents the average annual estimates of three labor force statistics by MIS: the number of unemployed workers, the number of employed workers, and unemployment rate. The table also presents the average labor force statistics over eight rotation groups, the slope of those indices with respect to MIS, and bootstrapped standard errors of the slope based on 500 draws. The counts are in thousands.

TABLE 3.—MULTIPLICATIVE INDICES OF ROTATION GROUPS BIAS IN THE FRACTION OF THE POPULATION BY RESPONSE TO UNEMPLOYMENT QUESTIONS, 1976–2014

	1	2	3	4	5	6	7	8	Mean	Slope	SE
Layoff											
76–93	103.8	98.1	98.2	102.7	97.8	98.2	99.1	102.1	0.7	–0.14	0.132
94–14	105.8	103.7	99.0	101.5	100.7	95.6	95.2	98.6	0.5	−1.24	0.139
Not working last week											
76–93	98.2	99.8	100.2	100.0	99.9	100.7	100.8	100.5	43.0	0.27	0.012
94–14	98.6	99.9	99.9	100.1	100.4	100.5	100.3	100.3	41.1	0.20	0.012
Looked for job in the last four weeks											
76–93	109.0	100.7	98.3	101.7	101.2	96.5	94.2	98.5	4.3	−1.33	0.048
94–14	111.5	105.0	101.5	98.5	99.3	96.4	94.2	93.5	3.9	−2.32	0.052
Active job search methods											
76–93	-	-	-	-	-	-	-	-	-	-	
94–14	112.5	104.7	101.0	98.3	100.0	96.2	93.8	93.6	3.6	−2.38	0.054
Available if offered a job last week											
76–93	108.0	100.7	98.6	102.1	100.5	96.7	94.6	98.8	3.9	−1.21	0.050
94–14	112.0	104.8	101.2	98.3	99.7	96.3	94.0	93.7	3.5	−2.33	0.054

The estimates are based on the CPS monthly files from January 1976 to December 2014. The estimation of multiplicative indices and slope is described in the notes to figure 2. The table presents several statistics as fractions of the population: the number of workers who are laid off, the number of individuals not working last week, the number of individuals who looked for a job in the previous four weeks among those who did not work last week, the number of active job seekers among those who looked for a job in the previous four weeks, and the number of individuals who would be available for a job last week among job seekers. Bootstrapped standard errors of the slope based on 500 draws are given in the last column.

ment margin. We find much greater increases in rotation group bias in the fraction of respondents who looked for work in the previous four weeks and among unemployed respondents who are available for work (which is asked only of those who looked for work in the previous four weeks).

IV. Channels

We next examine factors associated with the increase in rotation group bias over time. We can broadly group those factors into two categories: nonresponse and redesign effects.

A. *Changes in the Magnitude and Pattern of Nonresponse*

We first consider survey nonresponse as a candidate mechanism for both the baseline bias (i.e., the fact that there was systematic rotation group effect before the launch of the redesigned CPS in 1994) and the change after 1993.[10] For this analysis we consider type A noninterview households, or those eligible for interviews but were not interviewed because of refusal, temporary absence, noncontact, and other noninterview reasons.[11]

Figure 3 plots the rate of type A noninterview by year.[12] The rate of nonresponse was stable at around 4% between 1976 and 1993, and it jumped by approximately 2 percentage points between 1994 and 1995, coinciding with the 1994 redesign. Subsequent to the redesign, a noticeable upward trend in nonresponse, with a dramatic acceleration occurring after 2009, is driven by survey refusals.[13] This pattern of nonresponse is similar to the time series pattern of rotation group bias, which exhibits a break in 1994 and then a steeper downward trend over time.[14]

[10] Changes in the level of the nonresponse rate could change rotation group patterns of labor force status if response patterns are correlated with labor force status. In particular, people who remain in the survey were less likely to be unemployed. For example, between 1994 and 2014, the average unemployment rate was 7.2% for respondents in MIS1 who became type A noninterview in MIS2; the rate was 6.7% for those who responded in both MIS1 and MIS2. Meyer, Mok, and Sullivan (2015) suggest that nonresponse can be related to measurement error because less cooperative respondents tend to give less accurate answers.

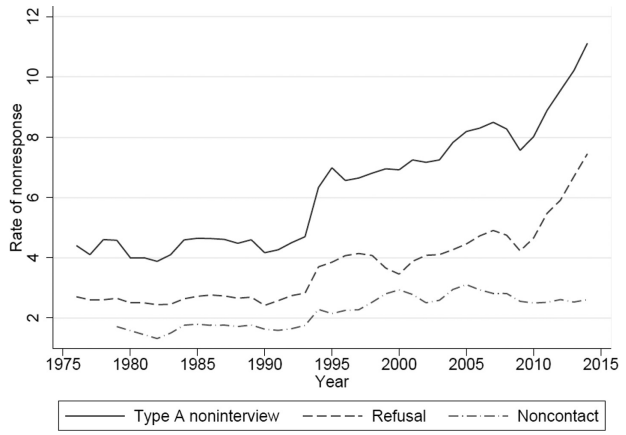
[11] We focus on type A households because that classification reflects individual decisions about survey participation. Two other types of noninterview, type B and type C, reflect the quality of the census's sampling frame. A type C unit is ineligible for interview because the address is not for occupancy. A type B unit is intended for occupancy but is not occupied by any individual eligible for interview.

[12] Information on type A nonresponse is available consistently in the public files only after 1981. Values prior to 1982 are obtained from the CPS technical paper 66, figure 16-2 (available at https://www.census.gov/prod/2006pubs/tp-66.pdf).

[13] The upturn in nonresponse beginning in 2010 coincided with publicity surrounding the 2010 census and calls by some irresponsible officials that individuals should not participate in the census.

[14] A scatter plot of the magnitude of bias against the rate of type A nonresponse shows a strong relationship (figure B4).

FIGURE 3.—RATE OF TYPE A NONINTERVIEW BY YEAR, 1976–2014



The estimates are based on the CPS monthly files from January 1976 to December 2014. The rate of type A noninterview is the number of type A noninterview households divided by the sum of interviewed households and type A noninterview households. The rate of type A noninterview due to refusal (or noncontact) is the number of type A household for the reason of refusal (or noncontact) divided by the sum of interviewed households and type A noninterview households.

TABLE 4.—CROSS-SECTIONAL RELATIONSHIP BETWEEN THE RATE OF TYPE A NONINTERVIEW AND THE MAGNITUDE OF ROTATION GROUP BIAS IN UNEMPLOYMENT RATE, 1994–2014

	(1)	(2)	(3)
Type A noninterview rate	−0.446***		
	(0.146)		
Refusal rate		−1.033**	
		(0.396)	
Other			−0.750***
			(0.228)
Constant	0.560	1.092	0.0547
	(0.892)	(1.243)	(0.682)
N	20	20	20
R^2	0.342	0.274	0.376

The estimates are based on the linked CPS monthly files. The sample includes those who were first selected into the survey in January 1994 or later. The sample is divided into twenty cells based on gender (men and women), race (white and black), and age group (16–24, 25–34, 35–44, 45–54, and 55–64). For type A noninterview households, demographic information is obtained from responses in other interviews if available. The dependent variable is the magnitude of rotation group bias in unemployment rate as described in the notes to figure 2. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Column 3 of table 1 formally tests whether nonresponse is associated with the time series pattern in rotation group bias. In column 1 we regress the bias measure from 1976 to 2014 against a time trend, and a post-1993 dummy. In column 3 we include the type A nonresponse rate. Without the nonresponse rate, the post-1993 dummy has a coefficient of −0.68 (t-ratio = −2.42), and when we include the nonresponse rate the coefficient falls to −0.43 (t-ratio = −1.43) and becomes statistically insignificant. Thus, controlling for the nonresponse rate appears to account for more than a third of the rise in rotation group bias after 1993. While we have only observational data and cannot unambiguously conclude that increased nonresponse caused the change in the pattern of rotation group bias, it seems plausible that nonresponse or some factor related to nonresponse is responsible for a substantial share of the rise in rotation group bias.

The relationship between nonresponse and rotation group bias also holds in cross-sectional data from CPS if we disaggregate the data into race-by-age-by-sex cells. For this analysis, we pooled data from January 1994 to December 2014. We divide the sample into twenty groups based on gender (men and women), race (white and black), and age (16–24, 25–34, 35–44, 45–54, and 55–64). For each of the twenty groups, the magnitude of rotation group bias and the rate of type A nonresponse were calculated.[15]

Table 4 presents results from regressions estimating the cross-sectional relationship between rotation group bias and nonresponse rates across the twenty demographic groups.[16] For all specifications, the dependent variable is the slope measure of the multiplicative rotation group bias for the unemployment rate. Column 1 presents the estimated coefficient on the type A nonresponse rate, column 2 presents the estimated coefficient on the refusal rate, and column 3 presents the estimated coefficient on the type A nonresponse rate for reasons other than refusal. The relationship between the magnitude of rotation group bias and the rate of type A noninterview is statistically significant in all specifications. Type A noninterview accounts for about a third of the variation in rotation group bias across demographic groups.

B. *Redesign Effects*

To investigate the role of changes in reporting behavior, we use the panel structure of the CPS. If changes in reporting behavior due to the redesign, as opposed to changes in the patterns of nonresponse, brought about the change in rotation group bias, we would expect to see the shift in bias for respondents who participated in all eight interviews. We therefore link CPS panels from January 1976 to December 2014 to examine whether the rotation group pattern of unemployment holds for respondents who are present for all eight interviews.[17]

Table 5 presents multiplicative indices of the unemployment rate for the subset of individuals who are present in all eight interviews ("Present in MIS 1–8"), for respondents who report valid labor force status in at least one interview but not in all eight interviews ("Missing at least one"), and all respondents ("All"). We split the sample into periods 1982–1993 and 1994–2014. Between the two periods 1982 to 1993 and 1994 to 2014, the magnitude of rotation group bias remained stable for those who responded to the survey

[15] The CPS does not report demographic information for members of noninterview households. To estimate the rate of type A noninterview for each of the twenty demographic groups, we can obtain demographic information for members of type A noninterview households from survey responses in other MIS if available. See online appendix A for details.

[16] See figure B5 for a scatter plot of this relationship.

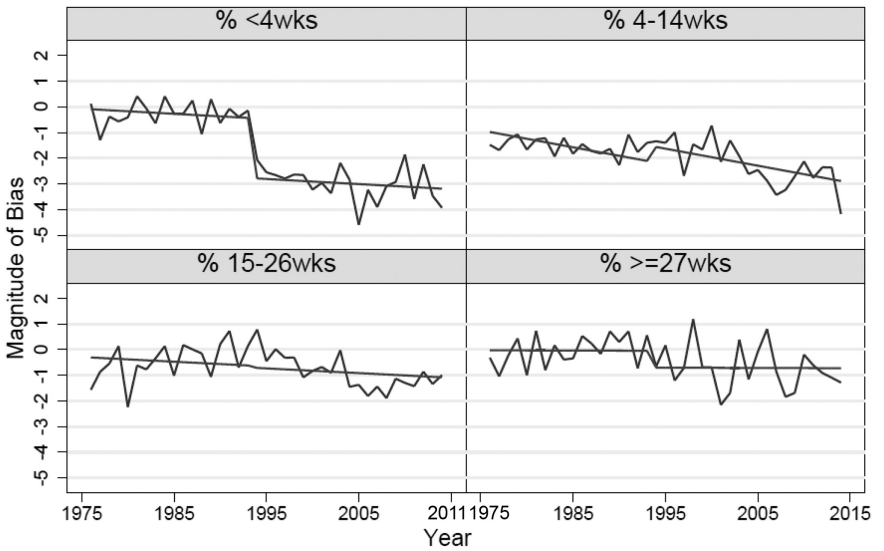
[17] To construct the linked sample, we assemble a balanced panel of dwellings that includes dwellings eligible for all eight interviews during the sample period (those first selected into the sample from January 1982 to September 2013). To avoid mismatches, we keep matched interviews with consistent demographic characteristics, specifically the same reported gender and age (± 2 years) in all interviews. An individual is considered to be present in an interview if there is a valid entry for labor force status. We also remove observations from months in which the match rates are low due to sampling issues with the CPS. Details on the construction of the linked file are available in online appendix A.

TABLE 5.—MULTIPLICATIVE INDICES OF ROTATION GROUPS BIAS IN UNEMPLOYMENT RATE BY RESPONSE PATTERN ACROSS INTERVIEWS, 1982–2014

		1	2	3	4	5	6	7	8	Mean	Slope	SE
82–93	Present in MIS 1–8	107.0	101.7	99.9	104.1	96.4	96.2	95.3	99.4	5.6%	−1.23	0.125
	Missing at least one	110.4	101.7	99.8	103.2	99.8	96.1	93.1	95.9	9.1%	−1.89	0.142
	All	108.4	101.9	99.9	103.5	98.3	96.3	94.2	97.5	7.0%	−1.55	0.096
94–14	Present in MIS 1–8	106.4	103.5	100.5	99.5	98.5	96.6	96.3	98.7	5.1%	−1.22	0.086
	Missing at least one	113.3	104.3	100.8	99.1	102.6	96.5	92.9	90.6	7.9%	−2.68	0.109
	All	108.9	104.2	101.1	99.6	100.1	96.6	94.7	94.9	6.1%	−1.88	0.067

The estimates are based on the linked CPS monthly files. The sample includes those who were first selected into the survey in January 1982 or later. The estimation of multiplicative indices and slope is described in the notes to figure 2. "Present in MIS 1–8" includes respondents who have valid labor force status for all eight interviews. "Missing at least one" includes those who are present in at least one interview but do not provide valid labor force status in at least one of the eight interviews. "All" includes all respondents. The linked sample is restricted to include cohorts with matching rate greater than 40% and individuals with consistent age (±2 years) and gender in all interviews. Bootstrapped standard errors of the slope based on 500 draws are given in the last column.

FIGURE 4.—MAGNITUDE OF ROTATION GROUP BIAS IN THE FRACTION OF THE LABOR FORCE UNEMPLOYED BY UNEMPLOYMENT DURATION, 1976–2014



The estimates are based on the CPS monthly files from January 1976 to December 2014. The figure plots the magnitude of rotation group bias in the fraction of the labor force unemployed by unemployment duration and year. The estimation of the magnitude of bias, or slope, is described in the notes of figure 2. The solid line is the fitted line of the magnitude of bias, allowing for a linear time trend and a level shift between 1993 and 1994.

each month; the magnitude of bias increased by 0.8 point for those who inconsistently participated in the sample. This finding suggests that a change in interviewee response behavior to the labor force questions, independent of any effect on survey nonresponse rates, played a secondary role in the change in rotation group bias compared with nonresponse. An important caveat, however, is that respondents who participate in the survey each month could have a different response to the redesign than the intermittent survey participants because of differences in some aspects other than survey participation.[18]

C. Other Explanations

We have ruled out a number of additional explanations for the increase in rotation group bias. While the increase in the magnitude of bias is slightly greater for men than women following the redesign, that difference is not sufficient to explain the large overall increase in bias. Thus, changes in the way labor force questions were worded for female respondents did not play a major role (table B1).[19]

Our analysis of rotation group bias by unemployment duration also casts doubt on the existence of a Heisenberg principle of rotation group bias, in which repeated questioning about search activity inevitably alters subsequent responses. Figure 4 shows that newly unemployed workers (or those who had been unemployed for less than four weeks) as a share of the labor force, who were not asked about job search in the previous interview, exhibit the greatest degree of rotation group bias. Workers who had been unemployed for longer periods of time exhibit a milder pattern of rotation group bias that decreased or remained constant after 1994. The large increase in rotation group bias among short-term unemployed workers could be an incidental result because of the adoption of dependent interviewing for MIS 2 to 4 and 6 to 8, not an independent

[18] In general, older people, women, whites, and non-Hispanics are more likely to be present in all eight interviews. However, the likelihood of being present in all eight rotation groups increased over time for younger people, men, and minority groups compared to others.

[19] The wording was changed so that there would not be an asymmetry between men and women (Polivka & Miller, 1998). Cohany, Polivka, and Rothgeb (1994) found in the parallel CPS sample that these changes likely increased the unemployment rate of women relative to men.

source of the changing pattern of rotation group bias, but it does suggest that being previously asked about job search is not central to the increase in rotation group bias.

Finally, we find no evidence that changes in imputation for item nonresponse (table B2), economic conditions (table B3), proxy responses (table B4), or unemployment duration (figure B6) led to the rise in rotation group bias over time.

V. Conclusion

This paper documents that rotation group bias in the CPS has substantially worsened, with a marked increase in bias since the 1994 CPS redesign. We find suggestive evidence that the increase in rotation group bias is related to survey nonresponse, which has a similar pattern over time as rotation group bias, as well as possible effects on reporting behaviors from the 1994 redesign of the CPS. The results suggest several important avenues for future research. It remains an open question as to which rotation group provides the most accurate measure of the unemployment rate and whether the increase in rotation group bias has affected the trend in the official unemployment rate.

The results on bias by unemployment duration suggest that there is not a Heisenberg principle of rotation group bias, whereby rotation group bias is an inherent feature of any labor force survey with repeated interviews. Our finding in Krueger, Mas, and Niu (2014, figure 8) that the unemployment rate derived from the Canadian labor force survey does not exhibit rotation group bias further suggests that the bias is not an inherent feature of repeated labor force surveys. These observations lead to the question of which aspects of survey design and implementation can be improved to mitigate rotation group bias. The evidence presented here suggests that we need a better understanding of survey nonresponse, particularly finding ways of reducing nonresponse and better imputation methods to adjust for nonrandom nonresponse, to help mitigate rotation group bias.

Finally, in Krueger et al. (2014), we examined whether alternative weightings of the unemployment rate by rotation group could predict macroeconomic relationships, such as the Phillips curve or Okun's law, better than the official unemployment rate. We found that no alternative measure consistently outperformed the official rate, despite the evolving pattern of rotation group bias over time.

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