Current Population Survey Correlations Across and Within the 1990/2000 Phase-In/Phase-Out Period

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Abstract
The Current Population Survey is a monthly sample survey of housing units that produces reliable estimates of labor force statistics for the working-age population of the United States. In order to maintain the efficiency of the survey's design, the sampling frame has historically been updated every decade with the most recent census data. A new CPS sample design is transitioned in from the old over a 16-month phase-in/phase-out period. We will measure correlations of estimates for key labor force characteristics for months both inside and outside the transition period.

Key Words: sample redesign, sampling correlation, year-to-year correlation, between-month correlation, transition period, modeling

1. Introduction

1.1 Purpose of the Research

When a new Current Population Survey (CPS) sample is implemented, it is currently phased in over a 16-month Phase-in/Phase-out (PIPO) period. In addition to minimizing as much as possible the effects on field operations, this transition period is believed necessary to avoid the sudden impact of a sample change on the CPS estimates. However, the disruption of the rotation pattern, the change in sample areas, and the introduction of new Core Based Statistical Areas can still have the potential to affect the continuity of the data series. Up to this point, the CPS replicate variance system has been designed only to measure correlations where the sample is totally from one design. In order to better understand the effects of the PIPO period, it is desirable that we extend this system of replicate factors and variances to specifically measure sampling correlations of national estimates for key labor force characteristics *across* and *within* PIPO. The rotation group redesign scheme is the key to the analysis. We are interested in examining month-to-month and year-to-year correlations where: (1) all rotations in one month are totally from the 1990 design sample and the other month is a mixture of the 1990 and 2000 design samples (*across*); (2) all rotations in one month are totally from the 2000 design sample and the other month is a mixture of the 2000 and 1990 design samples (*across*); and (3) both months are mixtures of the 1990 and 2000 design samples (*within*). Comparisons will be made to the 'usual' correlations where both months are either entirely from the 1990 or from the 2000 design sample. Finally, comparisons of the replicate system results are made to similar correlations derived from a model approach and from a second empirical analysis.

Any views expressed are those of the authors and not necessarily those of the U.S. Census Bureau.

1.2 Statements, Clarifications and Assumptions

- The CPS sample in this analysis includes the supplemental sample of the State Children's Health Insurance Program (SCHIP) survey, resulting in a monthly sample of approximately 72,000 assigned housing units (HUs), or roughly 60,000 eligible HUs (Census 2006).
- An excellent overview of the CPS survey requirements and design is provided in Chapter 3, 'Design of the Current Population Survey Sample,' of *CPS Design and Methodology: Technical Paper 66* (Census 2006). Of relevance to this paper are the descriptions of the two stages of the sample design[1] and the rotation of the sample.
- As will be discussed in Section 2, the definition, stratification and selection of sample stratification primary sampling units (PSUs) occur every decade. Since these PSUs may differ from one redesign to the next, when sample overlap is discussed as it is in this paper, the term sample *areas* is used rather than sample *PSUs*.
- Only levels of the chosen key labor force characteristics are of interest in this research, not rates.
- All analyses are at the national level.
- All estimates are based on weighting through the second-stage.
- New PSUs in initial rotations that are included in sample for training purposes, and are not used for estimation, are not included in this research.

2. Basics of the Current Population Survey

The U.S. Census Bureau has conducted the CPS every month since 1942 and it is sponsored jointly by the Census Bureau and the Bureau of Labor Statistics (BLS).

This monthly sample survey was the response to the need for reliable and current estimates of unemployment in the late 1930s. Today, the main purpose of the CPS is to provide national and state estimates of unemployment, employment, and other characteristics of the general labor force and for various subgroups of the population. With a total sample size of 72,000 assigned HUs per month, the CPS is able to produce reliable monthly estimates for the country, and for all states and certain metropolitan areas on an annual average basis.

The CPS is one of the ongoing surveys of the Census Bureau's demographic surveys sample redesign program whose basic sampling frame has historically been updated every ten years with the most recent census data. This is done to maintain the efficiency of the sample design. The CPS is a monthly probability sample based on a stratified sampling design, with two basic stages. The first stage of sampling involves dividing the nation into PSUs, most of which comprise a metropolitan area, a large county, or a group of counties. Every PSU falls within the boundary of a state. The PSUs are then grouped into strata on the basis of independent information that is obtained primarily from the most recent decennial census. These strata are constructed so they are as homogeneous as possible with respect to labor force and other social and economic characteristics that are highly correlated with unemployment. One PSU is then sampled in each stratum.

In the second stage of sampling, the old construction and new construction sampling frames are developed and Ultimate Sampling Units (USUs) are chosen within the sample PSUs. USUs are small groups or clusters of HUs. Post-sampling codes (e.g., final hit

[1] A third stage of sampling, sub-sampling, can occur in the field.

number and rotation group) are also assigned during this second stage. The final hit number identifies the original within-PSU order of selection. All USUs in a hit string are assigned the same final hit number. For each PSU, this code is assigned sequentially. The final hit number is used in the application of the CPS replicate variance estimation method. The sample is partitioned into eight representative subsamples, called rotation groups. Rotation groups help define the CPS rotation scheme. All USUs in a hit string are assigned to the same rotation group. Assignment is performed separately for old construction and new construction. Rotation groups as assigned after sorting hits by state, metropolitan statistical area (MSA)/non-MSA status (old construction only), self-representing (SR)/non-self representing (NSR) status of the PSU[2], PSU, and final hit number. This sorting enables the eight subsamples to be balanced across the PSUs, states, and the nation. Rotation group with sample designation determines the units in sample for particular months during the decade.

2.1 The Sample Rotation Scheme (*Non* PIPO)

While reading this section, it is suggested to follow along with Figure 1: CPS Rotation Chart, in Section 3. The reader is cautioned that this figure depicts the phase in of a new design which is detailed in Section 3 ... so ignore the interior intersecting lines and PIPO regions for this current discussion on the Non-PIPO rotation scheme.

The CPS sample rotation scheme is a compromise between two extremes: a permanent sample, from which a high response rate would be difficult to maintain over an extended period of time, and a completely new sample each month, which would be marked by more variable estimates of change. As detailed in the *CPS Technical Paper 66*, the rotation scheme attempts to strike a balance between these two extremes in the minimization of:

- Variance of estimates of month-to-month change: Consecutive monthly samples have six of the eight rotation groups (75 percent) in common.
- Variance of estimates of year-to-year change: Monthly samples one-year apart have four of the eight rotation groups (50 percent) in common.
- Variance of other estimates of change: outgoing sample is replaced by sample likely to have similar characteristics.
- Response burden: eight interviews are dispersed across 16 months.

The rotation scheme is designed so that outgoing HUs are replaced by HUs from the same hit string which are assumed to have similar characteristics. The main characteristics of this *Non*-PIPO rotation scheme are listed on the following page.

- Each month's sample is made up of eight panels that rotate on a schedule of four months in, eight months out, four months in (i.e., 4-8-4 rotation scheme). Thus, only 25 percent of the HUs is different between consecutive months. The eight months that a HU is interviewed are designated month-in-sample 1 (MIS-1) through MIS-8.
- In any one month, one-eighth of the sample HUs is interviewed for the first time, another eighth is interviewed for the second time, etc.

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[2]A self-representing (SR) PSU is treated as a separate stratum. They are usually the most populous PSUs in each state and are selected for sample with certainty. The remaining strata are formed by combining PSUs that are similar in characteristics such as unemployment, proportion of HUs with three or more persons, etc. The single PSU randomly chosen from each of these strata is NSR because it represents not only itself but the entire stratum (BLS 2004).

- One new sample designation/rotation group is activated each month. This new rotation group replaces the rotation group leaving the sample permanently.
- One rotation group is reactivated each month after its eight-month resting period. The returning rotation group replaces the group beginning its eight-month resting period.

3. The Phase-In/Phase-Out Sample Rotation Scheme

The remainder of this paper discusses specifically the phase in of the CPS 2000 sample design (new) and phase out of the 1990 sample design (old). A more detailed description of the PIPO sample rotation scheme can be found in Shoemaker (2004).

As stated in Section 2.1, producing more variable estimates of change is a major reason why old CPS sample shouldn't be discarded one month and replaced with a completely redesigned sample the next month. Also, since a redesigned sample contains different areas, field representatives might need to be hired or let go, and modifications in survey procedures are often made for a redesigned sample. These factors can cause discontinuity in estimates if the transition is made at one time. Instead, a gradual transition from the old sample design to the new sample design is undertaken; hence, PIPO.

PIPO has two dimensions. The first is those areas selected in both the 1990 and 2000 sample designs; i.e., continuing areas. Sample HUs selected from Census 2000 and building permits for new residential construction since Census 2000 replace HUs selected from the 1990 Census lists and from building permits for new residential construction issued since the 1990 Census. The second dimension involves changing the areas selected for sampling (or the sample PSUs). These are outgoing areas (in the 1990 design but not in the 2000 design) or incoming areas (not in the 1990 design but in the 2000 design).

PIPO takes place over 16 months. The phase-in period consists of gradually replacing the sample selected from the 1990 Census-based frames with that selected from the Census 2000-based frames. Monthly fluctuations are minimized since new sample is phased in slowly. Also, there are only four months during which there are PSUs in sample from both the 1990 and 2000 designs. This short overlap is probably beneficial to the field since 24 percent of PSUs changed from the 1990 and 2000 designs. Base weights and weighting factors used in computing the estimates are updated to account for the change in the areas that compose the sample.

Looking at Figure 1 on the next page, the rotation group redesign scheme of the 1990/2000 PIPO can be summarized as follows:

- For each month from April 2004 through July 2004, in the continuing areas, one additional rotation group from the 2000 design sample is introduced, while one additional rotation group from the 1990 design sample is dropped.
- For each month from August 2004 through November 2004, two additional rotation groups from the 2000 design sample in the incoming 2000 areas are introduced, while two additional rotation groups from the 1990 design sample in the outgoing 1990 areas are dropped.
- No changes November 2004 through March 2005.
- For each month from April 2005 through July 2005, in the continuing areas, one additional rotation group from the 2000 design sample is introduced, while one additional rotation group from the 1990 design sample is dropped.
- By July 2005, PIPO is complete with all eight rotation groups made up of 2000 design sample, from both continuing areas and incoming 2000 areas.

- Regions I and II represent the 1990 design. The 1990 design only uses 1990 PSUs but these 1990 PSUs may contain areas with sample that were selected for 2000. Regions III and IV represent the 2000 design. The 2000 design only uses 2000 PSUs but these 2000 PSUs may contain sample that was selected for 1990.

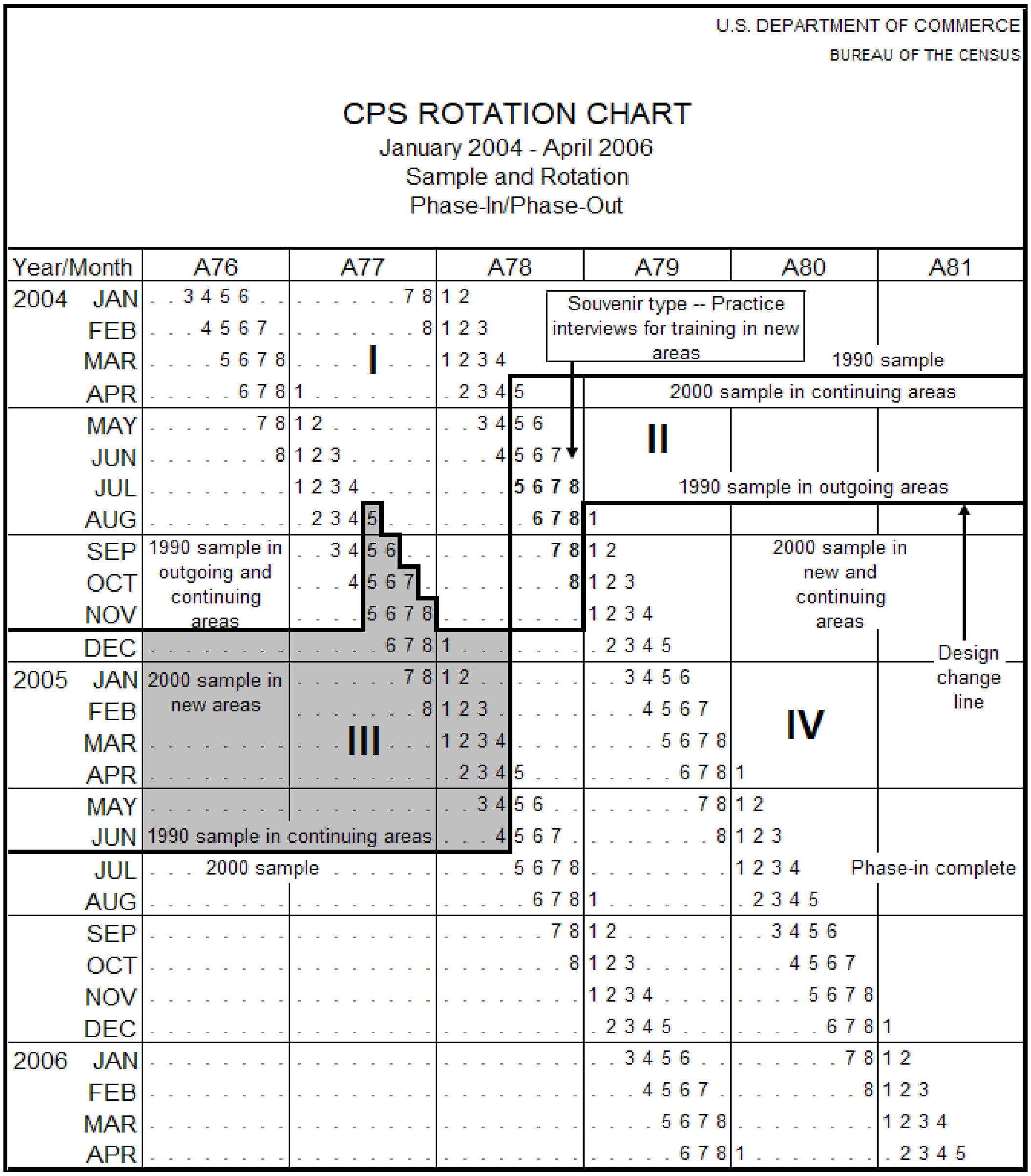

Figure 1: CPS Rotation Chart for 1990 Sample Phase-Out and 2000 Sample Phase-In

Relating this to the paper's title, notice the 1990/PIPO *across* months of March and April 2004; i.e., going from all 1990 design sample to within PIPO. Also, notice the PIPO/2000 *across* months of June and July 2005; i.e., going from within PIPO to having all 2000 design sample. Lastly, April 2004 through June 2005 are the *within* PIPO months.

4. Methodology

4.1 Data

CPS micro data from February 2003 through December 2005 were easily accessible for capturing month-to-month and year-to-year correlations outside of PIPO, across PIPO, and within PIPO. It would have been advantageous to have had more months of all 2000 design sample included in this initial empirical analysis, especially for the derivation of year-to-year correlations. (See Section 8, 'Further Research.')

The key labor force characteristics (levels) that are the focus of this research are as follows. Abbreviations used in Figures 2 through 7 of the Results Section are included in parentheses.

- Unemployed (UE)
- Employed (EMP)
- Civilian Labor Force (CLF)

for each of the following categories:

- Both sexes, 16+ years of age (UE, EMP, CLF)
- Males, 16+ years of age (Male)
- Females, 16+ years of age (Female)
- Both sexes, 16-19 years of age (16-19)

This results in a total of 12 key labor force characteristics[3].

4.2 Method

During a non-PIPO period, there is little difficulty calculating total variances and thus, correlations of national estimates. As stated in this paper's Introduction, Section 1.1, the CPS replicate variance system has been designed only to measure correlations where the sample is totally from one design. Thus, referring to the Rotation Chart in Figure 1, the replicate system methodology for Region I (all 1990 design sample) and Region IV (all 2000 design sample) is understood and validated.

When there is not a mixture of sample designs, replicates are formed differently for SR and NSR samples to produce estimates of total variance. For SR samples, variances are calculated using Successive Difference Replication (SDR) (Fay and Train 1995). For NSRs, they are calculated using the Collapsed Stratum Estimator (Wolter 1985). In addition to these two references, a less technical description of these two methods is provided in Chapter 14 of *CPS Technical Paper 66*, 'Estimation of Variance.' If these methods are also applied to the mixture of sample designs in PIPO, incorrect variances and correlation estimates result; in fact, estimated correlations delve very close to zero.

The main concept that should be taken from this paper's description of the PIPO sample rotation scheme (Section 3) is that of rotation groups. Depending on the month and type of area, as many as two additional rotation groups from the 2000 design sample are phased in, while two additional rotation groups from the 1990 design sample are phased out. For NSR PSUs that are in sample during PIPO, the Collapsed Stratum Estimator is still valid since rotation groups are not an issue. However, for SR PSUs that are in sample

[3] The characteristic 'Not in Labor Force' was also included in the analysis, but is not included in this paper's results since it is the complement of Civilian Labor Force.

during PIPO, a modification has to be made before the SDR method can be used. Typically, when calculating variances using SDR, the sample file is sorted in the order in which the units are selected, and paired 'successively.' Rotation groups are then assigned in that same type of ordering: 1 through 8, 1 through 8, etc. The problem arises as some rotation groups are phased in and others are phased out. For example, SDR could pair a hit of a rotation group with one of a rotation group that has been phased out, thus resulting in an excessively large squared difference term. Putting rotation group at the beginning of the sort, and then performing SDR within a rotation group, is the solution.

In terms of mechanics, the available files are a within-PSU hit-level file for each 1990 and 2000 design sample. These files contain all necessary sort and stratification variables, but not rotation group. Rotation group has to be included on the file. By rotation group, the files are indexed according to the order used for their systematic sampling. To each sample hit, 160 replicate factors are assigned according to (Fay and Train 1995), which leads to a replication approximation of the successive difference estimator found in (Wolter 1985). Then, 160 replicate weights are calculated (second-stage weights in this research), followed by 160 replicate estimates. These are used to calculate reliable estimates of the variance and covariance:

$$V(\hat{X}_t) = \frac{4}{160}\sum_{r=1}^{160}\left(\hat{X}_{t,r} - \hat{X}_{t,0}\right)^2$$

where $\hat{X}_{t,r}$ is the estimate for month t, replicate r and r = 0 is the full sample.

$$Cov(\hat{X}_t, \hat{X}_{t+1}) = \frac{4}{160}\sum_{r=1}^{160}(\hat{X}_{t,r} - \hat{X}_{t,0})(\hat{X}_{t+1,r} - \hat{X}_{t+1,0})$$

Finally, the correlations are calculated:

$$Corr(\hat{X}_t, \hat{X}_{t+1}) = \frac{Cov(\hat{X}_t, \hat{X}_{t+1})}{SE(\hat{X}_t)\, SE(\hat{X}_{t+1})}$$

5. Results

Figures 2 through 4 are graphs of month-to-month correlations for the 12 key labor force characteristics (see Section 4.1). The shaded area is the 16-month PIPO period beginning April 2004 and ending July 2005. The plots begin with the month-to-month correlation between February 2003 and March 2003 and end with the same for November 2005 and December 2005. (Month-pairs are not labeled along the x-axis since they are not necessary for the discussion.) Similarly, Figures 5 through 7 are graphs of year-to-year correlations for the same key labor force characteristics. The plots begin with the correlation between February 2003 and February 2004 and end with the same for December 2004 and December 2005. It did not seem intuitive to label the PIPO period on these figures.

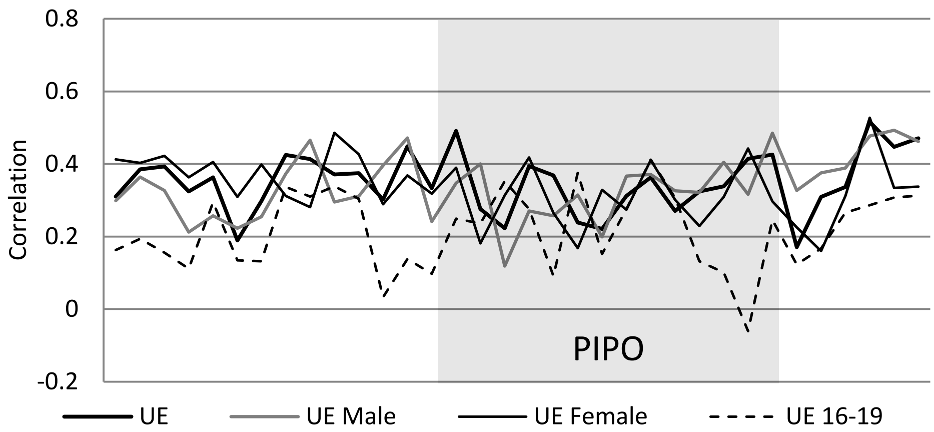

Figure 2: Month-to-Month Correlations for Four Categories of CPS Unemployed

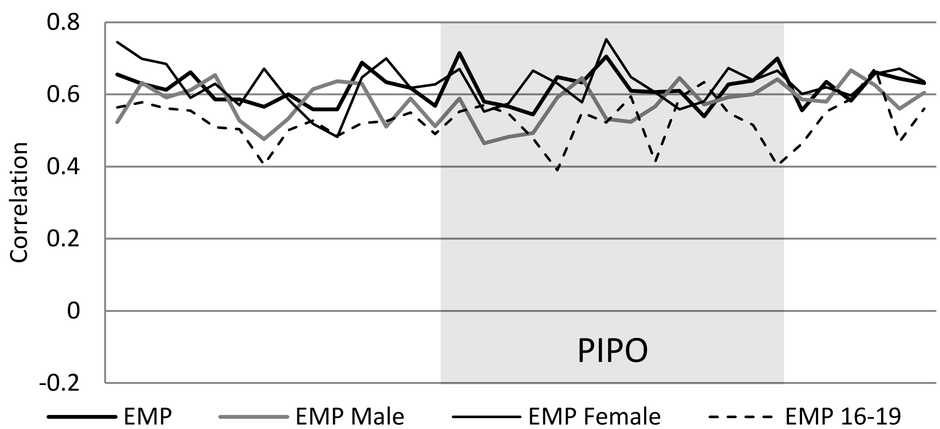

Figure 3: Month-to-Month Correlations for Four Categories of CPS Employed

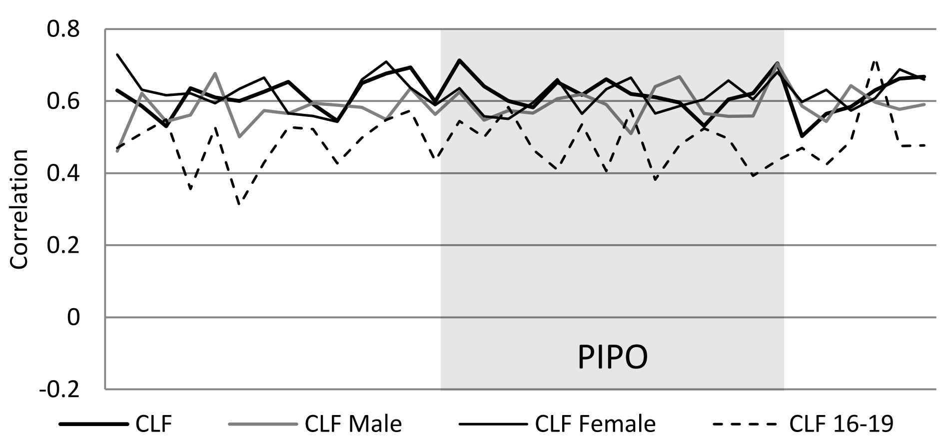

Figure 4: Month-to-Month Correlations for Four Categories of CPS Civilian Labor Force

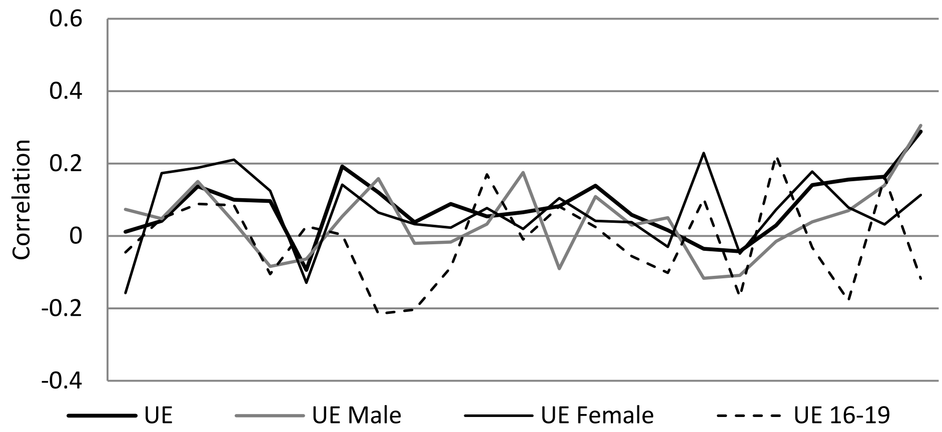

Figure 5: Year-to-Year Correlations for Four Categories of CPS Unemployed

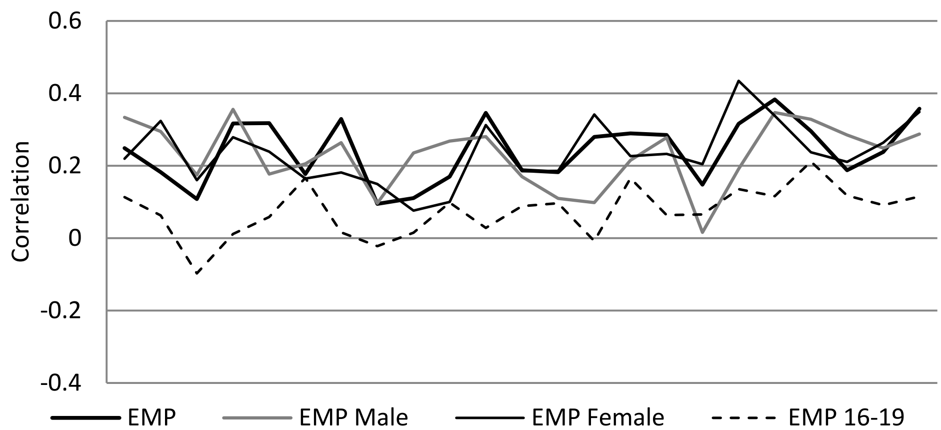

Figure 6: Year-to-Year Correlations for Four Categories of CPS Employed

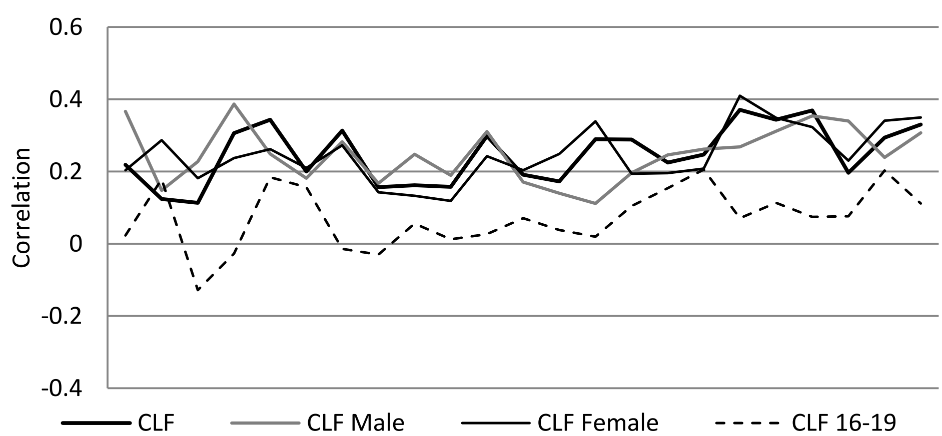

Figure 7: Year-to-Year Correlations for Four Categories of CPS Civilian Labor Force

The intent of each figure is not a comparison of total vs. male vs. female vs. 16-19. Rather, what is of importance is looking at the plots across time: moving from totally 1990 design, across and into PIPO, within PIPO, and totally into the 2000 sample design. Fluctuations do exist[4], but it would be difficult to determine where the PIPO period began and ended from the correlations if that time period was not known.

Incorporating rotation groups into the replicate variance methodology seems to be working. The time series fluctuates, especially for the unemployed 16-19 years olds which we will be looking at in further research, but that is evidence of sampling error and variance of the variance.

6. Comparisons to another CPS Empirical Study and a Model-Based Approach to Measuring PIPO Correlations

Table 1 below presents average[5] unemployment correlations derived from two separate analyses, as well as the results from the current research, for several time periods:

- 1990: All available months are entirely from the 1990 design sample.
- 1990/PIPO: All rotations in the first month are from the 1990 design sample and the second month is a mixture of the 1990 and 2000 design samples; i.e., across.
- Within PIPO: All months are mixtures of the 1990 and 2000 design samples.
- PIPO/2000: All rotations in the second month are from the 2000 design sample and the first month is a mixture of the 1990 and 2000 design samples; i.e., across.
- 2000: All available months are entirely from the 2000 design sample.

Table 1: Correlations for CPS Unemployed: Empirical vs. Model-Based vs. Empirical*

	Month-to-Month			*Year-to-Year*	
	Empirical	*Model*	*Empirical**	*Model*	*Empirical**
1990	.355	.415		.113	
1990/PIPO	.333	.411		.087	
Within PIPO	.335	.406		.066	
PIPO/2000	.171[6]	.412		.093	
2000	.309	.415	.372	.113	.109

Empirical* is based on 2000 design sample months 7/05-12/06.

The empirical (not empirical*) month-to-month correlations are those derived in this research. They are the averages from the same data as presented in the UE plot of Figure 2 in Section 5.

[4] Runs tests (also called Wald-Wolfowitz tests, (Mendenhall 1986)) were performed on the unemployed data. A runs test is used to test the hypothesis that the elements of the sequence are mutually independent. Results failed to show a statistically significant pattern.

[5] Correlation averages for each of the five periods used the Fisher's z transformation (Hawkins 1989.)

[6] This low value may be influenced by the low estimates for 16-19, it being based on just one data point, and variation of the correlation.

Model-based month-to-month correlations for unemployed are in the third column of the table (Rottach 2010). In his paper 'Sampling Correlation of Current Population Survey Unemployment Statistics,' Rottach studied the effect of different stages of sampling and weighting adjustments on CPS correlations and variances. In so doing, he derived a model-based approach to estimating correlations, for a non-PIPO sampling scheme; i.e., where the sample is entirely from one sample design. Central to his analysis is the 4-8-4 rotation scheme, and that one of the eight rotation groups is new to the survey in any given month, thus replacing an outgoing rotation group selected from the same second-stage cluster of HUs. He realized that this CPS sampling scheme resulted in a complex pattern of correlations among rotation group totals, both within and across months. His paper details his model development. When requested by the authors of this paper, Rottach was able to extend his model-based approach to measuring month-to-month and year-to-year correlations within and across PIPO for months from March 2004 (the last month before PIPO begins) through August 2005 (the second month of phase-in complete).

Notice the model's 'smoothing' of the correlations across months. Also, the model-based correlations appear higher overall than the ones computed directly. The parameters for the model were computed using data from August 2005 through April 2010, and (Rottach 2010) showed that the correlations changed substantially as the unemployment rate changed during this time period. The correlations are considered feasible values at a six percent unemployment rate, which is approximately one-third higher than the rate during PIPO. The model illustrates the relative change in correlations due to PIPO rather than predicting values for a particular time period.

The empirical* month-to-month correlations were derived with the same methodology as those of the current research. Eltahir (2008) previously produced autocorrelations for second-stage estimates for the 2000 CPS sample design. July 2005 - December 2006 micro data files were used to empirically calculate variance, covariance, and correlation estimates for several labor force characteristics for each pair of months separated by different lags, from lag 1 (month-to-month) through lag 12 (year-to-year). Although Eltahir had 12 more months of data in her analysis than that in our research, all months were entirely from the 2000 design sample. The average month-to-month correlation is presented in the fourth column cell for '2000.'

The year-to-year correlations portion of Table 1 presents the analogous model-based and empirical* values. Empirical year-to-year correlations from the current research are not included in this table. Although the data are plotted in Figure 5 and we performed some preliminary analyses, we do not feel the average value is comparable since we have so few data points. Also, there is considerable variability in empirical-based year-to-year correlations. This is included in further research.

The empirical* value is consistent with that of the model-based approach. While the .109 value is not a PIPO correlation, the model-based numbers give us some idea of what the PIPO correlations could look like when we go further into PIPO months.

7. Discussion and Conclusions

The sampling frame for the CPS has historically been updated every decade with the most recent census data. The new sample design is transitioned in from the old over a 16-month PIPO period. Although the 4-8-4 pattern of the CPS design is disrupted, the gradual aspect minimizes the impact on the continuity of the CPS data series. Up to this point, the CPS replicate variance system has been designed only to measure correlations where the sample is totally from one design, not a mixture of designs. Using 1990 and 2000 design CPS data, we have now extended this system of replicate factors and variances to specifically measure sampling correlations of national estimates across and within PIPO.

The following table (Shoemaker 2004) is another visualization of the 1990/2000 PIPO, in addition to Figure 1 of Section 3. It focuses on the rotation group redesign scheme, with incoming new or outgoing old areas comprising ten percent of the sample. Placing rotation group at the beginning of the sort, and then performing SDR within a rotation group is the solution. Assignment of replicate factors by rotation group is the key to the analysis and derivation of the correlations; thus, the overlap of the two designs is captured by this empirical method.

Table 2: Rotation Group Redesign Scheme of PIPO

	Continuing Areas		*Outgoing 1990 or Incoming 2000 Areas*	
Yr: Month	*Number of 1990 Sample Rotations*	*Number of 2000 Sample Rotations*	*Number of 1990 Sample Rotations*	*Number of 2000 Sample Rotations*
2004: Apr	7	1	8	0
May	6	2	8	0
Jun	5	3	8	0
Jul	4	4	8	0
Aug	4	4	6	2
Sep	4	4	4	4
Oct	4	4	2	6
Nov	4	4	0	8
Dec	4	4	0	8
2005: Jan	4	4	0	8
Feb	4	4	0	8
Mar	4	4	0	8
Apr	3	5	0	8
May	2	6	0	8
Jun	1	7	0	8
Jul	0	8	0	8

Although the month-to-month and year-to-year correlations via the empirical method exhibit fluctuations across time (which were tested to be random), these fluctuations are most likely indicative of sampling error and variance of the variance. However, the model-based approach to the estimation of correlations is ‘smooth.’ Whereas the model should be able to predict the effects of a design change, it is not designed to predict for particular months; rather the expectation of the underlying curve, and predicting for a 6% unemployment rate.

We now have an empirical method to measure sampling correlations within and across PIPO, as well as outside of PIPO, and we have the basis of a model. Until further research is performed, it is suggested that the empirical method be used in for the derivation of month-to-month correlations. The model is an attractive alternative for year-to-year correlations or when enough (or any) direct estimates may not be available.
This research and its results are especially applicable if the CPS embraces annual sampling (Adeshiyan 2009).

8. Further Research

Further research on correlations across and within PIPO may include the following. They are not presented in any prioritized order.

- Access CPS data beyond December 2005 to better capture the correlations trend outside of PIPO, especially for the derivation of year-to-year correlations. Having more months of all 2000 design sample in this empirical analysis would allow a more thorough comparison to Rottach's model-based and Eltahir's empirical approaches.
- Investigate this variance estimator involving rotation groups for use both during PIPO and beyond. Results would definitely benefit an annual sampling scenario.
- Analyze correlations for other between-month lags; for example, those based on quarterly average CPS estimates.
- Better understand the lower month-to-month and year-to-year correlations for CLF 16-19 years of age.
- Reconcile in more detail differences with model-derived correlations.
- Some HUs which are in sample during MIS-1 through MIS-4 are replaced by different HUs for MIS-5 through MIS-8, adding variability. Bias due to this sampling scheme is unknown but should be evaluated.
- Determine the individual contributions of the first-stage (sampling PSUs) and second-stage (sampling HUs) on the total sampling correlations given in this paper.
- Examine the effect of these correlations on the actual variance estimates.
- Re-examine the results obtained by (Rottach et al. 2009) regarding the estimation of the variance of the correlation estimates from the model and those directly computed from the data.

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