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errata

A correction to this article was made on June 14, 2018. Specifically, in table 3, the 2026 employment value for surgeons was changed from “5.5” to “51.5.”

Corrections to this article were made on June 26, 2019. The changes were primarily to the table 3 discussion section and to Appendix table A-1 and related discussion. See https://www.bls.gov/bls/erratabydate.htm for more information.

Occupational separations: a new method for projecting workforce needs

The U.S. Bureau of Labor Statistics (BLS) Employment Projections program publishes estimates of total occupational openings, an important career information metric. This metric has two components: projections of new jobs (growth) and projections of openings that arise from existing workers leaving the occupation (separations). BLS has adopted a new method for projecting separations with the 2016–26 projections. This article outlines the new separations method that more accurately captures the concept of occupational openings by independently measuring workers who leave the labor force and workers who transfer occupations. Because neither data source is large enough to generate reliable estimates for all detailed occupations, BLS uses historical data to estimate the impact of various characteristics on workers' propensity to separate from an occupation using probit models. The results of the models are applied to current data on detailed occupations for estimating future separation rates.

Openings concepts

Projections of employment growth and decline are straightforward concepts; they are net measures of jobs expected to be created or eliminated. These concepts are sufficient for examining how the economy is changing at the macro level. However, for workforce development and

career guidance purposes, employment change is not the only relevant concept. Career seekers want to know whether they will be able to find a job in a particular occupation. Although projections cannot be used in determining whether any specific individual will be able to find a job, aggregate numbers (how many jobs are available for new entrants into an occupation) are useful to these customers and to the workforce development system, which trains workers. Therefore, the concept of interest is how many openings, or opportunities, there will be to enter an occupation. The concept of openings differs from an employment projection because it includes opportunities that arise to replace workers leaving an occupation. That is,

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occupational opening = occupational separations + net employment change.

BLS produces an estimate of net employment change through the National Employment Matrix. Therefore, estimating occupational openings over the projection period requires a separate estimate for the number of occupational separations.[1] Reasons for separating from an occupation include retirement and career changes, among others, but the specific cause of an employee's separation from an occupation does not affect the need to replace the departing employee. The exception is declining occupations, in which workers may be laid off or leave voluntarily without creating a need to be replaced, but this exception is accounted for by a negative value for net employment change.

Table 1 shows the possible transitions between states over time. Workers employed in a given occupation can remain employed in that occupation, can be employed in another occupation, or can exit the labor force. Workers exiting the labor force (*C* in table 1) may be the more obvious source of openings—many of these exits are retirements in which another worker will need to be hired to replace the retiree. Labor force exits also include those who decide to temporarily stop working to pursue more education or to accomplish some other endeavor. Occupational transfers (*B* in table 1) are another important source of openings that must be measured so that opportunities for new entrants are fully captured. A worker leaving an occupation creates an opening that needs to be filled, whether he or she enters a different occupation or leaves the labor force entirely. That is,

occupational separations = occupational transfers (*B*) + labor force exits (*C*).

Table 1. Occupational transitions

Employment status		Status at time *t* + 1		
		Employed in occupation X	**Employed in another occupation**	**Out of the labor force**
Status at time *t*	**Employed in occupation X**	*A*	*B*	*C*
	Employed in another occupation	*D*	*E*	*F*
	Out of the labor force	*G*	*H*	*I*

See footnotes at end of table.

Source: U.S. Bureau of Labor Statistics.

Table 1 shows workers who fill occupational openings as those not employed in a given occupation in the first period but are employed in the second period. Workers transferring from other occupations (*D* in table 1) or entrants into the labor force (*G* in table 1) can fill the openings. That is,

occupational openings = occupational entrants (*D)* + labor force entrants (*G).*

The relationship between occupational separations and occupational openings just noted therefore can also be expressed as

net employment change = (*D* + *G*) – (*B* + *C*).

Note that for any specific occupation, no fixed relationship exists between labor force exits (*C*) and labor force entrants (*G*) or between occupational transfers (*B*) and occupational entrants (*D*). That is, an estimate of the number of labor force exits does not provide information on the number of labor force entrants.

Entrants and separations are related to the "turnover" concept. However, turnover often refers to job churn, or all movements between jobs, including movements by workers who change jobs but remain in the same occupation. The BLS Job Openings and Labor Turnover Survey (JOLTS) measures this metric.[2] Turnover is sometimes used to discuss workers leaving an occupation; the projections program measures this concept.

BLS historical measures of openings

Over the years, BLS has used many methods to estimate openings. In the early years of the projections program, its primary tool was worklife tables. The program used this method to determine the patterns of labor force exits from the workforce as a whole by age and gender and then applied these rates to occupations on the basis of the demographic profile of the occupation. The problem associated with this technique is that not all occupations experience labor force exits in the same manner as the labor force as a whole. In addition, this method does not capture workers who separate from an occupation for any reason other than exiting the labor force.

BLS attempted to find data sources and methods that would allow for differences between occupations. At different times, the Bureau used the 1960 and 1970 decennial censuses and postcensal surveys, various supplements to the Current Population Survey (CPS), and the National Longitudinal Surveys (NLS) to measure labor force movements by occupation. However, none of these sources supplied data regularly that allowed for more than a single snapshot of the situation.[3] In 1980, BLS released a report on using the longitudinal characteristics of CPS data to describe the dynamics of the labor market.[4] This initial report clearly stated that the results referred only to the historical period and should not be applied to future periods. Nonetheless, the technique outlined in this article was renamed "replacement rates" in a 1984 *Monthly Labor Review* article and was used to project future job openings by occupation through the end of the 1980s.[5]

In 1990, the Bureau undertook a major review of replacement rates and established a framework for projections of job openings that was used from the 1990–2005 projections through the 2014–2024 projections.[6] The 1984 measure of replacement rates was renamed "total replacements," and a new measure, named "net replacements," was introduced. This new measure was intended to fill a gap in what people wanted as a measure of job openings. Net replacements (as did total replacements) used CPS data, although without the use of the longitudinal

component. Whereas the total replacement measure counted all people who left an occupation, the new measure (net replacements) was intended to count only those who left an occupation permanently. As implied by the name, net replacements are smaller than total replacements, but by excluding temporary leavers, they provide a better overview of opportunities for new workers. An outline of the net replacements concept is presented later in this article.

In 2008, a review of replacement rates methods concluded that users found having two different measures confusing and that, as a result, users did not generally use the total replacement rates measure. Total replacement rates were discontinued, and net replacement rates were renamed simply “replacement rates” and published as the sole BLS estimate of this concept. Minor changes were made to the methodology for replacement rates, but the overall approach remained unchanged and was used through the 2014–24 projections, released in December 2015.

Replacement rates method

The replacement rates method introduced with the 1990–2005 projections is based on the cohort component method of projecting population. Monthly CPS data are used for calculating employment change over a 5-year period for 13 different age cohorts in each occupation.[7] A cohort’s decline in employment within an occupation is considered a measure of separations.

Historical replacement needs are estimated based on these separations. Replacement needs are equal to separations unless total employment for the occupation declined. If occupational employment declined, the decline is subtracted, proportionally, from the cohort separations, since not all workers who left were replaced. A historical replacement rate is determined when the observed number of replacement needs for the cohort is divided by the cohort employment in the first reference year.

Historical replacement rates are used for projecting replacement needs. (See table 2.) First, for determining replacement needs over the first 5 years of the projection period, the historical cohort replacement rates are multiplied by base-year employment in that cohort. Next, midyear employment by cohort is estimated by applying the historical rate of change to the base-year employment.[8] Then the historical replacement rates are again applied to the appropriate midyear cohort employment estimates for projecting replacement needs over the final 5 years of the projection period. The projected replacement needs are summed across all cohorts and both 5-year periods for determining the 10-year projected replacement needs.

Table 2. Measuring replacement needs by age cohort

Age cohort	Historical replacement rate	First 5 years of projection		Second 5 years of projection	
		Base employment	Replacement needs	Base + 5 employment	Replacement needs
16 to 19	α	A	Aα	—	—
20 to 24	β	B	Bβ	A − Aα	(A − Aα)β
25 to 29	γ	C	Cγ	B − Bβ	(B − Bβ)γ
30 to 34	δ	D	Dδ	C − Cγ	(C − Cγ)δ
35 to 39	ε	E	Eε	D − Dδ	(D − Dδ)ε
40 to 44	ζ	F	Fζ	E − Eε	(E − Eε)ζ
45 to 49	η	G	Gη	F − Fζ	(F − Fζ)η

See footnotes at end of table.

Table 2. Measuring replacement needs by age cohort

Age cohort	Historical replacement rate	First 5 years of projection		Second 5 years of projection	
		Base employment	Replacement needs	Base + 5 employment	Replacement needs
50 to 54	θ	H	Hθ	G − Gη	(G − Gη)θ
55 to 59	ι	I	Iι	H − Hθ	(H − Hθ)ι
60 to 64	κ	J	Jκ	I − Iι	(I − Iι)κ
65 to 69	λ	K	Kλ	J − Jκ	(J − Jκ)λ
70 to 74	μ	L	Lμ	K − Kλ	(K − Kλ)μ
75+	ν	M	Mν	(L − Lμ) + (M − Mν)	((L − Lμ) + (M − Mν))ν

Note: Historical replacement rate is zero for cohorts with net entrants.

Source: U.S. Bureau of Labor Statistics.

The key attribute of the current method is that it compares cross-sectional CPS data from two points in time that are 5 years apart. This comparison allows for the observation of all leavers, no matter the cause, although the comparison is not able to differentiate between different types of leavers. The downside is that the comparison does not capture all instances of labor force movements. This issue is discussed in the next section.

Limitations of the replacements method

Because no data source directly measures the concept of occupational openings, any estimate of openings will rely on the assumptions and methods used to generate the estimates. The assumptions underlying the replacements method result in a method that does not capture what it is intended to estimate. In addition, the way the replacements method uses the source data results in a large potential survey error.

The cohort component method used in the replacements method works by comparing the size of a cohort at two different times. If the cohort increased, net entrants occurred; if the cohort decreased, net separations occurred. For this reason, the replacements measure was originally called net replacements (as mentioned earlier). Nothing about the total number of entrants or separations can be determined with this method, only the net change for each cohort. For example, a cohort that had 50 entrants and 100 separations would yield an estimate of 50 net separations, the same as a cohort with 150 entrants and 200 separations. The key to understanding the limitations behind the replacements method lies in the differences between the number of net separations measured with the use of the replacements method and the number of openings for new workers to enter the occupation.

The number of net separations is, by definition, lower than the number of total separations. Not all separations represent opportunities for new entrants, because some represent just temporary separations in which the worker intends to return to the occupation. This discrepancy, however, is not necessarily a problem. The accuracy of the replacements method depends on how closely the separations excluded by the cohort component method match temporary separations. That is,

permanent separations = total separations – temporary separations,

and

net separations = total separations – cohort component-excluded separations.

Two key types of separations are excluded in the replacements method: separations that involve replacement by workers of the same age and separations by individuals reentering an occupation later at an older age.

Same-age cohort replacements

With the use of the replacements method, no separations offset by entrants from the same-age cohort are counted as opportunities for new entrants. These offset separations must be temporary separations rather than permanent separations that result in openings for new workers if the method accurately measures openings. To evaluate whether this assumption holds, consider that if workers typically stay in one occupation for their entire career, then separations will occur only in older age cohorts and entrants only in younger cohorts. This assumption would then affect only a limited number of separations. However, working in more than one occupation over a career is common. Although BLS has never estimated the number of career changes in a person's lifetime,[9] CPS reports that the median employee tenure was 4.2 years in 2016.[10] Furthermore, NLS reports that respondents to the National Longitudinal Survey of Youth 1979 (NLSY79) held an average of 11.7 jobs over a 30-year period.[11] Although many job changes do not result in occupational separations (because workers can find new jobs in the same occupation), some do.

With large numbers of separations at young ages and entrants at older ages, the assumption that the excluded separations are temporary separations becomes critical to the accuracy of the results. Imagine that a worker enters an occupation early in his or her career, works for a few years, and then leaves, perhaps because the worker determined that field was not appropriate. This separation is temporary only if the worker returns to the occupation in the future. If the worker does not return to this occupation, then the assumption is incorrect and the method undercounts permanent separations. However, even if the worker returns to the occupation, the method still does not accurately count separations because of the way it handles reentering workers.

Reentering workers

The impact of a dynamic workforce, with workers at all ages entering and leaving occupations and sometimes returning to their original occupation, is best demonstrated with an example of the cohort method. To simplify the discussion, the example uses a two-cohort model with a young cohort and an old cohort. Furthermore, the example assumes that employment is constant over time and that the patterns of entrants and exits remain the same in every period. Therefore, the number of exits always equals the number of entrants.

If the traditional concept of staying in a single occupation for one's whole career were true, workers would only enter while in the young cohort and exit while in the older cohort; in this case, the cohort component method measures all exits (exits = observed exits) as shown in the text table:

Cohort	Entrants	Exits	Observed exits (exits – entrants, only if positive)
Young	100	0	0
Old	0	100	100
Total	100	100	100

However, when some workers decide to leave the occupation while still relatively young and when some workers enter the occupation at older ages, the dynamics are more complicated. Because only net exits are observed with the use of the replacements method, these entrants and exits of workers at different ages reduce the number of observed exits as the text table shows:

Cohort	Entrants	Exits	Observed exits (exits – entrants, only if positive)
Young	100	25	0
Old	25	100	75
Total	125	125	75

Not counting all exits may be appropriate, since the goal is to count permanent occupational separations that result in opportunities for new entrants. However, even if one assumes that all workers separating at a young age will reenter the occupation and thus that the older entrants are reentrants and not new entrants, the replacements method still underestimates the number of openings for new entrants, because it excludes reentrants twice shown in the following:

- When young workers leave, it does not count the separation, because there are net entrants in that cohort.
- When workers reenter in the older cohort, they reduce the observed number of separations in that cohort, because only the net change is recorded.

In the following text table example, the total for observed exits (75) does not accurately reflect the number of new entrants who were needed (100):

Cohort	Entrants		Exits	Observed exits (exits – entrants, only if positive)
	New	Reentrants		
Young	100	0	25	0
Old	0	25	100	75
Total	100	25	125	75

Not assuming that all young workers who leave will reenter magnifies the problem. In the next text table example, 25 workers exit the occupation at a young age, but only 10 of these reenter. Fifteen entrants in the older age cohort are first-time entrants into the occupation:

Cohort	Entrants		Exits	Observed exits (exits – entrants, only if positive)
	New	Reentrants		
Young	100	0	25	0
Old	15	10	100	75
Total	115	10	125	75

The assumptions necessary for using the replacements method limit the usefulness of the results. The assumption that only separations filled by workers of a different age are permanent separations excludes a larger number of separations than the actual number of permanent separations, given the dynamics of the labor force. In addition, the undercounting of separations because of the dynamics of reentering workers results in measured net separations that further undershoot actual permanent separations.

Examining the results of the replacements method helps show how unrealistically low the measured net separations are. Only 14 occupations had 10-year replacement rates greater than 50 percent in the 2014–24 projections. A 50-percent replacement rate over 10 years implies that workers currently in an occupation would remain in the occupation for an average of 10 more years. A complete turnover in an occupation would take 20 years. Even when the tenure that current workers already have in an occupation is excluded, a 50-percent replacement rate represents a stable workforce for an occupation. Yet, almost all occupations had published replacement rates well below 50 percent. The average across all occupations was 23.5 percent with the 2014–24

projections, which implies about 21 years of future tenure in the same occupation for current workers. An occupation with a constant distribution of workers by age would have an average worker spending 42 years in the occupation—nearly his or her entire career. Over a 10-year period, 54 occupations had separation rates lower than 10 percent—implying that over 90 percent of current workers would remain employed in that occupation, an implausible level of stability.

Survey error

In addition to the limitations of the method and assumptions found with using the replacements method, survey error also exists in the data published. The cohort component technique used in the replacements method requires measuring change in employment by age cohort within an occupation. The CPS collects data on approximately 500 occupations, and the replacements method requires 14 age cohorts per occupation, which results in dividing the sample into over 7,000 cohorts. Cohorts have a median employment level of 7,500, for which the relative standard error of estimates of employment is about 37 percent. Therefore, for many cohorts, even large numbers of measured net separations may not be statistically significant.[12]

One can see consequences of survey error in the variation of published replacement rates estimates from year to year. Although replacement rates are expected to vary some from year to year, large changes are likely caused by survey error, since the underlying method is unchanged and since 8 out of the 10 projected years overlap. Comparing the published 2012–22 replacement rates with those of 2014–24 shows similar rates at the overall level —23.4 percent and 23.5 percent, respectively. This result is expected because survey error is unlikely to be biased in one direction and therefore is minimized at aggregated levels. However, for detailed occupations, rates varied by as much as 54 percentage points. For example, lifeguards, ski patrol, and other recreational protective service workers had a rate of 68.4 percent in the 2012–22 projections and 14.1 percent in the 2014–24 projections. In total, 64 occupations had rates that varied by more than 10 percentage points.

Another source of error is caused by changes made to the CPS microdata to protect confidentiality. Individuals ages 65 and older included in public-use microdata records can have their recorded ages altered to prevent them from being identified as respondents. A study of the impacts of these adjustments revealed large discrepancies between data calculated from the adjusted microdata and published estimates calculated from the full data sample. These discrepancies were large enough that the authors recommended that all individuals ages 65 and older be treated as a single group because of the unreliability of specific age estimates.[13] The replacement rates method used age cohorts of 65–69, 70–74, and 75–99 that were therefore of questionable reliability. These cohorts are the source of a large number of replacements because of retirements, magnifying the impact of this problem.

A new approach: occupational separations

Because of the shortcomings of the replacements method and a review of available data, BLS has implemented a new approach—occupational separations—to estimating occupational openings, starting with the 2016–26 projections. The approach drops the focus on net employment change in favor of directly observing the two sources of replacement demand: workers who exit the labor force and workers who transfer to different occupations. (See the following box on how BLS gathered feedback regarding the new separations method.)

How did BLS collect feedback about the change in methods for measuring openings?

BLS conducted a first phase of outreach on the proposed occupational separations method from March to September 2013. During this initial phase, BLS reached out to key user groups: the Projections Managing Partnership, Workforce Information Council, and National Career Development Association. BLS also presented information on the proposed separations methodology to its Data Users Advisory Committee. This outreach gauged reactions to changing the methodology and identifying issues for further research. BLS determined that further outreach would be necessary before any decision was made but enough support existed for a change to warrant an in-depth methodological review.

The methodological review occurred from September 2013 to March 2014 and consisted of internal BLS staff analysis from multiple survey programs and research groups. In addition, academic statisticians and economists of the BLS Technical Advisory Committee reviewed the method. Their review found the method to be statistically sound and identified specific issues with the method that were addressed.

After completing the methodological review, BLS moved to conduct a second, more formal, outreach phase by issuing a Federal Register notice to solicit feedback. The Federal Register notice was open from May 16 to July 15, 2014. BLS reviewed user feedback from this second outreach phase and conducted additional research before announcing its decision to adopt the new separations method in March 2015. BLS delayed implementation until October 2017 to allow for necessary changes to state projections programs

Measuring historical separations

The new separations approach measures the two sources (workers exiting the labor force and those transferring to different occupations) of replacement demand separately, using the data source that best captures each event. The two methods are described in detail in the following subsections. Both methods use CPS microdata to identify historical separations, and the technical details include the microdata variables used in performing the calculations.[14] Both methods then use regression analysis to identify the impact of factors that affect a worker's propensity to separate from an occupation and use the results of the regression to project separations.

Historical labor force exits

Workers who leave an occupation and exit the labor force are measured with matched CPS monthly data. The CPS is a monthly household survey with a sample size of about 60,000 households. It includes data on a wide variety of topics, including labor force status, occupation, and demographics. The design of the CPS includes a longitudinal component. Respondents are surveyed eight times in two 4-month intervals. After the fourth consecutive month of being surveyed, a respondent is temporarily excluded from the survey but reenters the sample after 8 months of being out of the survey. Thus, a respondent's second 4 months in the sample fall 1 year after his or her first 4 months. Matching unique individuals from the different months they were included in the sample allows for year-over-year comparisons.

Because workers are in the CPS sample for consecutive months, the measure of labor force exits can be designed to exclude those who were out of the labor force only for a short time or who were marginally attached to the labor force. This design restricts the focus to workers who were strongly attached to the labor force, then left the labor force for a substantial period. Transient workers who do not consistently stay in the labor force and those who leave the labor force for less than 4 months are excluded. Short-term movements of these workers are not likely to create opportunities for new workers to enter an occupation in the same way as long-term movements by labor force participants leaving for considerable time.

In meeting this focus, a labor force separation is defined as people in the labor force for the first 4 months they were surveyed and out of the labor force the second 4 months. Conversely, those workers considered to have remained in the labor force were those in the labor force for all 8 months they were surveyed. All other combinations of labor force status were excluded, since it is not clear whether they represent labor force exits—these other combinations make up approximately 20 percent of matched records. This definition measures the share of individuals who leave the labor force during a 9-month period.

This definition of labor force exits provides information on people who leave the labor force for at least 4 months. Four months is assumed to be a period long enough that workers would tend to be replaced. Some of these individuals may return to the labor force in the future, if (for example) they left the labor force to pursue higher education. However, those who exit the labor force for this reason are unlikely to return to the occupations they were in when they left, and therefore they still represent separations from an occupation that need to be filled by new workers.

Monthly CPS data include respondents who are in the sample for consecutive months, on an in-for-4-, out-for-8-, in-for-4-month pattern. Individual respondents are matched by records with equivalent household identifiers (HRHHID and HRHHID2), person line number (PULINENO), sex (PESEX), race (PTDTRACE), and age (PEAGE). This matching technique follows an approach advocated by the U.S. Census Bureau and other authors.[15] Once the people are matched, labor force status can be examined over each of the 8 months an individual is surveyed.

The universe is all respondents in the monthly CPS data who meet all the following criteria:

- Able to be matched over all 8 months
- Have one of the labor force patterns just defined (either in the labor force all 8 months or in the labor force each of the first 4 months and out of the labor force in each of the last 4 months)
- Have a valid occupation code in month 4 (PEIO1OCD not equal to –1)
- Not an unpaid family worker in month 4 (PEIO1COW not equal to 8)
- Not in the Armed Forces in month 4 (PEIO1OCD not equal to 9840)

Historical matched data of 10 years are used for improving sample sizes and mitigating cyclical factors.

Once the universe of matched records is created, respondents are identified as either labor force exits or labor force stayers. They are labor force exits if they were in the labor force (PEMLR 1–4) for each of the first 4 months of their rotation but out of the labor force (PEMLR 5–7) for each of the second 4 months. As labor force stayers, they were in the labor force for all 8 months. The focus is on workers who were strongly attached to the labor force

in the first year and who either remained strongly attached to the labor force or were long-term exits from the labor force. Respondents with all other combinations of labor force status are excluded from the data.

As mentioned earlier, BLS relies on several assumptions in estimating labor force exits. One assumption is that the data used represent the population. With any survey data, one must assume that the survey represents the population it is trying to measure. However, this particular use of CPS data introduces even more assumptions. The CPS is a voluntary survey with a response rate of about 90 percent,[16] which means a small number of households do not participate at all or during certain months, preventing matches over the full 8 months. The pool of respondents is limited to those who can be matched during all 8 months in the sample. Certain respondents are excluded, including people who moved to a different residence during the period they would be surveyed. Many people move upon retirement, but many people also move to pursue new job opportunities. Therefore, it is not clear that including only individuals matched over all 8 months biases the count of labor force exits in either direction.

The method for counting labor force exits also excludes from the data those workers not consistently part of the labor force. Therefore, workers strongly attached to the labor force are assumed to represent all workers. Although this assumption may not be the case, it keeps the focus on those whose labor force exits lead to opportunities for new workers to enter the occupation, rather than including temporary leavers who will return to the occupation.

Another assumption is that the measured rate is a 9-month rate. Respondents are in the survey for 4 months, out for 8 months, and back in for 4 months. Therefore, saying that labor force exits occurred over an 8-month period may seem natural. However, the reference week is the same for each month. Hence, the partial month after the month 4 response and the partial month before the month 5 response add another month during which the respondent may have separated from the labor force.

A third assumption is that a 4-month separation from the labor force is substantial enough to imply the worker has permanently left his or her previous occupation. As previously discussed, the separations method defines labor force exits as those who are out of the labor force for at least 4 months. Many of these individuals may return to the labor force in the future, if (for example) they left the labor force to pursue higher education. However, those who leave the labor force for this reason are unlikely to return to their previous occupation, and therefore they still represent separations from an occupation that need to be filled by new workers.

Historical occupational transfers

The CPS Annual Social and Economic Supplement (ASEC), sometimes referred to as the March supplement, is used to measure workers who transfer occupations. In measuring occupational transfers, minimizing occupational coding error is a priority. Coding error is minimized when occupations are dependently coded (e.g., “are you employed in the same occupation as a month ago?”). For this reason, the CPS ASEC, which has some dependent coding of the occupation from the prior year, is a better option than the monthly CPS used in the labor force exits method, because year-to-year matches in the monthly CPS are independently coded.[17]

Because of its greater sample size, the CPS ASEC is used instead of the Job Tenure and Occupational Mobility supplement (another CPS supplement), which also collects retrospective data on a respondent’s occupation from the prior year. Most monthly supplements have the same sample size as a single month’s CPS sample (60,000 households, or around 100,000 workers), but the ASEC actually oversamples in order to provide more reliable estimates for certain demographics and averages around 200,000 respondents a month.[18] However, this sample

is still not large enough to provide reliable data for every occupation. One solution is to combine multiple years of data. The January supplement is only conducted biennially, whereas the ASEC is conducted every year. Therefore, the combined sample size for several years of ASECs is roughly 4 times that of January supplements over the same period.

For counting occupational separations, occupational transfers are defined as movement from a given major occupational group to a different major occupational group (based on the 22 Standard Occupational Classification [SOC] system major groups). Measuring transfers between major occupational groups is preferred for several reasons. As mentioned when discussing potential data sources, occupational coding error is much more common at the detailed occupational level. Many workers who show up in the data as having changed detailed occupations may not actually have left their original occupation. Although the use of the ASEC limits these errors because occupation is dependently coded for those who do not change jobs, this error is further limited with the use of only major group transfers.

Conceptual reasons for measuring transfers at the major group level exist as well. Transfers at the detailed level occur, by definition, more often than transfers at the major group level. However, many of these transfers are not due to career changes that create replacement needs. Instead, they are due to similar occupations drawing from overlapping pools of workers. For example, a worker who was previously a parts salesperson (SOC 41-2022) may fill an opening for a retail salesperson (SOC 41-2031). Transfers in the other direction are also common. These transfers do not result in opportunities for new workers; they are simply shifting workers within a fixed pool.

Although transfers among detailed occupations may occur because of similar detailed occupations drawing from the same pool of workers, at the major group level, these types of transfer are unlikely. Workers changing major occupational groups are assumed to reflect long-term career changes, creating openings for new workers. A sales worker taking a healthcare job is probably changing careers and is unlikely to return to a sales occupation. Therefore, occupational transfers are defined as occurring when a worker switched major groups, not just detailed occupations.

The universe is all respondents in the ASEC who meet all the following criteria:

- Employed in the previous year (WORKYN = 1): only people who worked in the previous year are included since only employed people can transfer out of an occupation.
- Have a valid occupation code in the current year (ADTOCC > 0): current occupation is needed to be able to determine whether they switched occupation ***or*** are out of the labor force in the current year (ALFSR = 7): individuals employed in the previous year but out of the labor force the following year do not transfer occupations (these labor force exits will be counted in the labor force exits portion of the separations method).
- At least 16 years of age in the previous year (A-AGE > 16): this criterion is to match the definition of employment included in the National Employment Matrix (note that the age in the previous year is calculated as A-AGE – 1, so A-AGE – 1 ≥ 16 is equivalent to A-AGE > 16).
- Not an unpaid family worker in the previous year (CLWK < 4): this is to match the definition of employment included in the National Employment Matrix.

· Not in the Armed Forces in the previous year (WEMOCG < 23): this is to match the definition of employment included in the National Employment Matrix.

Data from 10 supplement years are used for improving sample sizes and mitigating cyclical issues.

As just discussed, an occupational transfer is defined as switching major occupational groups. However, further considerations were needed to account for all workers. A worker employed in the previous year could have one of three job statuses in March:

1. **Employed:** These workers were recorded as an occupational transfer if their longest job major occupational group did not match their current major occupational group.

2. **Unemployed:** Although these workers were unemployed at the time of the survey, they were coded to the occupation of their most recently held job if their current major occupational group

   - was different from the longest job occupational group, a transfer was recorded because this finding indicates they transferred occupations before becoming unemployed or
   - matched their longest job occupational group, they were included in the sample as a worker who had not transferred.

3. **Not in the labor force:** These individuals were included in the sample as workers who had not transferred occupations. Their inclusion is necessary to make the number of workers employed in the previous year correct. Their separation from the occupation, however, is not counted here because those transfers are counted in the labor force exits model.

BLS also relies on several assumptions in estimating occupational transfers. The first assumption is that the measured rate is a 9-month rate. The Bureau interprets occupational transfers in the CPS ASEC as occurring over a 9-month period.[19] The Supplement asks about a respondent's longest job in the previous year. A respondent holding no more than two jobs and employed the entire year meant that he or she must have held that job in at least part of June. Most likely, some respondents held more than two jobs or were not employed for part of the year and as a result were not employed in their longest job in June. For some of these people, their job in June may have been in the same occupation as their current job even though they showed up as occupational transfers, leading to potential overcounting. Others may have been employed in a different occupation in June despite the data showing that their longest job was in the same occupation as their current job. These factors may balance out to some extent and were not considered a major concern in using these data.

Another assumption is that current demographic data represent the prior year's demographic data for respondents. The demographic data collected in the ASEC reflect respondents' demographics when they were surveyed, but the method requires the workers' demographics at the time they transferred out of their occupation in the prior year. This discrepancy is corrected by decreasing each worker's age by one to reflect the age during the previous year.[20] Determining whether a respondent's educational attainment has changed over the past year is impossible. As a result, the model uses the current values for education and assumes that changes do not occur frequently enough to alter the results of the model.

Another assumption is that no seasonal effects exist in using data from ASEC, conducted in March. This assumption may not hold in a few occupations (such as farming occupations or lifeguards). However, the

comparison works for most occupations, and no data source works better for the occupations in which this assumption might not hold without sacrificing the quality of the data used for all other occupations.

The last assumption noted here is that only different major occupational group transfers count as occupational transfers. As previously discussed, workers who transfer to another major group are unlikely to return to their previous occupation. The model limits transfers to those between major occupational groups as a data quality screen as well, though. Household surveys like the ASEC rely on individuals to provide enough information to allow survey processors to code the correct occupation. This coding is prone to error, which is critical when the number of workers moving from one occupation to another is measured.

In a study on response accuracy, BLS economists comparing CPS-coded occupations and employer records found disagreement 42.4 percent of the time at the detailed occupational level and 19.0 percent at the major occupational group level.[21] Not all error comes from coding—employer records can also be wrong. In a similar study, the U.S. Census Bureau found error rates of 48.2 percent and 24.3 percent at the detailed and major group levels, respectively. The study also was able to estimate 12.7 percent as the error rate of the company record, leaving the majority of the discrepancy due to inaccurate coding in the interview.[22]

Although limitations from coding error cannot be avoided altogether, the use of occupational transfers only at the major group level limits the impact of this error.

Estimating regression models

The historical data sources chosen for labor force exits and occupational transfers have relatively large sample sizes. However, these sources are not suited for estimating separations directly for all detailed occupations, even when multiple years of historical data are combined. Estimating separations only for aggregate occupations, such as at the minor or major occupational level, would limit the number of occupations and thus provide data of greater reliability. However, employment is projected at the detailed occupational level, and customer demand is for openings data available at the detailed level as well. Rates for aggregate occupations could be used as a proxy for detailed occupational rates, but this usage would mean every occupation in a group would have the same rate, making the data less useful for customers comparing detailed occupations.

To address these issues, BLS uses historical data to estimate regression models for both labor force exits and occupational transfers and uses those models to generate projections of separations. This has several benefits.

A regression model calculates the impact of each explanatory variable across the sample, while controlling for the other variables that may explain separations. When a regression is run, the impact of a certain occupational or age group and the impact of other factors can be calculated without a large sample of respondents that meets every combination of those factors. Similarly, a regression model allows for projections even when a particular combination of characteristics does not exist in the survey data.

As discussed, the available survey data are not sufficient to create reliable historical rates for every detailed occupation. A regression model offers a solution: by including the major occupational group as an explanatory variable, it captures the information from viewing historical data at an aggregate level while still projecting unique rates for detailed occupations. When regression results are applied, the impact of the major occupational group will be the same for every detailed occupation within that group. However, the unique demographics for the detailed

occupations (i.e., the differences in the other explanatory variables) allow the model to capture how workers in these occupations are likely to behave differently in the future.

The benefits of a regression model are also important because new occupations are added. Historical data to generate estimates of labor force exits and occupational transfers are not available for new occupations until several years of data have been collected. However, by using the major occupational group as an explanatory variable, a separation rate can be calculated for these workers.[23]

Because projecting replacement needs involves predicting the probability of the categorical outcome “will this worker leave the occupation?” the probit model is used for the regressions. For each included explanatory variable, the probit model generates coefficients that indicate the variable’s impact on the probability of leaving an occupation. These results can be used with base-year microdata on the characteristics of workers by detailed occupation for producing occupation-specific estimates of future replacement needs.

Applying regression results to project replacement needs will better handle the small samples that exist when detailed occupations are estimated. Applying the results of a probit regression to each record in the base year calculates a probability of leaving, which is based on information drawn from the entire sample. The probability does not depend on what a few workers who met those exact characteristics did historically and is therefore unlikely to generate extreme unreliable estimates.

With the method for measuring the outcomes (labor force exits and occupational transfers) established, factors were identified that likely affected an individual’s probability of separating and that are recorded in the CPS data. For consistency, the same explanatory variables are used in the labor force exits model and the occupational transfers model, with a couple of exceptions. The following characteristics are included in the models:

- **Age:** Although age will affect a worker’s propensity to leave an occupation, it is not likely to be a linear relationship.[24] The use of a categorical variable for age allows the effect of age to take on any shape.[25] Five-year age groups are used, with the exception of the youngest and oldest workers. The youngest workers are split into 16–17 and 18–19, because graduating from high school, typically at age 18, affects both labor force decisions and occupational transfers. The oldest workers were grouped into a single cohort because of sample size issues and limitations, on the basis of the way CPS codes the data; these groupings were different for the two models.[26]
- **Sex:** A categorical variable is used to differentiate between males and females. Members of each sex behave differently in the labor market.[27]
- **Age and sex interaction:** This interaction is used only in the labor force exits model. The categorical age variable is interacted with the sex variable. Men and women of similar ages behave differently regarding labor force status, with women much more likely than men to leave the labor force between the ages of 20 and 49. At older and younger ages, men and women have similar behavior. No discernable difference exists in propensity to transfer occupations.
- **Occupation:** A categorical variable specifies in which of the 22 SOC major groups the respondent was employed. Those in different occupational groups may be expected to leave the labor force or transfer occupations at different rates. The major occupational group is used because the sample size is not sufficient to model these differences at the detailed occupational level.[28]

- **Education:** A categorical variable specifies the respondent's highest level of educational attainment in one of the following seven categories: less than high school; high school; some college, no degree; associate's degree; bachelor's degree; master's degree; and doctoral or first professional degree. Workers with certain levels of education are more likely to leave the labor force to return to school, and different levels of education may affect retirement rates as well. Regarding occupational transfers, workers who have spent more time training for a job tend to be more attached to that job.[29]
- **Occupation and education interaction:** The categorical occupation variable is interacted with the education variable. Although the CPS does not provide any information on the field of study of a worker's educational attainment, this interaction likely captures some of that. Workers in occupations that do not typically require the level of education that they have behave differently than workers whose education is more closely tied to their occupation.
- **Race:** A categorical variable is used to classify respondents as "White only," "Black only," "Asian only," or "other," which includes American Indian or Alaskan Native only, Hawaiian/Pacific Islander only, and any combination of two or more races.[30]
- **Ethnicity:** A categorical variable indicates, with two options, whether the respondent is Spanish, Hispanic, or Latino, or not Hispanic.[31]
- **Citizenship:** A categorical variable indicates the respondent's citizenship, with three options: native-born U.S. citizen, foreign-born naturalized U.S. citizen, and non-U.S. citizen.[32]
- **Full-time status:** A categorical variable is used to indicate whether the respondent was in the labor force part time or full time.[33]
- **Class of worker:** A categorical variable indicates the ownership of the organization that employed the respondent, with four options: private, government (federal, state, or local), self-employed incorporated, or self-employed not incorporated.[34]
- **Industry:** A categorical variable specifies in which of the 13 North American Industry Classification System industry sectors the respondent was employed.[35]
- **Year:** A categorical variable identifies the year during which the data were collected.[36]

The model specification for labor force exits is as follows:

Prob(exit) = *f*(age, sex, age * sex, occupation, education, occupation*education, race, ethnicity, citizenship, full-time status, class of worker, industry, year).

The model specification for occupational transfers is as follows:

Prob(transfer) = *f*(age, sex, occupation, education, occupation * education, race, ethnicity, citizenship, full-time status, class of worker, industry, year).

Projecting separations

The coefficients of the historical data regressions provide information on the probability that a worker with those characteristics will leave the labor force or transfer from his or her current occupation to another occupation. These coefficients are applied to the current demographic structure of occupations for projecting the number of workers expected to leave the labor force or transfer occupations. The process for converting the results of each model into a projection is nearly identical, so the two models are discussed together in this section.

Current data on occupations come from the monthly CPS data. All months from the current base year are used, along with all months from the previous year for increased sample sizes. The independent variables are taken directly from each monthly data respondent for all respondents who are employed (ALFSR = 1 or 2). Note that, for the occupational transfers model, variable names in the monthly data do not always match the variable names from the ASEC; equivalent variables are identified and used.

The parameters for each respondent, plus the regression coefficients, generate a *z*-score for the probability of that worker leaving the labor force or transferring to a different occupation. The *z*-score is converted into a probability for each respondent. That probability is multiplied by the respondent weight (PWCMPWG), which is an estimate of how many people an individual respondent represents in the population. For instance, if an individual represents 100 people and has a 5-percent chance of separating, then the estimate is that 5 of those 100 represented people will leave the occupation. The estimated number of workers leaving and the total represented employment are aggregated by occupation for calculating occupation-specific projected rates of leaving the labor force or transferring occupations. Thus, individual propensities to leave the labor force or transfer occupations allow one to calculate a projected rate of separation for each occupation.

In projecting separations, BLS makes several assumptions. First, the near future will resemble the recent past. The use of 10 years of historical data assumes that rates of leaving the labor force and transferring occupations in the near future—given specific demographics, educational attainment, and occupational group—will be similar to rates observed in the recent past. Using more historical data would generate more reliable regression results, but those results would be based on increasingly out-of-date data.

A second assumption is that business cycles do not have a major impact on the historical data. The projections program assumes full employment in the projected year, but the historical data used to run the regression may have been drawn from years at different points in the business cycle. In particular, data from the great recession is currently included in the historical data. BLS has examined the issue and found that historical data for the years 2008–10 do not display substantially different behavior than data from before or after the recession. Calculated occupational transfer rates averaged 4.2 percent during the years 2008–10 compared with 4.4 percent during nonrecession years, whereas calculated labor force separations averaged 2.7 percent for both periods. Excluding the recession years from the model would only reduce the sample size of the historical data and therefore the reliability of the historical estimates, without any appreciable impact on the overall magnitude of the results. Furthermore, the use of year dummy variables in the regression model will help smooth any year-specific factors not included in the other explanatory variables. Therefore, BLS believes that using a full 10 years of historical data in developing historical estimates is appropriate.

A third assumption is that current demographics represent demographics over the projections period. The use of current demographic data along with the results of the regression model assumes that the demographic profile of an occupation will not change appreciably over the next 10 years. This assumption is necessary because BLS does not project the demographic changes in occupations. Most demographics of *current* workers would be easy to estimate, because they are either unlikely to change or would change in a predictable manner, such as age. Educational attainment will change over time, but likely not substantially. However, predicting the demographics of new entrants is not feasible. The assumption is therefore that the overall demographic profile of an occupation will

remain constant. Although demographics of an occupation do change slowly, these small changes are not likely to substantially affect the calculated separation rates.

Incorporating separations into employment projections

The labor force exits model and the occupational transfers model each produce 9-month rates. These are converted into annual rates by multiplying the rates by 12/9. The model rates are available for the 533 detailed occupations available in the CPS microdata. In cases in which multiple SOC occupations are aggregated into one CPS occupation, the rate from the CPS occupation is assigned to all the component SOC occupations. As a result, some detailed SOC occupations have identical rates.

The replacement rates method adjusted historical separation rates for historical employment declines in order to calculate replacement rates. The new separations method does not adjust historical rates for declines because projected declines are already projected separately, so the method does not need to use historical declines. Therefore, BLS produces and publishes projected separation rates. It uses these rates to project openings by adding projected employment growth or subtracting projected employment decline.

In addition to publishing separation rates, BLS publishes the projected number of openings for each occupation. Because the method produces annual average rates, BLS multiplies the rate by the midpoint projected employment (that is, the average of the base- and projected-year employment) to calculate a projected average annual number of labor force exits and occupational transfers.

Because employment and separations are projected independently, a projected decline in employment could possibly exceed the projected number of separations for a detailed occupation. This result is conceptually impossible (if employment declines by 1,000, then at least 1,000 workers separated from that occupation) but could theoretically occur because of independent projections methods. When this situation occurs, the separations rates are published as calculated, but openings are set to zero rather than reporting a negative number of openings. In the 2016–26 projections, this scenario occurred with two occupations—locomotive firers and respiratory therapy technicians.

For summary SOC occupations, the number of labor force exits or occupational transfers from each component detailed occupations are summed and used for calculating a rate for the summary occupation.

When incorporating separations into employment projections, one can assume that separation rates are not tied to occupational growth or decline. Separation rates are calculated independently of employment projections. Implicitly, this process assumes that workers will leave the labor force or transfer occupations at a similar rate regardless of employment growth or decline in their occupation, although this assumption may not be entirely valid. The employment projections program focuses on long-term trends and does not include year-to-year employment change in the regression model.

Another assumption is that employment will grow or decline at a steady rate over the projections period. Applying the separation rate to the midpoint between base and projected employment assumes that employment will grow or decline at a steady rate over the projections period. BLS does not project the path of employment from the base to the projected value, and the actual midpoint employment may not match the projected midpoint employment, even if the projection for the target year is correct. However, the most common paths from base-year to projected-

year employment would all lead to similar annual average levels of employment and not substantially affect the overall projected number of replacement needs.

Results

In this section, the results from the 2016–26 employment projections, which use the separations method, are presented. A comparison with the results from the 2014–24 employment projections, which use the replacements method, is given in appendix A. Although the differences in projections periods slightly affect comparability, the concepts measured by these methods are mainly driven by long-term demographic changes in the labor market and do not vary much from year to year.[37]

Additional information is provided in appendix B that compares projections of occupational openings with JOLTS data to illustrate the differences in concepts between these data sources.

Table 3 shows the data elements released for each occupation as part of the 2016–26 employment projections, along with data for two occupations—surgeons who have a low separations rate and bartenders who have a high rate. Surgeons have a higher labor force exit rate than occupational transfer rate. This finding is not surprising because surgeons require lengthy educational preparation, which is not transferrable to most other occupations, whereas bartenders have much lower barriers to entry and have a higher occupational transfer rate than labor force exit rate.

Table 3. Occupational separations, 2016–26 (numbers in thousands)

Occupation	Employment		Employment Change, 2016–26		Separations rate, 2016–26 annual average		
	2016	2026	Number	Percent	Labor force exit rate	Occupational transfer rate	Occupational separations rate
Surgeons	45.0	51.5	6.5	14.4	1.5	1.1	2.6
Bartenders	611.2	626.3	15.1	2.5	4.8	11.5	16.3

Source: U.S. Bureau of Labor Statistics.

The separations rates are annual averages over the projection period and reflect the share of workers employed in an occupation that is expected to leave the occupation. Therefore, on average, 1.5 percent of surgeons leave the occupation by exiting the labor force each year, whereas 11.5 percent of bartenders leave the occupation and find work in a different occupation. The numeric occupational separations are also annual averages and reflect the average number of positions in which the incumbent worker leaves the occupation. Therefore, on average, 500 surgeons leave the occupation to find work in a different occupation, whereas 29,800 bartenders leave the labor force each year. The 1,900 occupational openings per year projected for surgeons represent opportunities for new workers to enter the occupation.

Also notable is the interplay of projected employment change and occupational openings. Bartenders are projected to grow by only 2.5 percent over the 10-year projection period, yet they will average 102,500 openings per year—almost all of them are because of separations. Surgeons are projected to grow much faster at 14.4 percent,

yet will only provide 1,900 openings per year, because of the much lower separation rates and the smaller size of the occupation.

Overall, the 2016–26 projections show an annual average separation rate of 11.0 percent, based on a 4.7-percent labor force exit rate and a 6.4-percent occupational transfer rate (see occupational separations and openings table on the Bureau's website).[38] This overall rate implies that the average worker spends a little over 9 years in an occupation and that, over the course of a 35–40-year career, the average worker has jobs in about four occupations. Rates for detailed occupations range from a high of 24.4 percent to a low of 2.5 percent. Occupations with the highest rates tend to be transient or seasonal jobs, whereas those with the lowest rates tend to be professional occupations with high entrance requirements.

The annual average number of occupational openings range from 736,700 for combined food preparation and serving workers, including fast food, to approximately zero for certain small occupations.[39] An annual average 19.0 million occupational openings are projected across all occupations, resulting from 17.8 million occupational separations and a 1.2-million net change in employment.

Conclusion

BLS has implemented a new occupational separations method for projecting occupational openings beginning with the 2016–26 projections. This method uses matched CPS and CPS supplement data to measure historical separations caused by workers either leaving the labor force or transferring to a different occupation and then projects this using probit models. This method improves on previous methods by better capturing all the separations that create opportunities for new entrants into an occupation, an important metric for career planning and workforce development.

Appendix A. Comparison with replacements rates method in the 2014–24 projections

The annual average replacement rate in the 2014–24 projections was 2.4 percent, which is far below the 2016–26 occupational separation rate of 11.0 percent.[40] Similar differences exist in the total number of openings, from 4.7 million in the 2014–24 projections to 19.0 million in the 2016–26 projections. BLS switched from the replacements method to the separations method because the limitations of the replacements method resulted in it not capturing as many actual replacements as it should, so this higher rate from the separations method was expected. Note that the higher rate (and higher number of occupational openings) is not the result of changes in economic conditions but rather a change to the method that better captured openings that already existed.

Table A-1 shows the annual average replacement and separation rates by major occupational group. In addition to overall higher rates, the separations method results show greater dispersion across occupational groups. Although the overall rate is about 4.5 times higher, the rate for healthcare practitioners and technical occupations is only 2.4 times higher, and the rate for personal care and service occupations is 7.2 times higher. Generally, the separation rates are lower for more highly educated professional occupations and higher for lower skilled occupations. The replacement rates show no such clear trends.

Appendix table A-1. Comparison of replacement and separation rates by occupational group, 2014–24 and 2016–26

Occupational group	2014–24 replacement rate (annual average)	2016–26 separation rate (annual average)
Total, all occupations	2.4	11.0
Management occupations	2.2	7.9
Business and financial operations occupations	2.0	8.9
Computer and mathematical occupations	1.5	6.5
Architecture and engineering occupations	2.5	7.1
Life, physical, and social science occupations	2.8	8.9
Community and social service occupations	2.2	10.7
Legal occupations	1.7	6.0
Education, training, and library occupations	2.1	8.5
Arts, design, entertainment, sports, and media occupations	2.5	10.4
Healthcare practitioners and technical occupations	2.2	5.2
Healthcare support occupations	2.2	11.2
Protective service occupations	2.4	10.6
Food preparation and serving related occupations	3.7	17.0
Building and grounds cleaning and maintenance occupations	2.0	12.9
Personal care and service occupations	2.1	15.1
Sales and related occupations	3.0	13.6
Office and administrative support occupations	2.0	11.2
Farming, fishing, and forestry occupations	2.6	14.8
Construction and extraction occupations	1.6	10.5
Installation, maintenance, and repair occupations	2.3	9.5
Production occupations	2.2	11.4
Transportation and material moving occupations	2.4	12.1

Source: U.S. Bureau of Labor Statistics.

Appendix B. Comparison with JOLTS data

BLS data on job openings, hires, and separations from the JOLTS program measure different concepts than the projections of occupational separations, but comparing the data can help explain these differences. The JOLTS job openings metric is a point estimate, because it measures the number of job openings on the last business day of a month. For example, the number of job openings in January 2017 was 5.6 million and in February 2017 was 5.7

million.[41] However, between the last business day of January and the last business day of February, some existing job openings were filled while new job openings were created. Determining how many of the job openings in January were the same as the job openings in February was not possible. Therefore, an annual average metric of job openings from JOLTS cannot be created that could be compared with the annual average number of occupational openings.

Two other JOLTS metrics, however, are flow metrics that can be compared with occupational openings and separations. Hires (new employees added to the payroll) and separations (employees removed from the payroll) are measured monthly but can be summed over all months to get an annual total. In 2016, there were 62.7 million hires and 60.4 million separations. The 62.7 million hires are comparable to the 19.0 million occupational openings, with the difference in magnitude being that JOLTS hires cover all workers who start new jobs with a different employer, whereas occupational openings covers all workers who start new occupations. Therefore, the JOLTS hires metric is several times larger than the occupational openings metric because JOLTS hires capture workers who change employers but not occupations, but occupational openings only capture workers who change occupations. Notwithstanding the differences in time, this result implies that workers are much more likely to change jobs than change occupations.

Similarly, the JOLTS separations estimate of 60.4 million and the occupational separations estimate of 17.8 million separations differ because the JOLTS separations metric measures movements out of jobs, whereas the occupational separations metric measures movements out of occupations.

The number of observed exits (75) has not changed, but the number of new entrants has increased, increasing the magnitude of the undermeasurement even more.

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NOTES

1 For more on the National Employment Matrix, see https://www.bls.gov/emp/documentation/definitions.htm

2 For more information on the BLS Job Openings and Labor Turnover Survey program, see https://www.bls.gov/jlt/.

3 S. C. Kelley, Thomas N. Chirikos, and Michael G. Finn, *Manpower forecasting in the United States: an evaluation of the state of the art* (Columbus, OH: Center for Human Resource Research, The Ohio State University, 1975).

4 “Measuring labor force movements: a new approach,” report 581 (U.S. Bureau of Labor Statistics, 1980).

5 Alan Eck, “New occupational separation data improve estimates of job replacement needs,” *Monthly Labor Review*, March 1984, pp. 3–10, https://www.bls.gov/opub/mlr/1984/0 3/art1full.pdf.

6 Alan Eck, “Improved estimates of future occupational replacement needs,” *Monthly Labor Review*, November 1991, pp. 95–102, https://www.bls.gov/opub/mlr/1991/11/art5full.pdf.

7 To increase the sample size and reduce cyclical fluctuations, one would average and use employment data from 5 years as the employment level in each reference year.

8 This step includes historical rates of increase for those occupations that had net entrants. For declining occupations, this step uses net separation rates, rather than replacement rates.

9 BLS does not measure the number of career changes as there is no consensus for what constitutes a career change. See https://www.bls.gov/nls/nlsfaqs.htm#anch43.

10 For a summary on employee tenure, see "Employee tenure summary," news release USDL–16–1867 (U.S. Bureau of Labor Statistics, September 22, 2016), https://www.bls.gov/news.release/tenure.nr0.htm.

11 For employment information on Americans at age 50, see "Results from a longitudinal survey," news release USDL–17–1158 (U.S. Bureau of Labor Statistics, August 24, 2017), https://www.bls.gov/news.release/pdf/nlsoy.pdf.

12 For further information on the reliability of CPS estimates, see "Calculating approximate standard errors and confidence intervals for Current Population Survey estimates," technical documentation (U.S. Bureau of Labor Statistics, May 2017), https://www.bls.gov/cps/calculating-standard-errors-and-confidence-intervals.pdf.

13 See J. Trent Alexander, Michael Davern, and Betsey Stevenson, "Inaccurate age and sex data in the Census PUMS files: evidence and implications," NBER Working Paper 15703, http://www.nber.org/papers/w15703.pdf.

14 CPS microdata files and data dictionaries are available from the U.S. Census Bureau website at https://www.census.gov/.

15 The matching technique is based on two U.S. Census Bureau papers: Jonathan Fisher and Christina Houseworth, "Occupation inflation in the Current Population Survey," no. CES 12-26 (Washington, DC: U.S. Census Bureau, Center for Economic Studies, September 2012), ftp://ftp2.census.gov/ces/wp/2012/CES-WP-12-26.pdf; and "How to link CPS public use data files" at https://www2.census.gov/programs-surveys/cps/methodology/How%20To%20Link%20CPS%20Public%20Use%20Files.pdf.

16 For more information about the CPS survey, see https://www.census.gov/programs-surveys/cps/about/faqs.html#Q6.

17 Question 46 in the CPS ASEC asks respondents whether the longest job they held in the prior calendar year is the same as their current job. If it is not, question 47 asks them what that job was, including information about the occupation, industry, and class of worker. These data are coded into Supplement variables that define the longest job held in the previous year.

18 See "Number of records by sample year: ASEC" (IPUMS-CPS, University of Minnesota), https://cps.ipums.org/cps/sample_sizes.shtml.

19 Gueorgui Kambourov and Iourii Manovskii discuss this interpretation, as well as its limitations, in an academic paper titled "A cautionary note on using (March) CPS and PSID data to study worker mobility," May 5, 2010, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.364.960&rep=rep1&type=pdf.

20 As previously stated, the longest job is assumed to be from 9 months prior, so subtracting 1 year from the age reflects the limitation that age is provided in years, not months.

21 Wesley Mellow and Hal Sider, "Accuracy of responses in labor market surveys: evidence and implications, *Journal of Labor Economics*, vol. 1, No. 4, October 1983, pp. 331–344, https://www.journals.uchicago.edu/doi/abs/10.1086/298016.

22 Nancy A. Mathiowetz, "Errors of reports in occupations," *The Public Opinion Quarterly*, vol. 56, No. 3, Autumn, 1992, pp. 352–355.

23 The Standard Occupational Classification was revised in 2018. Each revision typically includes the addition of several new occupations. For more information, see https://www.bls.gov/soc.

24 For labor force exits, age is drawn from PEAGE in month 4. Workers ages 80 and older are grouped into a single cohort. For occupational transfers, age is calculated as A-AGE – 1. Workers ages 75 and older are grouped into a single cohort.

25 Although retirements clearly increase with age, pursuing schooling or raising a family does not, so even for labor force exits, the overall impact of age is not linear.

26 The age recorded in the supplement is the age at the time of the survey, but the age from the previous year is necessary for comparison to base-year data when replacements are projected, so the age is decreased by one. CPS codes all workers 80–84 as "80" and all workers 85 and over as "85," so subtraction would not give us accurate numbers for age groups 75–79 or higher. The maximum cohort is therefore age 75 and up.

27 For labor force exits, gender is drawn from PESEX in month 4. For occupational transfers, gender is drawn from A-SEX.

28 For labor force exits, occupation is drawn from PRDTOCC1 in month 4. For occupational transfers, occupation is drawn from WMOCG.

29 For labor force exits, education is drawn from PEEDUCA in month 4. For occupational transfers, education is drawn from A-HGA; this is the worker's current education, since his or her education level in the previous calendar year cannot be measured.

30 For labor force exits, race is drawn from PTDTRACE in month 4. For occupational transfers, race is drawn from PRDTRACE.

31 For labor force exits, ethnicity is drawn from PEHSPNON in month 4. For occupational transfers, ethnicity is drawn from PEHSPNON.

32 For labor force exits, citizenship is drawn from PRCITSHP in month 4. For occupational transfers, citizenship is drawn from PRCITSHP.

33 For labor force exits, full-time status is drawn from PRFTLF in month 4. For occupational transfers, full-time status is drawn from HRCHECK.

34 For labor force exits, class of worker is drawn from PEIO1COW in month 4. For occupational transfers, class of worker is drawn from LJCW.

35 For labor force exits, industry is drawn from PRMJIND1 in month 4. For occupational transfers, industry is drawn from WEMIND.

36 For labor force exits, year refers to month 5 of the survey. For labor force exits, year refers to the year in which the survey was conducted.

37 For example, the overall replacement rate for all occupations was 23.5 percent in the 2014–24 projections, 23.4 percent in the 2012–22 projections, and 23.6 percent in the 2010–20 projections.

38 Projected data for all occupations are available from table 1.10: Occupational separations and openings, projected 2016–26, "Employment projections: occupational separations and openings" (U.S. Bureau of Labor Statistics), https://www.bls.gov/emp/tables/occupational-separations-and-openings.htm.

39 Although no occupations have zero openings, the employment projections data are rounded to the hundreds, so any openings less than 50 are reported as zero.

40 The 2014–24 projections, which used the replacements method, presented data as 10-year totals; to ease comparisons, we present these data here as annual averages.

41 For January 2017 job openings, see "Job openings and labor turnover survey," news release USDL–17–0320 (U.S. Bureau of Labor Statistics, March 16, 2017), https://www.bls.gov/news.release/archives/jolts_03162017.htm; and for February 2017 job openings, see "Job openings and labor turnover," news release USDL–17–0416 (U.S. Bureau of Labor Statistics, April 11, 2017), https://www.bls.gov/news.release/archives/jolts_04112017.htm.

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