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Occupational employment and wage differences across cohorts of establishments

We merge detailed microdata from the Occupational Employment Statistics survey with establishment founding dates from the BLS Longitudinal Database, which allows us to estimate the occupational and wage distributions of employees by the founding dates of their employing establishments. Overall, we find greater employment levels for older establishments—particularly in education, healthcare, and production occupations—but these differences in employment levels are entirely explained by establishment age. Examining wages, we find that, overall, older establishments pay higher hourly wages than younger establishments, and these differences are not entirely explained by establishment age. We also find noticeable differences in patterns of occupational wages across establishments of different ages. In particular, healthcare occupations have higher wages in younger establishments.

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To our knowledge, this is the first article to examine employment differences by occupation for employer "birth" cohorts, as well as the first to examine wage differences—overall and by occupation—by these employer cohorts. The employer cohorts are defined by the business cycle stages (expansions or contractions) at the time the establishments first reported employment. Although our analysis is descriptive, the importance of new employers in aggregate job creation and future employment and wage levels lends significance to our findings. In contrast to a 2016 study by Sara Moreira and a 2017 study by Petr Sedláček and Vincent Sterk, our study finds that establishments "born" during recessions are no smaller than employers born during expansions—after accounting for the age of the establishment.[1] However, our findings show that employers born during the Great Recession (2007–09) pay lower wages overall than similarly aged employers born

during the surrounding establishment birth cohorts, with some notable exceptions, such as in healthcare occupations.

Our analysis relies on a new combination of data, in which information collected by the BLS Occupational Employment Statistics (OES) survey during the period from November 2012 to May 2015 is matched with decades of data assembled from the BLS Quarterly Census of Employment and Wages (QCEW). These matched data allow us to estimate for the first time the occupational and wage distributions of employees by their establishment founding date. Because the occupational employment and wage data were collected in six periods over 3 years, there is some overlap in age between establishments of different cohorts. This overlap allows us to estimate separately the impact of employer birth cohorts and employer age on employment size and wage levels.

Several scholars have previously studied the impact of establishment founding date on employment levels. In a 2013 article, for example, John C. Haltiwanger, Ron S. Jarmin, and Javier Miranda find that young firms tend to either grow quickly or go out of business, while older firms have much more stable employment patterns.[2] In an article that looks more specifically at establishment founding dates, Sara Moreira examines the entire universe of businesses that started during the 1978–2001 period and finds that businesses that began during contractionary periods started with smaller employment levels than other businesses, and these differences in employment size did not dissipate over time.[3] In addition, Moreira finds that the businesses that successfully started during recessions tended to be in industries requiring greater amounts of technical skill. Similarly, Sedláček and Sterk find that there is more employment in businesses founded during expansions and that this is due more to the size of these businesses than to their number.[4] Both the Moreira study and the Sedláček and Sterk study link the smaller size of businesses born during recessions to having fewer customers, and both find that cohort of birth is associated with greater differences in firm size in industries in which advertising and marketing are more important.

However, none of these scholars has had access to data that identify occupations within establishments. For example, the Moreira study's finding that businesses successfully started during recessions are mostly found in industries requiring higher levels of technical skill suggests that such businesses would employ more people in technical occupations, but the data used in that study do not include occupational composition. These earlier studies thus cannot show whether the patterns they document are driven by differences in the occupations in establishments with different founding dates, or whether these patterns are the same regardless of the establishments' occupational composition. Our employment results may also differ from those of the earlier studies because we examine a much shorter and slightly later period than the earlier studies. We introduce new data to study these questions, using a unique match of establishment founding dates from the QCEW combined with the microdata on occupations from the OES survey.

The remainder of this article is organized as follows: The first section describes the data we used in our analysis; the second section describes basic employment and wage patterns by employer cohort and major occupational category; the third section presents regression estimates of employer cohorts and age on establishment size and wage levels, with and without occupation controls; and the final section provides a brief conclusion.

Data matching and adjustments

The first set of data used in this article is from the BLS Quarterly Census of Employment and Wages (QCEW). These data are from the filings that every employer makes each quarter to comply with unemployment insurance (UI) regulations, as well as "Multiple Worksite Reports," which detail how the employment and wages of

multiestablishment employers are divided among worksites and reports to the “Annual Refiling Survey” that give updated industry information for each establishment. Each state’s workforce agency compiles these filings and transmits them to BLS. BLS then combines the reports from the 50 states and the District of Columbia to create a national database of establishments that is used (among many other purposes) as the sampling frame for the BLS Occupational Employment Statistics (OES) survey.

For this article, we used all of the QCEW data on establishments that existed from the fourth quarter of 2012 to the second quarter of 2015 and determined the year and quarter in which each establishment first appeared in the UI records. We consider this to be the establishment’s birth date. Using this information, we grouped the establishments into cohorts, separating establishments born during recessions from those born during expansions. (See table 1.)

Table 1. Birth cohort definitions and employment and wages, by birth cohort

Birth cohort	Business cycle	Number of birth quarters included	Estimated employment	Employment per quarter of cohort length	Average hourly wage
1. Q4 2000 and earlier	Expansions and contractions	Not well defined	87,858,370	529,267	$23.92
2. Q1 2001 to Q4 2001	Recession	4	2,987,580	746,895	21.49
3. Q1 2002 to Q3 2007	Expansion	23	16,882,920	734,040	21.02
4. Q4 2007 to Q2 2009	Recession	7	4,807,480	686,783	20.45
5. Q3 2009 and later	Expansion	24	16,072,030	669,668	19.97

Source: U.S. Bureau of Labor Statistics.

Because the QCEW data can only be linked back to late 1992, we cannot identify birth dates for establishments born before 1992, which means that establishment birth cohort 1 contains establishments born during both expansions and recessions.

The second set of data used here are the microdata that underlie the May 2015 estimates from the OES survey. These estimates of employment and wages by occupation are calculated by using data collected over a 3-year period from establishments selected in six biannual panel samples (from November 2012 to May 2015). For most establishments, these samples are selected from the QCEW data assembled for the previous year and can be perfectly matched with QCEW records. We exclude two main categories of employment: (1) railroad employment, which is not sampled for the OES because this industry is not part of the unemployment insurance system, and (2) employment in the federal government, the U.S. Postal Service, and state government outside of schools and hospitals.[5]

Matching OES estimates with QCEW microdata allows us to assign birth cohort information to all establishments that are included in the May 2015 OES estimates (with the previously noted exceptions). We also modified the OES imputation and benchmarking procedures so that data imputed to establishments that did not respond to the survey are taken from responding establishments within the same cohort, and total employment levels in the OES survey are benchmarked to the employment levels for each cohort in the QCEW. (Details of how the imputation

and benchmarking procedures were modified are given in the appendix to this article.) We use the number of quarters elapsed between the birth date found in the QCEW data and the date of observation in the OES survey microdata to calculate an age for establishments in the matched data. Because we do not know the birth dates for establishments that were already in existence in late 1992, we cannot calculate the ages of establishments that were born before then.

Patterns of employment and wages by establishment birth cohort

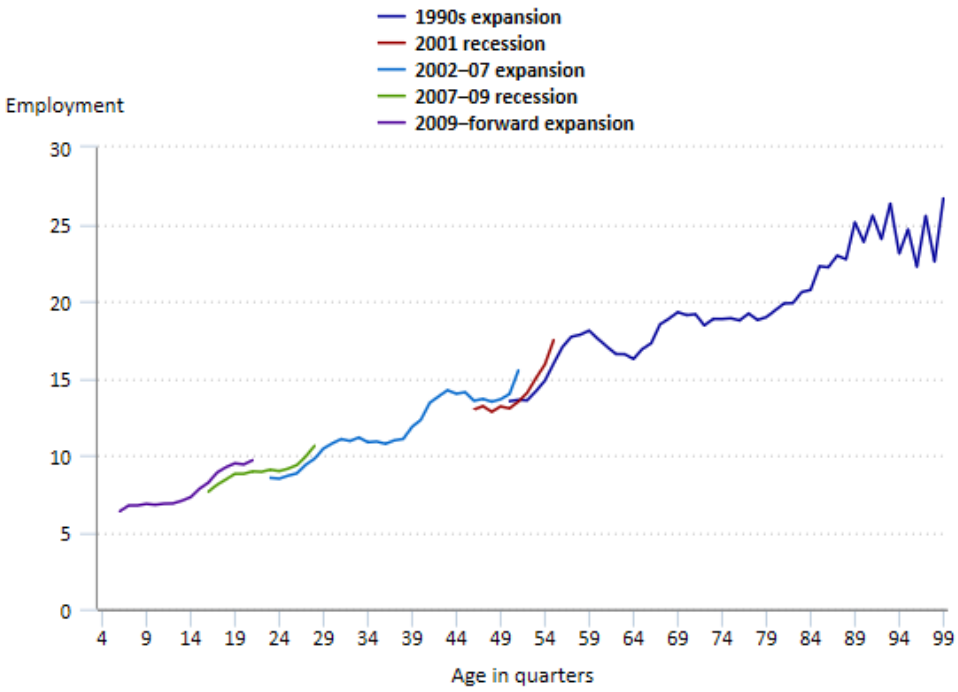
An examination of the May 2015 OES survey data on aggregate employment distribution by birth cohort shows that, overall, cohorts that span longer periods tend to have higher employment levels. Table 1 shows that most employment is in the earliest birth cohort, which represents 68 percent of total employment. The smallest cohorts correspond to the recessions of 2001 (the first quarter of 2001 to the fourth quarter of 2001) and 2007–09 (the Great Recession, which occurred from the fourth quarter of 2007 to the second quarter of 2009).[6]

Because these cohorts cover varying lengths of time, we normalize employment by using the number of quarters within each birth cohort. (For the first cohort, we arbitrarily choose a length of 166 quarters, to begin in the third quarter of 1959, when Hawaii joined the United States as the 50th state.) After carrying out this normalization, we find that, except for the oldest cohort, total current employment is positively correlated with establishment age.

Establishments born during the first cohort have the lowest average employment per quarter of cohort length, although this cohort is not entirely comparable to the other cohorts because of the somewhat arbitrary choice of 166 quarters for its length. Establishments born during the 2001 recession have the highest average current employment per quarter of cohort length.

The studies by Moreira and Sedláček and Sterk find that differences in employment between cohorts are driven by differences in establishment size.[7] In figure 1, we show average employment per establishment by age (up to 101 quarters, for establishments born in the third quarter of 1992 and observed in the second quarter of 2015) and cohort in the matched OES-QCEW data.

Figure 1. Average employment per establishment, by age and cohort

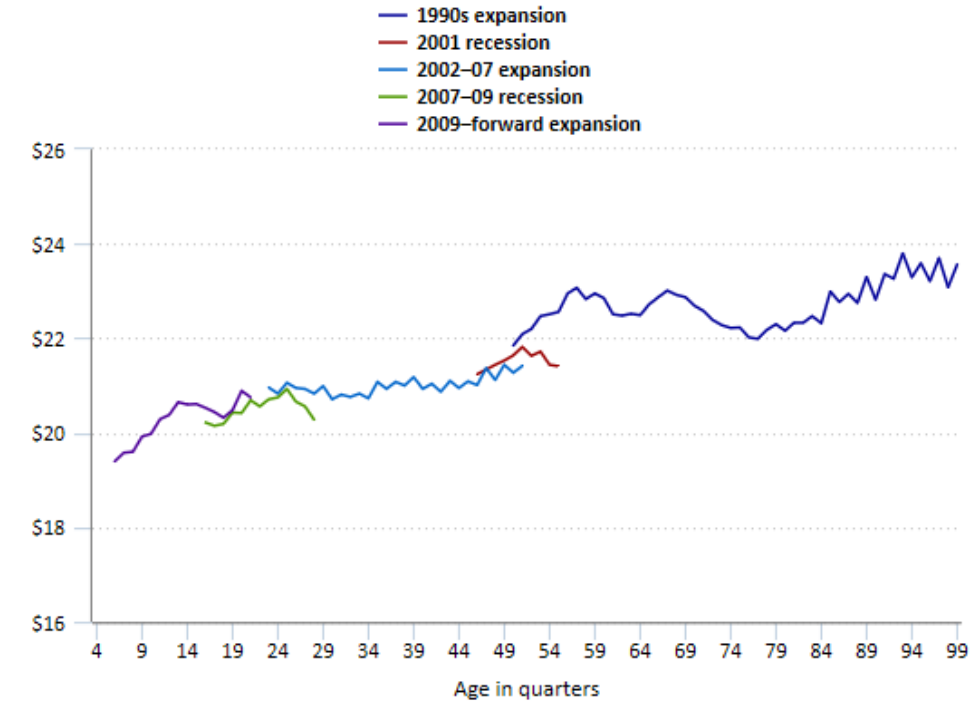


Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

Similar to the findings of Haltiwanger, Jarmin, and Miranda, our findings show a strong impact of age on establishment size, with younger establishments being considerably smaller than older establishments.[8] Because we use OES data collected during six collection periods, from the fourth quarter of 2012 to the second quarter of 2015, there is an overlap in age between the cohorts in our data. Figure 1 shows that for nearly every establishment age in these areas of overlap, newer cohorts have higher employment in each establishment. This is a different pattern from what the studies by Moreira and Sedláček and Sterk found (using Census Bureau data for a longer and earlier period)—both of these studies conclude that establishments born during contractions have lower employment levels for their age than establishments born during expansions.[9]

Turning to wage levels, shown in table 1, we find that current wages are positively correlated with establishment age, with the highest average hourly wages found in the oldest establishments (those born in the fourth quarter of 2000 and earlier) and the lowest average hourly wages found in establishments born in the fourth quarter of 2009 and later. Much of this overall pattern can be explained by the greater age of the establishments in the older cohorts—and, as we attempt to show later in this article, much of the wage difference by age of employer is itself driven by differences in employer industry and occupational composition. As noted by several previous studies, older businesses tend to pay higher wages.[10] Thus, in figure 2, we plot average wages per worker by establishment age in quarters for the employers of each cohort in the matched OES-QCEW data.

Figure 2. Average hourly wage per worker, by establishment age and cohort



Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

This figure shows that there are some differences in average wage levels for similarly aged establishments that are part of different birth cohorts. Establishments born during the 2001 recession had lower average wages than similarly aged establishments born before 2001, and establishments born in the Great Recession had lower wages than similarly aged establishments born during the 2002–07 expansion or during the current expansion that began in 2009. Older establishments born during the 2002–07 expansion that are observed 50 quarters later pay noticeably lower average wages than the youngest establishments born during the expansion of the 1990s and also observed 50 quarters later.

Employment patterns by industrial sectors

Table 2 presents employment levels by industrial sector and establishment birth cohort. These estimates include all of the employment shown in table 1 grouped into the sectors of the North American Industry Classification System (NAICS).

Table 2. Employment and hourly wages, by establishment birth cohort and industry sector

Industry sector	NAICS code	First reported employment occurred:									
		Q4 2000 and earlier		Q1 2001 to Q4 2001		Q1 2002 to Q3 2007		Q4 2007 to Q2 2009		Q3 2009 and later	
		Employment	Hourly wage	Employment	Hourly wage	Employment	Hourly wage	Employment	Hourly wage	Employment	Hourly wage
All industry sectors	00	87,858,370	$23.92	2,987,580	$21.49	16,882,920	$21.02	4,807,480	$20.45	16,072,020	$19.97
Agriculture, forestry, fishing and hunting	11	230,930	14.1	10,800	13.74	67,370	13.11	24,950	12.65	80,600	11.95
Mining, quarrying, and oil and gas extraction	21	500,700	31.52	16,770	27.63	117,670	29.31	43,330	27.11	137,630	28.38
Utilities	22	475,640	35.79	10,110	34.14	34,330	33.96	8,540	33.16	24,770	31.76
Construction	23	3,881,280	25.86	157,780	23.88	1,013,800	22.93	275,270	22.52	1,120,520	22
Manufacturing	31–33	10,429,400	24.27	185,330	22.35	938,050	21.37	211,250	21.7	622,430	20.14
Wholesale trade	42	4,128,800	26.47	139,990	27.04	728,020	26.41	200,740	25.37	688,490	26.2
Retail trade	44–45	9,828,160	15.58	463,610	14.59	2,715,820	14.51	724,500	14.45	2,196,380	14.09
Transportation and warehousing	48–49	3,197,360	22.44	107,630	19.37	601,350	19.87	159,980	19.38	533,850	19.1
Information	51	1,922,630	33.77	87,510	33.01	366,490	33.03	100,600	33.22	304,270	31.85
Finance and insurance	52	4,035,770	32.73	151,800	33.39	756,920	32.23	206,940	31.91	558,950	31.03
Real estate and rental and leasing	53	1,156,400	22.15	58,660	21.91	349,130	21.52	112,080	21.24	412,340	20.81
Professional, scientific, and technical services	54	4,939,540	38.22	242,470	36.94	1,439,730	36.21	416,820	35.38	1,502,390	34.32
Management of companies and enterprises	55	1,888,650	38.49	36,970	38.49	198,470	36.58	43,010	38.54	109,930	37.88
Administrative and support and waste management	56	5,139,670	17.6	293,720	18.09	1,603,180	17.79	440,340	17.63	1,531,000	17.11
Educational services	61	11,772,700	25.36	96,600	22.4	532,040	22.7	148,870	21.83	416,600	21.77
Healthcare and social assistance	62	13,889,150	25.35	376,690	22.01	2,156,520	22.29	605,870	21.8	1,834,500	22.44
Arts, entertainment, and recreation	71	1,476,600	16.92	53,300	16.49	282,620	17.25	93,800	16.84	351,770	16.98
Accommodation and food services	72	6,518,230	12.06	406,250	11.83	2,381,420	11.73	793,590	11.59	2,942,640	11.39
Other services (except public administration)	81	2,446,760	20.02	91,590	17.74	599,990	17.66	197,000	17.14	702,960	16.6

Source: U.S. Bureau of Labor Statistics.

Employment levels by employer birth cohort vary greatly by industrial sector. The accommodations and food services sector has more employment in younger establishments, with only 50 percent of employment found in the establishments of the oldest cohort and 23 percent of employment found in the establishments of the youngest cohort. This sector is followed by the real estate and rental and leasing sector, with 55 percent of employment found in the establishments of the oldest cohort and 20 percent of employment found in the establishments of the youngest cohort. The construction sector also has a disproportionate amount of employment in younger establishments. At the opposite extreme, the educational services sector has more employment in older establishments, with 91 percent of employment found in the establishments of the oldest cohort and 3 percent of employment found in the establishments of the youngest cohort. The educational services sector is followed by the utilities sector, with 86 percent of employment found in the establishments of the oldest cohort and 5 percent of employment found in the establishments of the youngest cohort. The manufacturing sector also has a disproportionate amount of employment in older establishments.

Wage patterns by sector

Variations in wages are related to industrial sector far more than to establishment birth cohort, with wages ranging from an average of about $17 per hour in the accommodations and food services sector to about $38 per hour in the management of companies and enterprises sector. Within sectors, wages generally increase with cohort age, following the overall pattern shown in figure 2. However, there are a few exceptions to this overall pattern. Wages in the management of companies and enterprises sector are highest in establishments born in recessionary periods. Wages in the mining, quarrying, and oil and gas extraction sector are markedly lower in establishments born in recessionary periods. Wages in the healthcare and social assistance sector are generally increasing for newer cohorts of establishments. Wages in the wholesale trade; administrative and support and waste management and remediation services; and arts, entertainment, and recreation sectors have no clear pattern of wages by cohort age.

Employment patterns by occupational group

The key advantage of using the OES-QCEW matched data to look at employment and wage patterns by establishment birth cohort is that we can examine how overall employment patterns vary by occupation. Table 3 presents the employment levels by establishment birth cohort and major occupational group. These estimates include all of the employment shown in table 1 grouped into the major categories of the Standard Occupational Classification (SOC) system.

Table 3. Employment and wages, by establishment birth cohort and major occupational group

Occupational group	SOC code	First reported employment occurred:									
		Q4 2000 and earlier		Q1 2001 to Q4 2001		Q1 2002 to Q3 2007		Q4 2007 to Q2 2009		Q3 2009 and later	
		Employment	Hourly wage	Employment	Hourly wage	Employment	Hourly wage	Employment	Hourly wage	Employment	Hourly wage
All occupations	00-0000	87,858,370	$23.92	2,987,610	$21.49	16,882,950	$21.02	4,807,460	$20.45	16,072,040	$19.97
Management	11-0000	4,503,470	57.92	145,330	57.67	778,590	54.99	218,610	53.16	710,760	51.06
Business and financial operations	13-0000	4,194,700	35.49	144,480	36.01	786,580	36.32	223,440	35.86	720,820	35.2
Computer and mathematical	15-0000	2,570,860	41.56	94,840	41.79	525,600	41.61	142,510	41.24	455,710	41.22
Architecture and engineering	17-0000	1,681,290	39.69	44,620	39.07	217,790	38.46	53,820	40.06	180,740	38.11
Life, physical, and social science	19-0000	653,520	33.58	13,920	34.09	79,640	35.84	22,390	35.15	74,430	34.73
Community and social services	21-0000	1,129,110	21.93	26,980	19.34	160,820	20.11	40,650	20.39	141,740	19.52
Legal	23-0000	536,480	56.32	20,120	48.05	103,990	45.94	36,280	41.39	107,000	41.5
Education, training, and library	25-0000	7,438,460	26.07	74,360	20.15	416,650	20.67	128,580	19.04	357,430	19.27
Arts, entertainment, and media	27-0000	1,224,240	27.23	37,630	26.57	228,660	27.08	64,750	25.4	246,540	25.72
Healthcare practitioners and technical	29-0000	6,027,270	37	122,530	38.02	723,280	38.75	195,800	39.08	570,310	41.12
Healthcare support	31-0000	2,695,580	14.19	88,310	13.82	509,810	13.87	159,960	13.59	430,510	14.15
Protective service	33-0000	1,063,110	14.39	36,380	12.86	179,080	14.04	51,010	13.49	128,950	13.34
Food preparation and serving related	35-0000	6,676,690	11.16	372,140	10.98	2,162,110	11.03	705,780	10.99	2,707,630	10.88
Cleaning and maintenance	37-0000	2,815,090	13.11	98,850	12.04	570,200	12.15	173,680	11.66	537,760	11.82
Personal care and service	39-0000	2,293,060	12.38	129,440	11.82	713,500	11.87	223,520	11.9	762,860	12.06
Sales and related	41-0000	8,620,390	19.69	436,860	18.74	2,520,780	17.88	716,850	17.88	2,370,450	17.65
Office and administrative support	43-0000	13,567,830	17.6	475,210	16.75	2,664,140	16.27	719,490	16.04	2,244,100	15.84
Farming, fishing, and forestry	45-0000	251,200	12.66	10,130	11.88	69,430	11.85	23,670	11.59	85,270	11.32
Construction and extraction	47-0000	3,056,100	24.01	123,190	21.62	789,750	21.44	216,340	20.79	886,430	20.53
Installation, maintenance, and repair	49-0000	3,515,930	22.55	118,460	20.86	618,530	20.14	168,050	20	577,550	19.28
Production	51-0000	7,059,670	17.74	167,660	16.47	896,190	15.84	214,440	15.58	713,730	15.16
Transportation and material moving	53-0000	6,284,320	17.22	206,170	15.19	1,167,830	15.3	307,840	15.11	1,061,320	14.89

Source: U.S. Bureau of Labor Statistics.

Employment for some occupational groups follows the overall pattern for employment per quarter of cohort length shown in table 1 (for brevity, this calculation is not shown in table 3, although it can be easily estimated from the employment figures in this table). Employment in management, business and financial operations, computer and mathematical, and office and administrative support occupations is positively related to establishment age, except for establishments born in the oldest birth cohort.

There are other occupational groups in which the highest levels of employment (for the number of quarters per cohort) are found in the oldest cohort. These include life, physical, and social science occupations; education, training, and library occupations; healthcare practitioners and technical occupations; and production occupations. Most notable among these are education, training, and library occupations, which have a particularly large fraction of employment (88 percent) in establishments that are part of the oldest birth cohort, as well as the healthcare practitioners and technical occupations, which have 79 percent of employment in establishments that are part of the oldest birth cohort.

Other occupational groups have larger shares of employment in establishments born in more recent cohorts. This is particularly true of the food preparation and serving related occupations, which have only 53 percent of employment in establishments that are part of the oldest birth cohort and 21 percent of employment in establishments that are part of the youngest birth cohort, as well as the farming, fishing, and forestry occupations, which have 57 percent of employment in establishments that are part of the oldest birth cohort and 19 percent of employment in establishments that are part of the youngest birth cohort.

Still other occupations have employment levels by cohort (per quarter of cohort length) that are more correlated with contractions and expansions than with cohort age. Construction and extraction occupations have especially high employment shares in newer establishments born during expansions, and so do arts, design, entertainment, sports, and media occupations. By contrast, legal, personal care and service occuaptions, and education, training, and library occupations have particularly high shares of employment in business establishments born during contractions.

Wage patterns by occupational groups

Wages for some occupational categories follow the overall pattern for all wages and are positively correlated with the age of the establishment cohorts. These occupational categories include management; sales and related; office and administrative support; farming, fishing, and forestry; construction and extraction; installation, maintenance, and repair; and production occupations. Table 3 shows average wages by establishment birth cohort for all major occupational groups. Notably, wages for healthcare practitioners and technical occupations show a very different pattern, with newer establishments having higher average wages than older establishments. This is also the average wage pattern for personal care and service occupations (except for the oldest cohort).

Variation in wages by establishment birth cohort is particularly wide for the legal occupations group and for the education, training, and library occupations group. Both of these occupational groups, which have large shares of employment in business establishments born during contractions, have substantially higher wages in establishments born in the oldest cohort compared with establishments born in newer cohorts.

Wages of some occupational groups seem to be related to the point in the business cycle at which their establishments were founded. Healthcare support occupations have wages that correspond to expansions and recessions, with higher wages for business establishments born in the expansion cohorts and lower wages for the

business establishments born during contractions. In contrast, architecture and engineering occupations have higher average wages for establishments born during contractions than establishments born during expansions.

Regression analysis

As noted previously, the oldest cohort of establishments has both the largest share of employment and the highest wages. Much of this pattern may be due to age, rather than to cohort. We also note very different employment and wage patterns for education, training, and library occupations compared with food preparation and serving occupations. This may be mainly the result of differences in the industries that employ these occupational groups. Thus, we use regression analysis to examine the impact of cohort on employment and wages, while controlling for age, industry, and geographic composition.

Employment regressions

Our first set of regressions takes the form

$$Employment_j = \alpha_t Cohort_{tj} + \beta_1 Age_j + \beta_2 Age_j^2 + \gamma_o Occupation_{jo} + \delta X_j + \varepsilon_j,$$

where the dependent variable is the employment level for each establishment j, α_t is the impact of being born in cohort t, β_1 is the impact of age, β_2 is the impact of age squared, γ_o is the impact of having any employees in occupation o, δ is the impact of other measured characteristics of the establishment X_j (such as industry and geographic location), and ε is an error term. We do not weight these regressions by employment size, and therefore a small establishment has as much weight as a larger establishment in these regressions. Because the QCEW data can only be accurately linked back to the third quarter of 1992, we only have accurate age data for establishments that first reported employment starting in this quarter or later.

Table 4 shows estimates of these employment regression coefficients. Column (1) shows the α coefficients for regressions that contain no regressors other than cohorts, and thus these coefficients represent average establishment sizes for each cohort—the same average establishment sizes plotted in figure 1. Column (2) repeats these estimates, but only for the establishments born since the third quarter of 1992, for which age can be calculated. The only establishment size that changes is the one for the earliest cohort. With the removal of the oldest establishments, the average establishment size for this cohort falls, but it is still higher than that of any other cohort. In column (3), we add age (measured in quarter years) and age squared to the regression. As expected from the pattern shown in figure 1, average establishment-size levels increase with establishment age, and they decrease with age squared. Once we have controlled for the impact of age, average establishment sizes in each cohort are no longer significantly different from each other. In column (4), we add dummy variables for whether each establishment employs workers in particular occupations (measured with 22 major occupational categories), industry (measured with 285 four-digit NAICS codes), and geography (measured with 50 states plus the District of Columbia). The differences in employment size between cohorts of establishments are now even smaller and less significant, although patterns of employment size by age continue to be quite significant. The amount of variation in overall employment that can be explained by the regression (the R^2 value) is much higher in column (4) than in the previous columns.

Table 4. Overall employment regression coefficients and standard errors

Characteristic	(1)	(2)	(3)	(4)
	All establishments	Establishments born since Q3 1992		
Q4 2000 and earlier	25.68	17.92	3.691	-19.73
	(0.1791)	(0.1301)	(0.7134)	(1.4710)
Q1 2001 to Q4 2001	14.18	14.18	3.01	-20.38
	(0.7212)	(0.3293)	(0.7236)	(1.4700)
Q1 2002 to Q3 2007	11.62	11.62	3.32	-20.21
	(0.2750)	(0.1255)	(0.5366)	(1.4080)
Q4 2007 to Q2 2009	8.90	8.90	3.76	-20.43
	(0.4511)	(0.2060)	(0.4168)	(1.3730)
Q3 2009 and later	6.95	6.95	4.55	-20.65
	(0.2178)	(0.0995)	(0.2064)	(1.3350)
Age	—	—	0.2560	-0.0086
	—	—	(0.0208)	(0.0188)
Age squared	—	—	-0.0007	0.0006
	—	—	(0.0002)	(0.0002)
Industry, occupation, and geography controls?	—	—	—	Yes
R^2	0.018	0.007	0.007	0.707
Establishments observed	1,088,032	664,112	664,070	664,070

Note: Dash indicates not included.

Source: U.S. Bureau of Labor Statistics and authors' calculations.

Following the methods used in the study by Moreira, we also group our data into only two groups (instead of five): establishments born during recessions and other establishments.[11] In this regression (not shown), we find that establishments born during recessionary periods have lower employment levels than other establishments, but this difference loses statistical significance as soon as we control for establishment age. This pattern of differences in cohort employment levels that are not statistically significant once we account for the impact of establishment age, industry, geography, and occupational employment patterns also holds for the employment of every major occupational group.

Wage regressions

Our wage regressions take the following form:

$$\ln(avg\ wage)_j = \alpha_t Cohort_{tj} + \beta_1 Age_j + \beta_2 Age_j^2 + \gamma_o X_j + \varepsilon_j.$$

Following the example of previous studies, we use the natural log (ln) of the average wage level for each establishment as our dependent variable, because ln(wages) follows a more normal distribution than the distribution of wages. On the other side of the equation, α_t is the impact of being born in cohort t, β_1 is the impact of age, β_2 is the impact of age squared, and Y is the set of impacts of other measured characteristics in the data. These other characteristics are the number of employees in each occupation, the industry of the establishment, and geographic location. We weight these regressions by the number of employees in each establishment.

Table 5 shows estimates of these wage regression coefficients. Column (1) shows the α coefficients for regressions that contain no regressors other than cohorts, and so these coefficients are average ln(wage) levels for each cohort. These correspond to the estimates shown in figure 2, with higher wage levels for older cohorts. Column (2) repeats these estimates, but only for the establishments born since the third quarter of 1992, for which age can be calculated. The only wage level that changes is the one for the earliest cohort. With the removal of the oldest establishments, the ln(wage) level for this cohort falls, but it is still higher than that of any other cohort.

Table 5. Overall wage regression coefficients and standard errors

Characteristic	(1)	(2)	(3)	(4)
	All establishments	Establishments born since Q3 1992		
Q4 2000 and earlier	2.987	2.910	2.783	0.038
	(0.0002)	(0.0005)	(0.0036)	(0.0015)
Q1 2001 to Q4 2001	2.860	2.860	2.732	0.014
	(0.0013)	(0.0014)	(0.0036)	(0.0015)
Q1 2002 to Q3 2007	2.840	2.840	2.731	0.013
	(0.0005)	(0.0006)	(0.0029)	(0.0011)
Q4 2007 to Q2 2009	2.812	2.812	2.735	0.008
	(0.0010)	(0.0011)	(0.0022)	(0.0008)
Q3 2009 and later	2.789	2.789	2.749	0
	(0.0006)	(0.0006)	(0.0012)	—
Age	—	—	0.004	0.001
	—	—	(0.0001)	(0.0001)
Age squared	—	—	0	0
	—	—	0	0
Industry, occupation, and geography controls?	—	—	—	Yes
R^2	0.018	0.007	0.007	0.707
Establishments observed	1,088,032	664,112	664,070	664,070

Note: Dash indicates not included, except in column (4), where the dash indicates "not applicable."

Source: U.S. Bureau of Labor Statistics and authors' calculations.

In column (3), we add age (measured in quarter years) and age squared to the regression. As expected, ln(wage) levels increase with establishment age, but not with age squared. Once we have controlled for the impact of age, the oldest cohort of establishments still has the highest ln(wage) levels, but now the lowest ln(wage) levels are for the three middle cohorts, which have ln(wage) levels that are not significantly different from each other. The most recent cohort now shows a ln(wage) coefficient level that is midway between that of the middle cohorts and that of the oldest cohort.

In column (4), we add dummy variables for occupation (measured with 94 minor occupational categories), industry (measured with 285 four-digit NAICS codes), and geography (measured with 50 states plus the District of Columbia). This returns the pattern of the greatest ln(wage) levels in the oldest cohort and the lowest levels in the youngest cohort, but the differences between cohorts are now smaller than those in column (3), which showed smaller differences between ln(wage) among cohorts than did column (2). Moreover, in this regression, there is no significant difference in ln(wage) levels between the cohort born during the 2001 recession and the cohort born

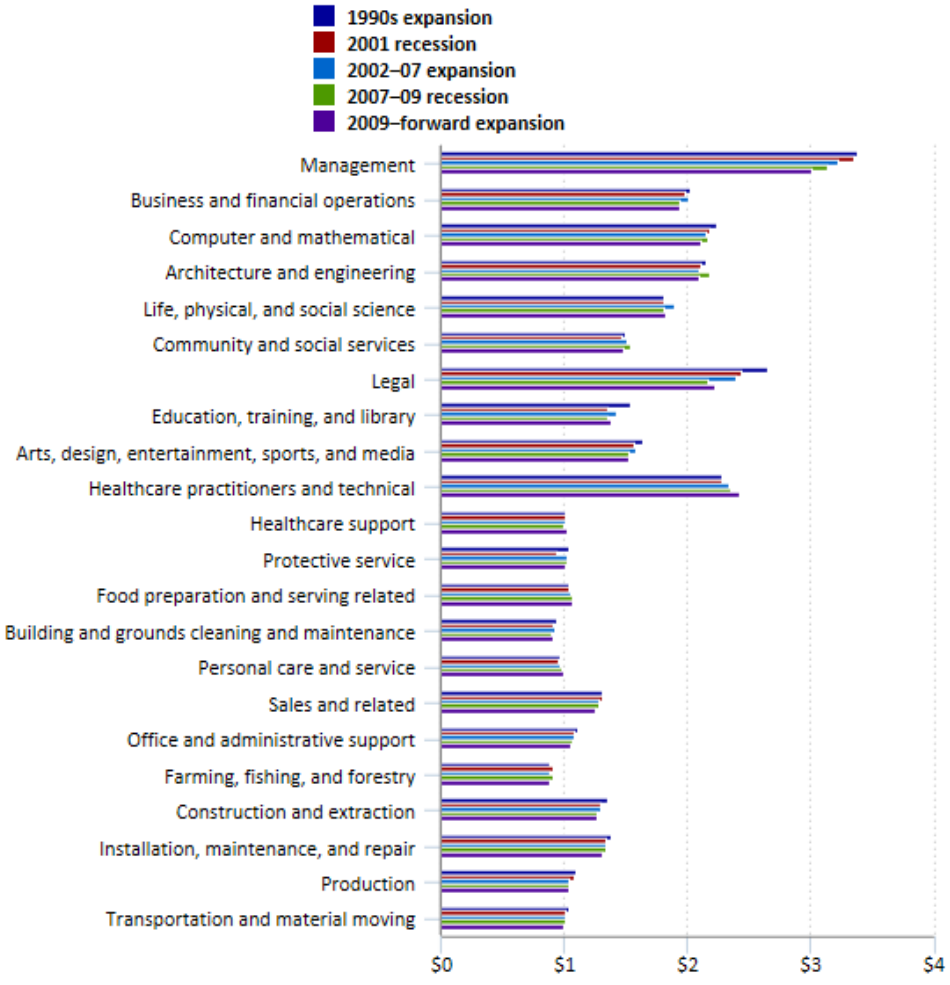
during the 2002–07 expansion, although wage levels are higher for the cohort of establishments born during the 2001 recession than for the cohort of establishments born during the Great Recession.

These same regressions can be run for individual occupational groups and occupations, using the following interaction specification:

$$\ln(avg\ wage)_j = \alpha_{to} Cohort_{tj} \times Occupation_{oj} + \beta_1 Age_j + \beta_2 Age_j^2 + \gamma_o X_j + \varepsilon_j.$$

In these regressions, there is a separate coefficient α for each occupational group within each cohort. For clarity of presentation, we take the exponential of these regression coefficients and plot them in figure 3.

Figure 3. Regression coefficient estimates for hourly wages, by establishment birth cohort and major occupation



Click legend items to change data display. Hover over chart to view data.
Note: Regression coefficient estimates are calculated after controlling for industry, minor occupation, age, age squared, and state.
Source: U.S. Bureau of Labor Statistics.

Figure 3 shows that even after controlling for age and industry, both legal occupations and education, training, and library occupations have noticeably higher wages in establishments founded before the 2001 recession, while

healthcare practitioners and technical occupations have higher wages in the establishments that are part of more recent cohorts.

Conclusion

This article matches data from the BLS Occupational Employment Statistics (OES) survey with data from the BLS Quarterly Census of Employment and Wages (QCEW) to examine employment and wage patterns by employer "birth" cohorts and occupation. We find overall patterns of higher employment and higher wages for workers in older cohorts of establishments, with substantial variations by occupation. Our findings also show that employment differences by establishment birth cohort can be entirely explained by establishment age, but some of the differences in wages cannot be entirely explained by establishment age. Overall, most occupations exhibit the highest wages in establishments "born" before the 2001 recession, yet some occupations, such as architecture and engineering occupations, have wages that are highest in establishments founded during the Great Recession, and other occupations, such as healthcare practitioners and technical occupations, show generally higher wages in younger establishments.

In future work, we plan to extend this match of data to additional panels of data from the OES survey and the QCEW to cover earlier collection periods. This will give us more statistical power to disentangle the impact of establishment birth cohorts and employer age and enable us to examine differential employer growth and exit by employer birth cohort and occupational structure. Analyzing more years of data may also show how wage differences between cohorts have emerged, and whether differential employer exit may drive some of the wage results that we describe in this article.

Appendix

In order to make valid comparisons of employment and wages across establishment birth cohorts, we modified the OES imputation and benchmarking procedures. The OES program uses imputation to mitigate errors caused by nonresponse. There are two types of data that are assigned to nonresponding sample units through imputation—occupational employment distributions and wage distributions—and there are separate imputation procedures for each. Because the usual imputation methods do not control for establishment birth cohort, nonresponding establishments could have their data imputed from a responding establishment found in a different birth cohort, which could affect the results of comparisons between different birth cohorts. Thus, we modified both occupational employment and wage imputation procedures to include birth cohort. In general, imputation procedures find units most similar to the nonresponsive units to "donate" their data to the nonresponsive units.

These procedures first try to find donors that are similar at the most detailed geography, industry, and size-class cells. If there is not a sufficient amount of respondent data at the most detailed level, the procedures move through a hierarchy to find donor establishments that are less precisely matched. The employment imputation uses a hierarchy that assigns importance to industry, meaning that geography and size-class detail can be allowed to vary before taking employment patterns from an establishment in a different detailed industry. The wage imputation uses a different hierarchy, prioritizing finding a donor at the same detailed geographic category over finding a donor in the same detailed industry. We modified these hierarchies by adding birth cohort as the most binding variable in selecting donor establishments. The employment imputation still prioritizes industry and the wage imputation still prioritizes geography, but both imputations are now done exclusively within birth cohorts.

We also modified the OES benchmarking procedures to improve the comparisons of employment and wages between birth cohorts. The OES program uses benchmarking to properly weight the sampled establishments so that the estimates for the second quarter of 2015 accurately represent the distribution of employment by industry, geography, size class, and ownership that is reported in the QCEW for the same quarter. Similar to imputation procedures, benchmarking relies on hierarchies when there is not a sufficient amount of data per benchmark cell. Each establishment in the OES microdata is assigned four benchmark factors, labeled 1 to 4 in table A-1.

Table A-1. Benchmark level definitions

Industry level	Geography level	Benchmark level	Birth cohort?	Size class	Ownership?
Four-, five-, or six-digit NAICS	State and MSA	1a	Yes	Definition 1	Yes
Four-, five-, or six-digit NAICS	State and MSA	1b	Yes	Definition 1	No
Four-, five-, or six-digit NAICS	State and MSA	1c	Yes	Definition 2	Yes
Four-, five-, or six-digit NAICS	State and MSA	1d	Yes	Definition 2	No
Four-, five-, or six-digit NAICS	State and MSA	1e	Yes	None	Yes
Four-, five-, or six-digit NAICS	State and MSA	1f	Yes	None	No
Four-, five-, or six-digit NAICS	State and MSA	1g	No	None	No
Four-digit NAICS	State	2a	Yes	None	Yes
Four-digit NAICS	State	2b	Yes	None	No
Four-digit NAICS	State	2c	No	None	No
Three-digit NAICS	State	3a	Yes	None	No
Three-digit NAICS	State	3b	No	None	No
Three-digit NAICS	State	4a	Yes	None	No
Two-digit NAICS	State	4b	No	None	No

Note: The North American Industry Classification System (NAICS) uses a six-digit hierarchical coding system to classify all economic activity into 20 industry sectors. Five sectors are mainly goods-producing sectors and fifteen are entirely service-providing sectors. Size class definition 1 has four classes: 0 to 19 employees, 20 to 49 employees, 50 to 249 employees, and 250 or more employees; size class definition 2 has two classes: 0 to 49 employees, and 50 or more employees.

Source: U.S. Bureau of Labor Statistics.

The final estimation weight is the product of the sampling weight and the four benchmark factors. We include birth cohorts in the benchmarking hierarchy as shown in table A-1. For example, if there is not enough data to create benchmark 1 using all the factors for benchmark 1a, the factors for benchmark 1b will be used; if there is not enough data available for 1b, 1c will be used; and so forth.

Note that establishment age is not considered in either the imputation or benchmarking procedures. For narrow cohorts of establishments, such as the cohort of establishments “born” during one of the four quarters of 2001, there is very little variation in establishment age. However, for the oldest cohort of establishments, the cohort that first reported employment to the UI system at any time during the fourth quarter of 2000 or earlier, there is a great deal of variation in establishment age. Imputations will introduce more age-related error in this oldest cohort of establishments than in other cohorts.

SUGGESTED CITATION

Elizabeth Weber Handwerker, David S. Piccone Jr, and Elizabeth Cross, "Occupational employment and wage differences across cohorts of establishments," *Monthly Labor Review,* U.S. Bureau of Labor Statistics, January 2020, https://doi.org/10.21916/mlr.2020.1

NOTES

[1] See Sara Moreira, "Firm dynamics, persistent effects of entry conditions, and business cycles" (Social Science Research Network, October 2016), http://dx.doi.org/10.2139/ssrn.3037178; and Petr Sedláček and Vincent Sterk, "The growth potential of startups over the business cycle," *American Economic Review*, vol. 107, no. 10, October 2017, pp. 3182–3210, https://doi.org/10.1257/aer.20141280.

[2] See John Haltiwanger, Ron S. Jarmin, and Javier Miranda, "Who creates jobs? Small versus large versus young," NBER Working Paper 16300 (Cambridge, MA: National Bureau of Economic Research, August 2010), https://www.nber.org/papers/w16300.pdf.

[3] Moreira, "Firm dynamics, persistent effects of entry conditions, and business cycles."

[4] Sedláček and Sterk, "The growth potential of startups over the business cycle."

[5] Although these data are included in the OES estimates, they are excluded here because they are not broken down into separate establishments when they are reported to BLS and thus cannot be matched with individual establishments in the QCEW.

[6] Recession dates are those determined by the Business Cycle Dating Committee of the National Bureau of Economic Research. For more information, see "US business cycle expansions and contractions" (Cambridge, MA: National Bureau of Economic Research, April 2010), https://www.nber.org/cycles.html.

[7] Moreira, "Firm dynamics, persistent effects of entry conditions, and business cycles"; and Sedláček and Sterk, "The growth potential of startups over the business cycle."

[8] Haltiwanger, Jarmin, and Miranda, "Who creates jobs? Small versus large versus young."

[9] Moreira, "Firm dynamics, persistent effects of entry conditions, and business cycles"; and Sedláček and Sterk, "The growth potential of startups over the business cycle."

[10] See, for example, John C. Haltiwanger, Julia I. Lane, and James Spletzer, "Productivity differences across employers: the roles of employer size, age, and human capital," *American Economic Review*, vol. 89, no. 2, May 1999, pp. 94–98, https://doi.org/10.1257/aer.89.2.94.

[11] Moreira, "Firm dynamics, persistent effects of entry conditions, and business cycles."

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