Occupational Restructuring after the Great Recession

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Abstract

We use data from the Occupational and Employment Wage Statistics survey to examine how establishments restructure employment in the cross-section and in response to the Great Recession shock. We find that high-wage establishments grow faster and are less likely to shrink than low-wage establishments. High-wage establishments are organized to use a higher share of employment in professional and computer occupations, and a lower share in routine occupations. During the Great Recession years, employment declines among continuing establishments were driven by declines in growth by high-wage establishments, with low-wage establishments exhibiting no change in employment growth. However, when we exploit geographic variation in the severity of the Great Recession, we find similar employment losses for both high- and low-wage establishments, which persist through at least 2015. These results suggest important differences in the impact of the Great Recession in the time series and cross-section across establishment types. Finally, we find that establishments in high-exposure MSAs reduced employment in routine-manual but not routine-cognitive employment, which is consistent with aggregate occupational employment from the Census/ACS. These results provide evidence of a within-the-firm channel for aggregate employment changes in response to the Great Recession shock.

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1 Introduction

The labor market is extremely dynamic, with establishments constantly entering, growing, shrinking, and exiting. During aggregate expansions, entry and growth exceeds exit and contractions, while during recessions, exits and contractions dominate. Although these dynamics are well-known, less known is how establishments choose which jobs to shed and add, and whether cyclical restructurings are temporary or permanent. In this paper, we use unique microdata from the Occupational and Employment Wage Statistics (OEWS) program to examine how the occupational structure of establishments change as they grow and shrink, with a particular interest in changes over the Great Recession and the subsequent recovery.

The occupational structure of establishments provides a description of the production structure of establishments that has been used in previous research (Forsythe (2019, 2023)). Hershbein and Kahn (2018) established that establishments changed their production process in response to the Great Recession, with more affected firms permanently increasing skill demand and more affected local labor markets experiencing a persistent decline in routine manual employment. By examining the occupational structure within establishments, we can examine how these changes unfold within establishments. We focus on two sources of variation, examining both time series variation across the Great Recession as well as panel variation based on differences across local areas in the severity of the Great Recession.

We begin by documenting aggregate job creation and job destruction data from the Business Dynamics Statistics (BDS). We show that job creation and job destruction by continuing establishments is substantially larger than creation and destruction driven by establishment entry and exit. We then show that, in local areas that were more affected by the Great Recession, changes in employment were driven primarily by increased job destruction and reduced job creation among continuing establishments, with much smaller effects from establishment entry and exit. These two sets of facts motivates our focus on changes in the occupational structure within establishments.

We then turn to the OEWS data. In our panel of establishments surveyed three years apart, we find on average 37% of establishments have more employees after 3 years, while 29% of establishments have fewer employees. We then leverage the OEWS wage data to classify establishments as high-wage or low-wage, building off previous research that employment flows differ by establishment wage rank (Haltiwanger et al., 2018). In particular, we use the establishment's wage rank within the MSA by 2-digit

industry, measured using the establishment's median wage in the previous period. We find that high-wage establishments grow about twice as fast as low-wage establishments, and are more likely to grow and less likely to shrink over a 3 year period.

Examining the occupational structure, we find that high-wage establishments have a larger share of high-skilled occupations and a lower-share of routine employment. We then separate establishments into growing, shrinking, or stable employment, based on employment changes over the three-year period. We find that establishments with stable employment nonetheless have about 1 percentage point less employment in service occupations and 1 percentage point more employment in management three years later. This suggests that even establishments with stable employment are replacing employment among lower-skilled service employees with managerial employment. In addition, growing establishments increase both service and management employment, while shrinking establishments decrease employment in both management and service occupations.

Next we examine how employment changes over the Great Recession differed for low-wage and high-wage establishments. When we focus on the time series, we find that aggregate declines in employment growth within establishments from 2007 to 2009 were entirely driven by reductions in employment growth among high-wage establishments. In particular, we find that during the Great Recession, high wage establishments employment growth and the share growing and shrinking converged with low-wage establishments. We interpret this as consistent with previous evidence on the break-down of the establishment-wage job ladder during the Great Recession (Haltiwanger et al., 2018).

We then examine heterogeneity at the local geographic area in response to the local severity of the Great Recession shock. This allows us to examine longer-term impacts from exposure to a larger economic disruption, comparing establishments in more and less affected locations. We find that establishments that were exposed to a larger negative economic shock had a decline in employment which persists through at least 2015. However, when we examine heterogeneity between low- and high-wage establishments, we do not find statistically significant differences in the impact of the negative shock between these two groups of establishments. Thus, although both the time series and panel results indicate employment declines, the mechanisms appear to be somewhat different. We then examine occupational changes in response to exposure to a larger negative shock, and find that establishments are more likely increase employment in professional and computer related occupations, while establishments reduce employment in clerical and routine manual occupations. Thus, when establishments shrink in response to a

negative economic shock, they appear to reduce employment in low-wage and more routine occupations at a faster rate than more skilled employment, resulting in a higher-skill occupational mix overall.

We supplement this analysis using individual-level data from the Census/ACS. Consistent with Hershbein and Kahn (2018), we find a persistent decline in the share of aggregate employment in routine manual occupations. Since we observe a similar decline within establishments in the OEWS, this provides further support that aggregate changes in occupational structures are being driven in part by changes within establishments.

Our paper contributes to a large literature examining the sluggish economic recovery from the Great Recession. The slow recovery of employment led many to try to understand this 'jobless recovery'. There are two dimensions to this issue. First, Jaimovich and Siu (2020) found that aggregate employment in routine jobs fell during the past several recessions, and never recovered. Hershbein and Kahn (2018) found that this was particularly a phenomenon of manual routine jobs, while firms actually increased employment and skill demand for cognitive routine jobs.

In addition, during the Great Recession job reallocations did not increase as much as would be expected from previous recessions. In particular, the process of employment reallocation from low to high productivity establishments slowed down (Foster et al., 2015), and the job ladder of workers moving to higher wage firms also declined (Haltiwanger et al., 2018). Finally, Barth et al. (2017) examine establishment growth and contraction, finding that losses from 2007 to 2009 were driven by contractions while the recovery from 2009-2012 was driven by establishment entry. Using different methodology, we find that most of the decline and recovery in employment were driven by continuing establishments.

2 Data and sample selection

We use MSA-level and time variation from the Great Recession to evaluate establishments' responsiveness to shocks. We combine information from a number of sources regarding employment occupational shares, wage distribution, and entrance and exit for the years surrounding the Great Recession.

Our primary data source is restricted microdata Occupational Employment and Wage Statistics (OEWS) survey, produced by the U.S. Bureau of Labor Statistics. This is a nationally representative establishment-level survey. We construct a panel of establish-

ments to examine changes in occupational structure in response to the Great Recession. We supplement our within-establishment analysis with individual-level data from the Census-American Community Survey (ACS) and aggregated establishment data from the Business Dynamics Statistics (BDS). We describe each source in turn.

2.1 OEWS Data

We use restricted microdata from the Occupational Employment and Wage Statistics (OEWS) survey to evaluate individual responses to shocks as well as firm's resource reallocation. The OEWS is a semi-annual survey of approximately 400,000 establishments surveyed each year. The purpose of the survey is to produce extremely accurate estimates of occupational wages within industry, geography, and ownership strata. The sample of establishments is a stratified random sample drawn from the Quarterly Census of Employment and Wages who respond to detailed information about the wage and occupational structure of the establishment. Aggregated over three years, the OEWS survey captures over half of all employment in the United States.[1] Although the OEWS is conducted as cross-sectional survey, in practice many establishments are surveyed multiple times. See Dey and Handwerker (2016) and Forsythe (2023) for more details on using the OEWS data as a panel.

Although the OEWS is a stratified random sample, the sampling procedure overweights larger establishments. This results in the panel sample being skewed toward larger establishments. The unweighted average size of establishments in our samples are about 90 employees. To recover the underlying establishment size distribution, we reweight establishments to match the QCEW employment within MSA by industry by ownership cells. We weight matched observations across time using the weight associated with the initial observation.

We construct two panels of data, using data from 2002 through 2017. First, we focus on establishments that can be matched across three or four years. This allows us to measure employment changes within continuing establishments. We can then define the change in establishment employment as the change from year t to year $t-3$, where t ranges from 2006 to 2017. There are a total of 1,716,282 establishment-year observations, with all establishments observed at least twice. The average weighted establishment size of 14.1.

In order to examine variation with the severity of the Great Recession shock in the

[1] See of Labor Statistics (2018) for more details.

local labor market, we define an alternative panel that pools more years of observations together to increase the sample size. In particular, we define the pre-period as 2004-2006, the Great Recession period as 2008-2009, the early recovery as 2010-2012, and the later recover as 2013-2015. We focus on four separate samples: establishments sampled in the pre-period and the Great Recession period (428,746 observations), establishments sampled in the pre-period and the early recovery (510,222 observations), establishments sampled in the pre-period and the late recovery (422,612 observations), and finally establishments surveyed in the pre-period, the Great Recession period, and the early recovery period (330,171 observations).

OEWS survey respondents are asked to provide the number of employees in each of 12 wage bins for each 6-digit occupation. This provides extremely detailed information on the wage and occupational structure of the establishment, as well as total employment. Moreover, since the OEWS sample is drawn from the QCEW, additional information such as the industry, geography, and other establishment characteristics are drawn from the QCEW.

For some analysis, we assign establishments to wage ranks. We do this by constructing cells based on MSA by 2-digit industry by year. We divide each cell into employment-weighted quintiles based on a variety of establishment-level wage statistics. Our preferred specifications use the median establishment wage within the MSA by industry cell. We further define high wage as establishments with median wages in the largest wage quintile within the MSA by industry cell. Note that we define wage ranks using the full sample of establishments, rather than the smaller panel sample. For each establishment, we define the wage rank at the $t-1$ period.

2.2 ACS

We use American Community Survey to evaluate establishment responses to shocks at the aggregate level. We construct the shares of employment by occupation using American Community Survey (ACS) provided by IPUMS.Steven Ruggles and Schouweiler. (2023)

Since 2005, this dataset has been gathered annually and includes a nationally representative sample of 1-in-100 individuals each year. It includes questions related to employment status, occupation, and demographic attributes. We harmonize occupational codes to the 2010 Standard Occupational Classification System (SOC). We examine changes in 5 major occupational groups: share of professional occupations (SOC 1X- and 2X- excluding SOC 11-), share of service occupations (SOC 3X-), share of

managerial occupations (SOC 11-), share of production occupations (SOC 53-, 51-, 45-, 47- and 49-) and share of clerical occupations (SOC 41- and 43-). We also examine changes in employment for IT workers (SOC 15-11). The smallest identifiable geographical unit in ACS data is the Public-Use Microdata Area (PUMA) defined by the Census Bureau every 10 years. We redefine population weights to work with Metro and Micropolitan Statistical Areas (MSAs) as defined by the Bureau of Labor Statistics for the construction of the Occupational Employment and Wage Statistics.[2]

2.3 BDS

We use data from the Business Dynamics Statistics (BDS) program to evaluate aggregate changes in employment at the establishment level. The BDS program is produced by the U.S. Census Bureau from the population of business establishments in the United States. By following establishments over time, the BDS captures year-over-year employment changes, as well as establishment entry and exit. The BDS program then constructs job flow numbers at the national level as well as within different firm and establishment characteristic cells. We use this data to examine trends in job creation and destruction over time as well as changes at the MSA-level in response to the Great Recession shock.

2.4 Other Data Sources

In addition, we use data from the Local Area Unemployment Statistics program to measure the unemployment rate at the MSA and county level which we use to create the Great Recession shock. We also use LAUS estimates of the size of the labor force to weight some specifications.

3 Empirical strategy

We are interested in understanding how establishments change employment and restructure across occupations in response to the Great Recession shock. We focus on two strategies, using the OEWS panel data to first examine how establishments change over time, and second to leverage geographic variation in the severity of the Great Recession shock to examine the cross-sectional impact of the Great Recession. The time series

[2]Geographic crosswalks are constructed using the Geocorr application from the Missouri Census Data Center (`https://mcdc.missouri.edu/applications/geocorr.html`).

strategy allows us to measure the impact of the Great Recession on the aggregate labor market, however limits our ability to examine the longer run impacts. By using the variation in the local shock, we can better distinguish the impact of the Great Recession from time trends, and further we can examine longer-effects in locations that were hit by a larger shock.

We begin by examining how establishments change over time. We take the first-difference of measures of employment or occupational employment shares, and regress them on year indicators, as in equation 1, where i indicates the establishment, and t indicates the year. As discussed in Section 2, establishments are surveyed at most every 3 years, so the α_1 coefficients can be interpreted as the change in employment over a 3 year period, among establishments that continued operating for at least 3 years.

$$Y_{i,t} - Y_{i,t-3} = \alpha_0 + I_t \times \alpha_1 + \epsilon_t \tag{1}$$

We weight all specifications using QCEW-adjusted sampling weights, and report robust standard errors. For some specifications we replace the year indicators with an indicator for the Great Recession, which equals 1 if the year is 2008 or 2009. For some specifications we further interact the Great Recession indicator with a measure of the establishment's pre-period wage rank, to examine how employment changes differ across the establishment wage rank.

We then focus on heterogeneity by the local severity of the Great Recession shock, following Yagan (2019) and Rinz (2022). In particular, we measure the magnitude of the growth in the MSA unemployment rate from 2007 to 2009. We follow Hershbein and Kahn (2018) and rescale the change to reflect the difference between the 10th and 90th percentile MSAs.

To evaluate changes at the establishment level we use a difference-in-differences analysis. We estimate the following equation:

$$Y_{im,t} = \alpha_0 + [\text{shock}_m \times I_t]\alpha_1 + \mu_i + \delta_t + \epsilon_{imt} \tag{2}$$

We include establishment (μ_i) and sampling quarter-year (δ_t) fixed effects, and cluster standard errors at the MSA-level (indexed by m). We weight using QCEW-adjusted sampling weights.

The parameter of interest α_1 represents how establishment-employment changes between the pre-period and period of interest for establishments in the 90th percentile shock MSA compared with 10th percentile shock MSAs.

We construct a variety of dependent variables to measure how establishment employment changes. First, we measure the change in log employment, as well as indicators for employment growth or employment declines. Further, we define a variety of occupational employment categories. We crosswalk occupations to a consistent 2010 SOC coding. We then construct 6 mutually exclusive occupational categories: management (SOC codes 11), supervisors, professional (SOC codes 13-29), clerical and sales (SOC codes 41-43), production (SOC codes 45-53), and service (SOC codes 31-39). We further measure the share of employment in computer related occupations as a measure of technological adoption.

Finally, we classify occupations as routine or offshorable. Routine jobs are those that are most likely to be replaceable by technology. Further, cognitive routine jobs are those that are typically office-based jobs (such as clerical positions), and routine manual jobs are those that require physical activities. We use occupational classifications based on the 1990 census occupations and the Dictionary of Occupational Titles developed by Autor and Dorn (2013), and follow Hershbein and Kahn (2018) by defining routine manual and cognitive routine occupations as occupations that score in the top quartile of the respective indices. Offshorable jobs are those that are comprised of tasks that can be performed in any location. We follow the definition from Acemoglu and Autor (2011b), and define occupations as offshorable if they fall in the top quartile of the offshorable index.

To provide further evidence, we also examine aggregate employment changes using Census/ACS and BDS data. Census/ACS data is collected at the individual level, which allows us to examine year-over-year changes in aggregate employment in different occupational categories. We use Census/ACS data to estimate the following time series specification:

$$Y_t = \alpha_0 + I_t \times \alpha_1 + \epsilon_t \tag{3}$$

In addition, we estimate how aggregate occupational employment changes in response to the severity of the MSA-level Great Recession shock using Census/ACS to examine occupational employment and the BDS to examine job creation and destruction. In particular we estimate

$$Y_{m,t} = \alpha_0 + [\text{shock}_m \times I_t]\alpha_1 + \gamma_m + \phi_t + \epsilon_{mt} \tag{4}$$

We omit 2006, so all measures are relative to 2006 and weighted by the 2006 labor

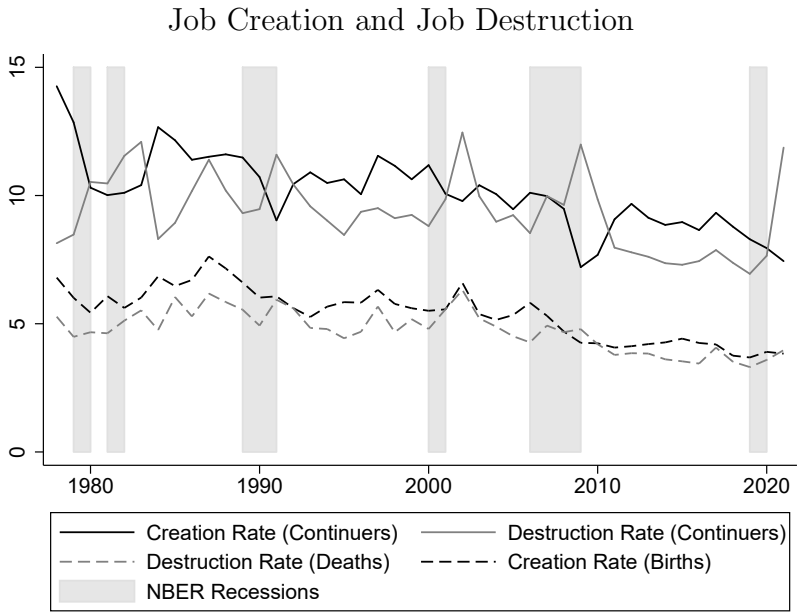


Figure 1: 1978 to 2021 Business Dynamics Statistics Data

force size as estimated by the Local Area Unemployment Statistics (LAUS). We cluster standard errors at the MSA level.

4 Results

4.1 Establishment Dynamics

We begin by examining aggregate establishment employment dynamics over time. In Figure 1, we plot the job creation and job destruction rates, separated by new entrants, exits, and continuers. Job creation is defined as the increase in total employment from all expanding and newly opened establishment, while job destruction is defined as the decrease in total employment from all shrinking or closed establishments. All statistics are measured at the annual rate, calculated from the week including March 12th each year. All rates are calculated by dividing by the total national employment, averaged between the previous and current year.[3]

There are several key patterns that are apparent in Figure 1. First, job creation from growing establishments is substantially larger than the job creation from new establishment births, and similarly the job destruction from shrinking establishments is

[3]This is the Davis-Haltiwanger-Schuh denominator, which smooths out transitory shocks in employment.

substantially larger than job destruction from establishment deaths. This is true even during all of the recessionary periods since 1978. This indicates that employment dynamics among continuing establishments are a larger driver of aggregate employment flows than establishment entry and exit, and motivates our focus on continuing establishments in the OEWS data.

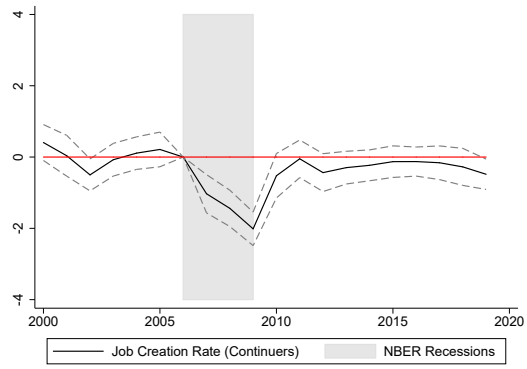
Second, the labor market is very dynamic, with gross reallocations of 20-30% of employment each year. Although there has been a secular decline in job creation (see for instance Decker et al. (2014)), even by the end of 2019 gross reallocation rates were 22%.

Third, while the two creation rates generally exceed the two destruction rates during economic expansions (consistent with broad employment growth) during contractions job destruction rates spike and job creation rates fall. Thus, there are important cyclical differences in the primacy of each of these statistics. While cyclical dynamics are primarily driven by continuing establishments, to a lesser extent we see a decline in job creation from establishment births and an increase in job destruction from establishment exits during recessions.

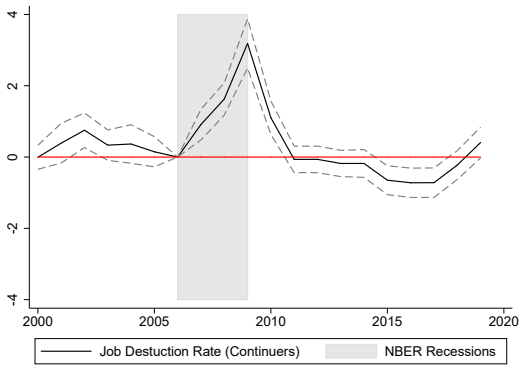
Next we want to examine how job creation and job destruction measures change in response to the MSA-level unemployment shock, as described in Section 3. In Figure 2, we plot the annual coefficients of the unemployment shock interacted with each year as in Equation 4. These coefficients measure the effect of the the unemployment shock on each job creation and destruction measure compared to 2006.

In Figure 2a, we show a sharp decline in job creation among continuing establishments beginning in 2007 and persisting through 2010. In Figure 2b, in contrast we see a sharp increase in job destruction, again beginning in 2007 and persisting through 2010. The peak job destruction rate is roughly twice the peak of the decline in job creation, indicating that shrinking establishments played a larger role in employment declines than establishments growing at a slower pace. For both of these series, the period from 2000 through 2005 show little evidence of pre-trends, and post 2010 the point estimates return to close to zero.

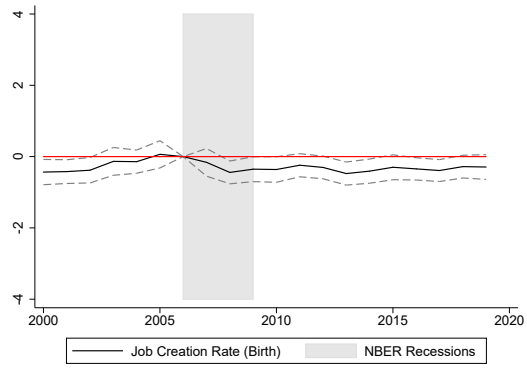
In Figure 2c and 2d, we instead examine job creation and job destruction rates for establishments entering and exiting, respectively. When we examine job creation from establishment births, we find weak evidence of job creation declines. This suggests that local areas that were harder hit by the Great Recession may have persistently lower job creation due to establishment entry, although there is some evidence of pre-trends so this may reflect pre-existing differences between MSAs. However, we do see evidence



(a) Job Creation Rate, Continuers



(b) Job Destruction Rate, Continuers



(c) Job Creation Rate, New Establishments

(d) Job Destruction Rate, Closures

Figure 2: Change in job dynamics in response to the MSA-level Great Recession shock, estimated from Equation 4 using MSA-level BDS data. Point estimates measure the estimated difference between the 90th percentile and 10th percentile MSA.

that job destruction from establishment closure spiked during the Great Recession, with a spike in job destruction from establishment exit around a quarter the size of the spike from continuing establishments.

Overall, our results from the BDS indicate that our measure of geographic variation in the intensity of the Great Recession shock performs well at identifying heterogeneity in employment gains and losses among continuing establishments. However, while we can see that job creation slows and job destruction spikes, we do not know which jobs within these establishments are shed. Thus, we next turn to the OEWS data to examine how establishments change their occupational structure in response to the Great Recession shock.

4.2 OEWS

Now that we have established that job creation and job destruction among continuing establishments are an important determinant of aggregate job flows from the BDS data, we turn to the OEWS to examine employment changes within establishments. We begin by examining employment changes on average, using data from 2003 to 2017. As discussed in Section 2, this panel data is constructed using establishments that are sampled 3 years apart.

In Table 1, we find that, on average, establishment employment grows by 8% over a 3 year period. However, columns 2 and 3 show this average reflects substantial heterogeneity by establishment. In these specifications, the dependent variable is an indicator that equals 1 if the establishment employment decreased since the previous observation 3 years prior (column 2) or increased (column 3). We find 28.9% of all establishments have fewer employees over a 3 year period, while 36.6% have more employees. These establishment-level statistics are consistent with the job-level statistics from the BDS, where each year 10 to 15% of aggregate jobs are destroyed from continuing establishments and 10 to 15% of aggregate jobs are created at continuing establishments.

To better understand which types of establishments are growing or shrinking, in Panel B of Table 1 we examine how employment growth differs by wage rank. We classify establishments by the establishment's median wage in the first year of the matched pair of years, and rank establishments within MSA by 2-digit industry. Rank 1 is the highest 20% of establishments within the cell, while rank 5 is the lowest 20%. Here we see that the highest wage establishments grow at an average of 15.6% over 3 years (that is, the constant term), while all other establishments have average growth rates of 5 to 7% (or 8-11% smaller than the highest-wage establishments). Similarly, we see that high-wage

establishments are more likely to grow and less likely to shrink than other wage groups. These results motivate examining how employment growth differs over the business cycle by establishment wage rank.

Table 1: Employment Growth and Establishment Wage Rank

	(1) Change in Log Emp.	(2) Shrink	(3) Grow
Panel A: All Establishments			
Constant	0.0811***	0.289***	0.366***
	(0.0123)	(0.0104)	(0.00825)
Panel B: Heterogeneity by Wage Rank			
Wage Rank 2	-0.0826***	0.0407***	-0.0313*
	(0.0169)	(0.0112)	(0.0122)
Wage Rank 3	-0.0975**	0.0854**	-0.0522*
	(0.0298)	(0.0326)	(0.0221)
Wage Rank 4	-0.110***	0.0586***	-0.0517**
	(0.0210)	(0.0157)	(0.0180)
Wage Rank 5 (lowest)	-0.0768	0.0247	-0.0544
	(0.0506)	(0.0315)	(0.0288)
Constant	0.156***	0.246***	0.405***
	(0.0137)	(0.00559)	(0.00891)
N	1716282	1716282	1716282

Note: OEWS panel data. Shrink and grow are indicators for whether the establishment employment decreased or increased over the 3 year period. Weighted using QCEW-adjusted sampling weights. Robust standard errors in parentheses. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

We next examine how the occupational structure differs by establishment wage rank and establishment growth rate. To facilitate comparison, we focus on the highest wage 20% of establishments (ie wage rank 1), and compare these establishments to the remaining 80% (ie wage ranks 2 through 5).

Occupations are a description of the tasks performed in an organization, so two establishments operating in the same industry with a different occupational mix are fundamentally producing in a different way. We describe the occupational mix in three different ways. First, we separate all occupations into 6 mutually exclusive categories (management, supervisors, professional, clerical, production, and service). Second, we isolate computer-related occupations, to capture occupations that may be associated with increased technological adoption. Finally, we identify occupations that are at heightened risk for offshoring or replacement by technology (cognitive and manual routine occupations. See Section 2 for more details.

In Panel A of Table 2, we see that more than three quarters of lower-wage establishments' employment is concentrated in lower-skill occupations: clerical, production and service occupations. We also observe that, compared to lower-wage establishments, high-wage establishments have 10 percentage points more employment in professional occupations, and 1 percentage points more employment in computer related occupations, while simultaneous employing 2 percentage points less in clerical occupations, 3 percentage points less in production occupations, and 6 percentage points less in service occupations. These results suggest that high-wage establishments operate in a way to use more professional labor and less low-skill labor. These results are consistent with previous research on occupational differences in service-sector establishments by wage rank (Forsythe (2019)).

Further, we see that these high-wage establishments employ 2 percentage points less employment in routine-cognitive occupations and 3 percentage points less employment in routine-manual occupations compared with lower-wage establishments. Moreover, we observe that establishments employ a higher share of workers in routine-cognitive occupations than in routine-manual occupations, which is consistent with the occupational structure observed, considering that job roles related to clerical, administrative, and sales positions have a higher concentration of routine-cognitive tasks, whereas routine-manual tasks are typically associated with roles in production and operative occupations.

In Table 1 we saw that these high-wage establishments grow at a faster rate than lower wage establishments, so in panel B we investigate whether the occupational shares are evolving differently between high-wage and low-wage establishments. We first observe that the only occupation share that is consistently growing for low-wage establishments is professional employment, with lower-wage establishments increasing the professional share by 0.7 percentage points. When we examine differences between high-wage and lower-wage establishments, we see high-wage establishments are more likely to decrease the management share of employment and the professional share of employment, as well as more likely to increase the service share of employment. This suggests that there may be some mean reversion at play, however we note that we do not find any convergence in the share of routine employment or computer-related employment.

Finally, in panel C we examine changes in the occupational share among establishments based on whether they are are growing, shrinking, or remain the same size. When we examine establishments that are staying the same size, we observe that these establishments increase the management share of employment by 1.2 percentage points on average, while decreasing the employment share of service employment by 1.0 percentage

points on average. Thus, although these establishments are not changing total employment, there is some evidence that the task structure is changing, with more white collar tasks and fewer workers performing service tasks.

In contrast, when we examine how establishments shrink, the only statistically significant decline is a 1.5 percentage points total decline in management employment, however these establishments also experience a decline in service employment that is at least as large as that of establishments that are not changing size. Finally, growing establishments exhibit a growth in management employment and a growth in service share, but no average differences across other occupations. Thus, in addition to substantial heterogeneity in employment dynamics across establishments, we have shown these dynamics are associated with changes in the underlying occupational structure and production process within establishments.

Now that we have documented how establishments grow and shrink on average, we turn to examining how these flows changed over the Great Recession. We focus on two different empirical strategies, first examining changes over time across the Great Recession period and second examining changes in response to the local severity of the Great Recession shock. The time series strategy allows us to include all variation that may be associated with the Great Recession, but there may be other trends over time that are included in the estimates. The specification based on variation in the local shock is able to isolate variation that is associated with the severity of the shock, but will exclude any effect from the Great Recession that has nation-wide effects.

In Table 3 we identify the Great Recession period as 2008 to 2010. Since our sample is a panel of establishments surveyed 3 years apart, the Great Recession dummy will measure the change in employment from 2005 to 2008, 2006 to 2009, and 2007 to 2010. The non-recession period is all other 3 year periods from 2003-2017. Since we are focusing on changes within establishments, our estimates are restricted to establishments that do not exit during the three-year period. However, although establishment exit did increase during the Great Recession period, we showed in the BDS data that the largest component of changes in job flows are due to continuing establishments.

We first focus on lower-wage establishments. Here we see during non-recessionary periods, average employment growth is 6%, while 30% of establishments shrink over a 3-year period and 36% of establishments grow. These point estimates are similar to what we saw in Table 1. This is because there are no statistically significant differences in employment growth during the Great Recession period for these lower-wage establishments.

Table 2: Level and Changes in Occupational Shares, by Establishment Wage Rank and Establishment Growth

	(1) Mgmt.	(2) Sup.	(3) Prof.	(4) Clerical	(5) Prod.	(6) Service	(7) Computer	(8) Offshorable	(9) CR	(10) RM
Panel A: Level of Occupational Share by Establishment Wage Rank										
High-Wage Est.	0.0108	-0.0156	0.103***	-0.0239*	-0.0294**	-0.0605***	0.0126***	0.0685***	-0.0215*	-0.0314***
	(0.0120)	(0.0121)	(0.00730)	(0.0114)	(0.00912)	(0.0130)	(0.000923)	(0.00932)	(0.0100)	(0.00632)
Constant	0.0939***	0.0550***	0.141***	0.354***	0.221***	0.190***	0.0112***	0.215***	0.233***	0.159***
	(0.0118)	(0.0121)	(0.00432)	(0.00994)	(0.00796)	(0.00843)	(0.000507)	(0.00760)	(0.00913)	(0.00540)
Panel B: Change in Occupational Share by Wage Rank										
High-Wage Est.	-0.0211**	-0.00742	-0.0288***	0.0178	0.00493	0.0271**	-0.00110	-0.0197*	0.00467	0.00548
	(0.00690)	(0.00523)	(0.00286)	(0.0119)	(0.00746)	(0.00940)	(0.000703)	(0.00806)	(0.00613)	(0.00821)
Constant	0.00665	-0.00265	0.00705***	-0.0120	0.0100	-0.0117	0.000591	0.0105	-0.000976	-0.00375
	(0.00437)	(0.00372)	(0.00166)	(0.0104)	(0.00617)	(0.00641)	(0.000396)	(0.00706)	(0.00401)	(0.00380)
Panel C: Change in Occupational Share, Conditional on Shrinking or Growing										
Shrinking Est.	-0.0274*	-0.0163	0.00657	0.0434	-0.0108	-0.0118	-0.00111	-0.0123	0.00419	-0.0130
	(0.0111)	(0.00981)	(0.00378)	(0.0265)	(0.0144)	(0.0175)	(0.000744)	(0.0172)	(0.00980)	(0.00995)
Growing Est.	-0.00431	0.00212	-0.00519	0.00498	-0.0131	0.0177**	-0.00106	-0.0222	0.000982	-0.00329
	(0.00516)	(0.00292)	(0.00312)	(0.0144)	(0.0140)	(0.00559)	(0.000906)	(0.0142)	(0.00640)	(0.00554)
Constant	0.0122***	-0.0000946	0.00168	-0.0231	0.0188	-0.00965*	0.00110	0.0185	-0.00167	0.00224
	(0.00368)	(0.00138)	(0.00223)	(0.0137)	(0.0135)	(0.00409)	(0.000642)	(0.0137)	(0.00477)	(0.00353)
N	1716282	1716282	1716282	1716282	1716282	1716282	1716282	1716282	1716282	1716282

Note: OEWS panel data, 2003 to 2017. Weighted using QCEW-adjusted sampling weights. Robust standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

In contrast, if we examine high-wage establishments, as in Table 1 we see that these establishments have higher overall employment growth than lower-wage establishments (17% on average), and are less likely to shrink and are more likely to grow. However, during the Great Recession period, we see that these high wage establishments' growth rate converges with low-wage establishments, with both growing at a rate of about 8% on average. Similarly, while high-wage establishments are more likely to grow and less likely to shrink compared with lower-wage establishment, those differences converge in the Great Recession period, with the growth and shrinking rates changing only for the high-wage establishments.

These results indicate that, in the time series, aggregate declines in employment are primarily driven by employment declines by high-wage establishments. This is consistent with previous evidence that worker flows from lower-wage to higher-wage establishments declined during the Great Recession (Haltiwanger et al. (2018)).

Table 3: Employment Changes over Great Recession

	(1) Change in Log Emp.	(2) Shrink	(3) Grow
Great Recession	0.0217	0.000983	0.0122
	(0.0298)	(0.0176)	(0.0170)
High Wage Establishment	0.112***	-0.0623***	0.0639***
	(0.0244)	(0.0174)	(0.0163)
GR × HW	-0.0950**	0.0416*	-0.0749***
	(0.0364)	(0.0206)	(0.0215)
Constant	0.0592***	0.299***	0.355***
	(0.0174)	(0.0160)	(0.0120)
N	1716282	1716282	1716282

Note: OEWS panel data. "Change in Log Emp." is the change in log-employment between the pre-period and the current period. Shrink and grow are indicators for whether the establishment employment decreased or increased from the pre-period to the Great Recession period. Weighted using QCEW-adjusted sampling weights. Robust standard errors in parentheses. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

We next turn to the panel variation in the Great Recession severity, leveraging the fact that there was substantial spatial heterogeneity in the magnitude of the growth in unemployment during the Great Recession. Since we are examining differences across MSAs, we construct the panel sample somewhat differently, defining the pre-period as 2004-2006, and focusing on establishments sampled during the pre-period as well as the Great Recession (2009-2009), the pre-period and the early recovery (2010-2012), or the pre-period and the later recovery (2013-2015). We include establishment and quarter-

by-year fixed effects, so estimates measure the change within establishments compared to the pre-period, controlling for economy-wide changes over time.

In Table 4, in the first column we see a point estimate of -0.064, which indicates that establishments in hard-hit MSAs (the 90th percentile most affected MSAs) had a 6.4% larger decline in employment compared with establishments in less hard-hit MSAs (the 10th percentile most affected MSAs). In column 2 we examine the early recovery period, and see a similar decline of 7.1%. In column 3, we restrict the sample to establishments that were sampled in all 3 periods (pre-period, Great Recession, and early recovery), and find that declines in employment from the Great Recession continue through the early recovery period. While there are no statistically significant differential effects through 2009, establishments in hard-hit MSAs present 7.6% larger declines in employment than establishments in less hard-hit MSAs in the early recovery (2010-2012). In column 4, we further see that employment declines of 6.5% continue through at least 2015. Finally, in columns 5 and 6, we see establishments that are exposed to high levels of the shock were 3 percentage points more likely to shrink between the pre-period and the Great Recession period, and 4 percentage points less likely to grow, compared with less treated establishments.

Thus, consistent with the evidence we found using the BDS job dynamics, we see the geographic variation in the Great Recession shock had a substantial impact on employment growth among continuing establishments, that persisted through at least 2015. This is a longer duration than we observed in the BDS, where the job creation and destruction rates returned to baseline by 2012, however those rates reflect employment flows. These establishment-level results from the OEWS suggest it took several additional years for employment counts to return to pre-recession levels.

In Table 5, we expand the analysis in Table 4 to examine heterogeneity between lower-wage and high-wage establishments. Here we see similar point estimates for the difference-in-difference estimates (that is, the time period interacted with the shock variable), however we find no differential impact on the change in employment growth for high-wage establishments. This is in contrast to the time-series evidence, for which all of the variation in employment growth during the Great Recession was driven by high-wage establishments. What could explain the difference? The panel specification includes time fixed effects, so is stripping out all variation over time, while the time series specification is averaging across all MSAs, so removing any variation by the severity of the Great Recession shock. The divergence of our results suggests that high-wage establishments experienced negative employment effects nation-wide during the Great

Table 4: Variation in Employment Changes with Great Recession Shock

	(1) Log Emp.	(2) Log Emp.	(3) Log Emp.	(4) Log Emp	(5) Shrink	(6) Grow
Shock	-0.0608	-0.225	-0.119	-0.162	0.0295*	-0.0405***
	(0.183)	(0.121)	(0.141)	(0.119)	(0.0135)	(0.00889)
GR × Shock	-0.0640**		-0.0282			
	(0.0229)		(0.0179)			
Early Recov. × Shock		-0.0706***	-0.0764***			
		(0.0205)	(0.0190)			
Late Recov. × Shock				-0.0652**		
				(0.0224)		
Constant	1.449***	1.565***	1.694***	1.883***	0.299***	0.393***
	(0.186)	(0.123)	(0.142)	(0.114)	(0.0129)	(0.0104)
N	428746	510222	330171	422612	214520	214520
Sample	Great Rec.	Early Recov.	GR and ER	Late Recov.	Great Rec.	Great Rec.

Note: OEWS panel data. Weighted using QCEW-adjusted sampling weights. All specifications include quarter-by-year fixed effects, columns 1 through 4 include establishment fixed effects. Shrink and grow are indicators for whether the establishment employment decreased or increased from the pre-period to the Great Recession period. GR indicates the Great Recession period (2008 to 2009), ER indicates the early recovery (2010-2012), and LR indicates the late recovery (2013-2015). Standard errors clustered at the MSA level. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Recession, while lower-wage establishments experienced stronger geographic variation in employment effects. In ongoing work we are further investigating the determinants of this result.

In Table 6, we examine how establishments change in occupational structure in response to the Great Recession shock. In Panel A, we examine the level of employment in each occupational category. We include establishment fixed effects and control for total employment in each period, so our estimates measure changes in employment in each occupational group, controlling for establishment size. Here we see that more treated establishments increase employment in professional and computer occupations, while decreasing employment in clerical and routine manual occupations. These results indicate that establishments reduce employment in clerical and routine manual occupations faster than they reduce employment overall, while preserving employment in professional and computer shares. In Panel B, we examine the occupational shares directly, that is, dividing occupational employment by total employment. We note that point estimates are consistent but not significant. In ongoing work we are continuing to examine the robustness of these results to alternative specifications.

4.3 Aggregate Dynamics in Occupational Employment

Now that we have identified how continuing establishments change their occupational structure over time and in response to the Great Recession, we next use aggregate data from the Census/ACS to investigate whether we find consistent trends in the aggregate occupational data.

In Figure 3 panel (a) we focus on the dynamics of occupations classified as Routine-Manual and Routine-Cognitive, that is occupations that are in the top quartile of the distribution of skills in terms of routine-manual and routine-cognitive skills as defined by Acemoglu and Autor (2011a); Hershbein and Kahn (2018). We observe that in 2005 the share of employment in routine-cognitive occupations is one quarter of total employment, while the share of employment in routine-manual occupations is one fifth of total employment. These fractions are consistent with the average establishment-level shares in the OEWS (measured from 2002-2017). During the Great Recession, employment in routine-manual occupations dropped precipitously, and did not recover as of 2019. In contrast, routine-cognitive employment was stable during the Great Recession, and only declined beginning in 2018-2019. We note, however, we do not see clear evidence of these trends in the establishment-panel data.

Regarding the occupational structure, in figure 3 panel (b) we can see that produc-

Table 5: Variation in Employment Changes with Great Recession Shock, High-Wage and Low-Wage Establishments

	(1) Log Emp	(2) Log Emp	(3) Log Emp	(4) Log Emp	(5) Shrink	(6) Grow
Shock	-0.0447	-0.204	-0.0906	-0.165	0.0300*	-0.0390***
	(0.185)	(0.121)	(0.140)	(0.120)	(0.0139)	(0.00966)
GR × Shock	-0.0704**		-0.0373			
	(0.0263)		(0.0201)			
High-Wage Establishment	-0.0291	-0.0618	-0.00377	-0.177	-0.0426*	0.0370
	(0.0460)	(0.0522)	(0.0406)	(0.143)	(0.0191)	(0.0225)
HW Est. × Shock	-0.0400	-0.0275	-0.0839*	0.0157	-0.00205	-0.00878
	(0.0404)	(0.0455)	(0.0377)	(0.0651)	(0.0174)	(0.0205)
GR × HW Est.	-0.0600		-0.0321			
	(0.0544)		(0.0505)			
GR × HW Est. × Shock	0.0328		0.0509			
	(0.0465)		(0.0458)			
Early Recovery × Shock		-0.0688**	-0.0863***			
		(0.0241)	(0.0238)			
Early Recovery × HW Est.		0.0419	-0.0389			
		(0.0473)	(0.0457)			
ER × HW Est. × Shock		-0.00901	0.0513			
		(0.0450)	(0.0434)			
Late Recovery × Shock				-0.0587		
				(0.0299)		
Late Recovery × HW Est.				0.0421		
				(0.106)		
LR × HW Est. × Shock				-0.0225		
				(0.0630)		
Constant	1.449***	1.553***	1.685***	1.903***	0.307***	0.386***
	(0.187)	(0.122)	(0.140)	(0.114)	(0.0131)	(0.0112)
N	428746	510222	330171	422612	214520	214520
Sample	Great Rec.	Early Recov.	GR and ER	Late Recov.	Great Rec.	Great Rec.

Note: OEWS panel data. Weighted using QCEW-adjusted sampling weights. All specifications include quarter-by-year fixed effects. Columns 1 through 4 include establishment-level fixed effects. Shrink and grow are indicators for whether the establishment employment decreased or increased from the pre-period to the Great Recession period. GR indicates the Great Recession period (2008 to 2009), ER indicates the early recovery (2010-2012), and LR indicates the late recovery (2013-2015). Standard errors clustered at the MSA level. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Table 6: Effect of Shock on Occupational Employment within Establishments

	(1) Mgmt.	(2) Prof.	(3) Clerical	(4) Prod.	(5) Service	(6) Computer	(7) Offshorable	(8) CR	(9) RM
					Panel A: Total Occupational Employment				
Shock	0.120	-0.227	0.124	0.193	-0.211	-0.0812	0.636	-0.261	-0.146
	(0.205)	(0.389)	(0.581)	(0.298)	(0.448)	(0.137)	(0.374)	(0.477)	(0.540)
GR × Shock	-0.0686	0.292***	-0.250**	0.0141	0.0122	0.0478***	0.0986	0.0158	-0.153*
	(0.0431)	(0.0799)	(0.0863)	(0.0638)	(0.0498)	(0.0143)	(0.0626)	(0.0521)	(0.0682)
Total Employment	0.0738***	0.345***	0.216***	0.245***	0.120***	0.0396***	0.242***	0.316***	0.186***
	(0.00849)	(0.0687)	(0.0328)	(0.0689)	(0.0204)	(0.00862)	(0.0412)	(0.0392)	(0.0289)
Constant	0.175	-1.649*	0.0171	0.229	1.229*	-0.174	-1.186*	-0.298	0.0623
	(0.203)	(0.791)	(0.679)	(0.724)	(0.502)	(0.170)	(0.570)	(0.620)	(0.646)
N	428746	428746	428746	428746	428746	428746	428746	428746	428746
					Panel B: Occupational Share				
Shock	0.0269	-0.0148	0.0222	0.00853	-0.0428	0.00133	0.0507	0.0872*	-0.0000143
	(0.0258)	(0.0342)	(0.0490)	(0.0364)	(0.0284)	(0.0107)	(0.0388)	(0.0401)	(0.0306)
GR × Shock	-0.00536	0.00305	0.000816	-0.00193	0.00342	0.000588	0.00182	0.00350	-0.00154
	(0.00732)	(0.00651)	(0.00858)	(0.00662)	(0.00410)	(0.00148)	(0.00654)	(0.00846)	(0.00736)
Constant	0.0623*	0.159***	0.307***	0.181***	0.290***	0.00896	0.148***	0.126**	0.144***
	(0.0249)	(0.0342)	(0.0507)	(0.0378)	(0.0291)	(0.0110)	(0.0389)	(0.0404)	(0.0309)
N	428746	428746	428746	428746	428746	428746	428746	428746	428746

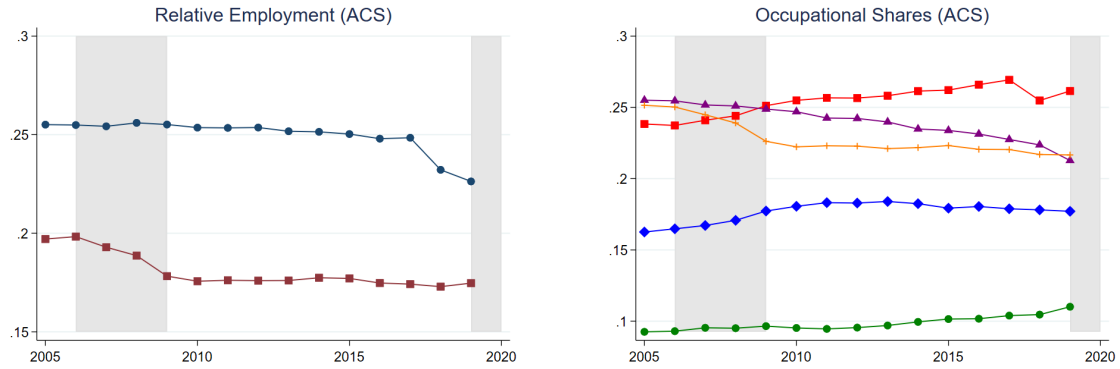
Note: OEWS panel data. Weighted using QCEW-adjusted sampling weights. All specifications include establishment-level fixed effects and quarter-by-year fixed effects. GR indicates the Great Recession period (2008 to 2009). Standard errors clustered at the MSA level. * p<0.05, ** p<0.01, *** p<0.001.

tion (orange +), professional (red square) and clerical (purple triangle) occupational groups represent three quarters of employment in 2005, while service occupations (blue diamond) represents 17% and managerial occupations (green circle) represents less than 10% of total employment. This structure is close to the average occupational structure of high-wage continuing establishments observed for the period 2003-2017, while lower-wage establishments have higher employment in service occupations and less in professional occupations.

In addition, we observe several trends in the aggregate occupational data that we can compare to what we observed within-establishments from the OEWS data. First, we observe that the management share of employment is increasing over the sample period, which is consistent with results in Table 2. Second, we see that the service share of employment is increasing. In Table 2 we found that high-wage establishments were increasing their share of service employment, while the effect for low-wage establishments was not significant. Third, we observe that professional employment is increasing over this time period in aggregate. In the establishment-level data, we found that professional employment was increasing for low-wage establishments and decreasing for high-wage establishments. However, since low-wage establishments comprise 80% of establishments, in aggregate this may reflect an overall increase.

Two occupational groups stand out when compare the individual data with the establishment-level data: clerical and production. Both of these groups show a secular decline, with clerical employment declining smoothly through the time period and production employment declining rapidly during the Great Recession and then stabilizing at a lower employment share, mirroring the trend we saw for routine-manual occupations in Panel (a). In contrast, we do not see clear evidence of these declines in the establishment-level data.

In Figure 4 we examine how the employment shares in MSAs were affected by the Great Recession by measuring the effects of the severity of the unemployment shock. Specifically, in Figure 4 we plot the point estiamtes of α_1 from equation 4, showing results for routine occupations in panel (a) and for employment shares of the five main occupational groups in panel (b). Panel (a) of Figure 4 shows how the share of MSA employment for routine-manual (red squares) and for routine-cognitive (blue circles) occupations varies with the severity of the unemployment shock. After the Great Recession, we find a large and persistent drop in routine-manual employment and an increase in the share of routine-cognitive employment that takes place several years after the Great Recession (2016-2019). These results are consistent with those observed by Hershbein



(a) Routine-Manual vs Routine-Cognitive

(b) Occupational Shares

Figure 3: 2005-2019 American Community Survey Data

Note: Panel (a) shows evolution of the employment shares of Routine-Manual occupations (red squares) and Routine-Cognitive occupations (blue circles). Panel (b) shows the evolution of the occupational structure by looking at the 5 main occupational shares: managers (green circle), production (orange +), professional (red square), service (blue diamond) and clerical (purple triangle).

and Kahn (2018). However, Hershbein and Kahn (2018) find a steady and modest rise in routine-cognitive employment starting in 2015.[4] We see similar results for routine-manual occupations within establishments in Table 6 and find consistent evidence of no increase in routine-cognitive through 2015.

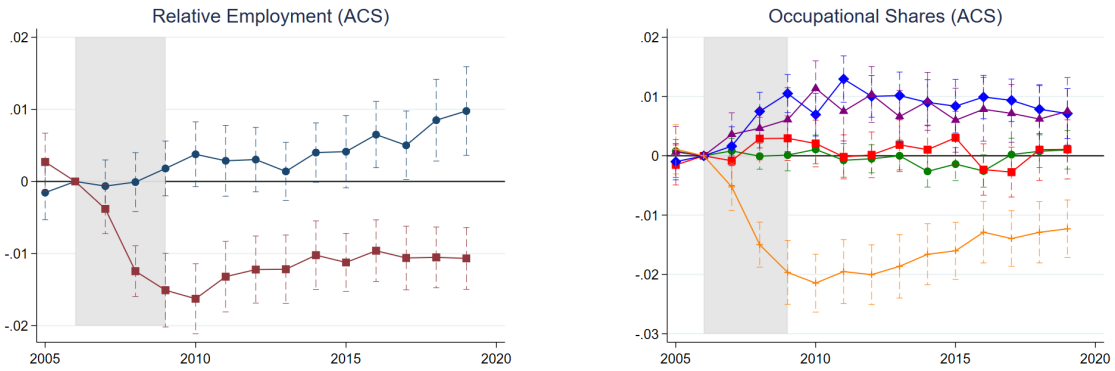
Panel (b) of Figure 4 shows a substantial decline in the employment share of production occupations by about 1.5 percentage points more in harder-hit MSAs and increases in employment shares in service and clerical occupations by about 1 percentage points more in harder-hit MSAs, both persistent in time but partially recovering by the end of the period. We also observe minor declines in management occupations in years 2014 and 2016 of 0.3 percentage points more in harder-hit MSAs. As we do not observe increases in employment of clerical, service or management occupations for establishments, nor declines in employment of production occupations, we are working on exploring if these differences are explained by establishments entry and exit or due to our sampling procedures. Moreover, contrary to what we observe at the national level and at establishment level, we do not observe differential effects in professional occupational shares in harder-hit MSAs versus mildly-hit MSAs. While there are sizable increases in the share of professional occupations in the years 2009 and 2010, which are the same years for comparison in our sample of establishments, those increases are not statistically

[4]See Table A.1.

significant.

In addition, in Table A.2 we see minor increases in IT workers occupational share in years 2018-2019 of 0.3 percentage points more in harder-hit MSAs, which match those observed in the level of employment of computer occupations in establishments. However, there is some evidence of pre-trends, suggesting it may reflect pre-existing differences between MSAs. [5]

Overall we conclude that many of the trends we observe in the establishment-level data from the OEWS are reflected in aggregate occupational data, indicating that this occupational restructuring is occurring within establishments. However, as discussed above, there remain some discrepancies between the aggregate and establishment data. These differences may reflect differences in the timing of the samples, differences driven by entry and exit of establishments, or inherent sampling differences from comparing individual and establishment surveys. In ongoing work we are working to disentangle these explanations.



(a) Routine-Manual vs Routine-Cognitive (b) Occupational Shares

Figure 4: Changes in Employment Shares

Note: Changes in employment shares for routine occupations and in occupational shares due to the Great Recession. Panel (a) shows the effects of the Great Recession on the employment shares of Routine-Manual occupations (red squares) and Routine-Cognitive occupations (blue circles). Panel (b) shows the effects of the Great Recession on the occupational structure by looking at the 5 main occupational shares: managers (green circles), production (orange +), professional (red squares), service(blue diamonds) and clerical (purple triangles).

[5] See Table A.2 in the Appendix.

5 Conclusion

In this paper, we present evidence of changes in the production process of establishments in response shocks. We investigate establishments' responses in terms of job creation and job destruction, as well as changes in employment shares for main occupational groups. Our identification strategy exploits the differences in the severity of the unemployment shock in hard-hit MSAs versus less hard-hit MSAs. The intuition behind our analysis is that establishments in hard-hit MSAs will have higher incentives to become more productive, either by reducing their size, growing less or substituting employees in lower skill occupations/higher routine skill occupations. We consider that heterogeneous establishments may have a differential response, and explore differences for high-wage and lower-wage establishments.

We use the Business Dynamics Statistics (BDS) to document two facts: that job creation and job destruction is largely explained by continuing establishments, and that these establishments played also a bigger role in explaining differences in employment in areas more affected during the Great Recession due to a higher reduction of job creation and increase of job destruction than exiting and entrant establishments.

Then, using establishments-level panel data from the Occupational Employment and Wages Survey, we focus on continuing establishments to document several key findings. First, high-wage establishments have higher employment growth, a higher probability of growing and a lower probability of shrinking than lower-wage establishments. Second, high-wage establishments and lower-wage establishments have different occupational structures. We find establishments are increasing their management share over time, even among establishments that are neither growing or shrinking, while growing establishments increase the service share and shrinking establishments decrease the management and service share.

When we examine changes over the Great Recession, we find that the decline in employment is driven by high-wage establishments in the time series. However, when we examine variation with the local severity of the unemployment shock, we find symmetric declines in employment for low- and high-wage establishments that persist through 2015. When we examine changes in occupational structure, and find that establishments in high-exposure MSAs reduce employment in routine-manual occupations, and increase in relative employment in professional and computer-related occupations.

Finally, we explore if those findings also match the trends observed with aggregate data using the American Community Survey (ACS). We observed that the aggregate

occupational structure has experienced substantial changes in the last decade, with low-skill/routine-manual occupations being substituted by high-skill occupations, and that those changes seem to originate during the Great Recession. Moreover, the declines in employment shares of low-skill/routine-manual occupations were larger in areas that suffered a larger shock in the Great Recession.

Overall, we conclude that when establishments grow and shrink, they change their relative occupational shares, which reflects changes in the production process. During the Great Recession, establishments became smaller by shedding relatively more routine employment, ultimately becoming more high-skill intensive. The aggregate occupation date shows that the decline in routine-manual employment was persistent, consistent with these restructurings reflecting a permanent change in the production process.

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A Appendix

Table A.1: Relative Employment Changes

	(1) Routine-Cognitive	(2) Routine-Manual
Shock x 2005	-0.00155	0.00270
	(0.00192)	(0.00204)
Shock x 2007	-0.000643	-0.00380**
	(0.00185)	(0.00174)
Shock x 2008	-8.48e-05	-0.0124***
	(0.00208)	(0.00179)
Shock x 2009	0.00180	-0.0151***
	(0.00194)	(0.00261)
Shock x 2010	0.00376	-0.0163***
	(0.00229)	(0.00247)
Shock x 2011	0.00287	-0.0132***
	(0.00250)	(0.00249)
Shock x 2012	0.00303	-0.0122***
	(0.00228)	(0.00237)
Shock x 2013	0.00139	-0.0122***
	(0.00205)	(0.00243)
Shock x 2014	0.00400*	-0.0102***
	(0.00210)	(0.00242)
Shock x 2015	0.00413	-0.0112***
	(0.00256)	(0.00206)
Shock x 2016	0.00649***	-0.00960***
	(0.00235)	(0.00218)
Shock x 2017	0.00501**	-0.0106***
	(0.00243)	(0.00225)
Shock x 2018	0.00850***	-0.0105***
	(0.00289)	(0.00215)
Shock x 2019	0.00977***	-0.0107***
	(0.00314)	(0.00218)
Constant	0.259***	0.184***
	(0.00208)	(0.00213)
Time FE	Yes	Yes
MSA FE	Yes	Yes
Observations	8,250	8,250
R-squared	0.735	0.949

Note: ACS panel data. Share of employment in occupations in the top quartile of the routine-manual and routine-cognitive distribution. Robust standard errors.

Table A.2: Occupational Shares Changes

	(1) Managers	(2) Professional	(3) Service	(4) Clerical	(5) Production	(6) IT worker
Shock x 2005	0.000778	-0.00153	-0.000991	0.000648	0.00110	-0.00136**
	(0.000987)	(0.00172)	(0.00157)	(0.00219)	(0.00212)	(0.000599)
Shock x 2007	0.000824	-0.000831	0.00163	0.00361*	-0.00524**	-0.00113*
	(0.00108)	(0.00214)	(0.00167)	(0.00185)	(0.00205)	(0.000583)
Shock x 2008	-6.26e-05	0.00290	0.00750***	0.00465***	-0.0150***	0.000384
	(0.00112)	(0.00182)	(0.00163)	(0.00169)	(0.00193)	(0.000593)
Shock x 2009	0.000121	0.00295	0.0105***	0.00609**	-0.0197***	1.24e-05
	(0.00136)	(0.00191)	(0.00163)	(0.00275)	(0.00275)	(0.000646)
Shock x 2010	0.00108	0.00208	0.00694***	0.0114***	-0.0215***	-0.000199
	(0.00124)	(0.00200)	(0.00184)	(0.00237)	(0.00250)	(0.000586)
Shock x 2011	-0.000757	-0.000174	0.0129***	0.00751***	-0.0195***	-0.000143
	(0.00145)	(0.00189)	(0.00199)	(0.00256)	(0.00276)	(0.000599)
Shock x 2012	-0.000498	0.000160	0.0100***	0.0103***	-0.0200***	6.14e-06
	(0.00121)	(0.00197)	(0.00180)	(0.00240)	(0.00256)	(0.000632)
Shock x 2013	5.82e-06	0.00186	0.0102***	0.00662***	-0.0186***	7.45e-05
	(0.00135)	(0.00215)	(0.00202)	(0.00226)	(0.00273)	(0.000656)
Shock x 2014	-0.00263*	0.00104	0.00901***	0.00919***	-0.0166***	0.000683
	(0.00135)	(0.00206)	(0.00196)	(0.00249)	(0.00262)	(0.000692)
Shock x 2015	-0.00140	0.00305	0.00837***	0.00600**	-0.0160***	-2.84e-05
	(0.00142)	(0.00226)	(0.00230)	(0.00275)	(0.00245)	(0.000822)
Shock x 2016	-0.00256*	-0.00232	0.00992***	0.00784***	-0.0129***	0.000463
	(0.00139)	(0.00221)	(0.00187)	(0.00274)	(0.00264)	(0.000923)
Shock x 2017	0.000205	-0.00276	0.00936***	0.00715***	-0.0140***	-0.000926
	(0.00141)	(0.00214)	(0.00182)	(0.00249)	(0.00239)	(0.000962)
Shock x 2018	0.000765	0.00104	0.00785***	0.00620**	-0.0129***	0.00316***
	(0.00141)	(0.00265)	(0.00211)	(0.00287)	(0.00263)	(0.00115)
Shock x 2019	0.00100	0.00109	0.00713***	0.00751***	-0.0123***	0.00312**
	(0.00166)	(0.00255)	(0.00215)	(0.00290)	(0.00248)	(0.00124)
Constant	0.0931***	0.248***	0.162***	0.258***	0.238***	0.0233***
	(0.00114)	(0.00184)	(0.00185)	(0.00236)	(0.00225)	(0.000628)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
MSA FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,250	8,250	8,250	8,250	8,250	8,250
R-squared	0.846	0.950	0.839	0.804	0.959	0.939

Note: ACS panel data. Occupational Shares constructed as employment in occupation i/Total Employment. IT worker employment share corresponds to occupations under the SOC "15-11". Robust standard errors.