JOB POLARIZATION AND JOBLESS RECOVERIES

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ABSTRACT

Job polarization refers to the shrinking share of employment in middle-skill, routine occupations experienced recently, over the last 35 years. Jobless recoveries refers to the slow rebound in aggregate employment following recent recessions, despite recoveries in aggregate output. We show how these two phenomena are related. First, essentially all employment loss in routine occupations occurs in economic downturns. Second, jobless recoveries in the aggregate can be accounted for by jobless recoveries in the routine occupations that are disappearing.

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1 Introduction

In the past 35 years, the US labor market has seen the emergence of two new phenomena: *job polarization* and *jobless recoveries*. Job polarization refers to the increasing concentration of employment in the highest- and lowest-wage occupations, as jobs in middle-skill occupations disappear. Jobless recoveries refer to periods following recessions in which rebounds in aggregate output are accompanied by much slower recoveries in aggregate employment. We argue that the emergence of jobless recoveries is linked to the job polarization process.

Consider first the phenomenon of job polarization. Acemoglu (1999), Autor et al. (2006), Goos and Manning (2007), and Goos et al. (2009) (among others) document that employment is becoming concentrated at the tails of the occupational skill distribution. This process has accelerated since the 1980s, as per capita employment in middle-skill jobs disappears. This hollowing out of the middle is linked to the disappearance of occupations focused on "routine" tasks—those activities that can be performed by following a well-defined set of procedures. Autor et al. (2003) and the subsequent literature demonstrates that job polarization is primarily due to progress in technologies that substitute for labor in performing routine tasks.[1]

In this same time period, Gordon and Baily (1993), Groshen and Potter (2003), Bernanke (2003), and Bernanke (2009) (among others) discuss the emergence of jobless recoveries. In the past three recessions (of 1991, 2001, and 2009), aggregate employment continues to decline for years following the turning point in aggregate income and output. No consensus has yet emerged regarding the source of these jobless recoveries.[2]

In this paper, we report two related findings. Our first point is that the disappearance of per capita employment in routine occupations associated with job polarization is not simply a gradual phenomenon: the loss is concentrated in economic downturns. Specifically, 88% of the job loss in these occupations since the mid-1980s occurs within a 12 month window of NBER dated recessions. A number of researchers have noted that the polarization process has been accelerated by the Great Recession (see Autor (2010); and Brynjolfsson and McAfee (2011)). Our first point is that routine employment loss has happened almost entirely in the last three recessions.

Our second, and main, point is that jobless recoveries in the aggregate can be accounted for by jobless recoveries in the routine occupations that are disappearing. This argument is based on three facts. First, employment in the routine occupations identified by Autor et al. (2003), Autor and Dorn (2013), and others account for a significant fraction of aggregate employment; averaged over the jobless recovery era, these jobs account for about 50% of total

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[1]See also Firpo et al. (2014), Goos et al. (2014), and the references therein regarding the relative role of technological change and outsourcing/offshoring in job polarization.

[2]See, for instance, Koenders and Rogerson (2005), Bachmann (2012), and Berger (2012) for recent theoretical work.

employment. Second, essentially all of the contraction in per capita aggregate employment during NBER dated recessions can be attributed to recessions in these middle-skill, routine occupations. Third, jobless recoveries are observed only in these disappearing, middle-skill jobs. The high- and low-skill occupations to which employment is polarizing either do not experience contractions, or if they do, rebound soon after the turning point in aggregate output. Hence, jobless recoveries can be traced to the disappearance of routine occupations in recessions. Finally, it is important to note that jobless recoveries were not observed in routine occupations—nor in aggregate employment—prior to the era of job polarization.

In Section 2, we present data on jobless recoveries and job polarization. In Section 3, we present data documenting that these two phenomena are related. In Section 4, we discuss additional evidence regarding the link between the decline of employment in routine occupations and jobless recoveries. Section 5 concludes.

2 Two Labor Market Phenomena

2.1 Jobless Recoveries

Figures 1 and 2 plot the cyclical behavior of aggregate per capita employment in the US during the past six recessions and subsequent recoveries.[3] Aggregate per capita employment is that of all civilian non-institutionalized individuals aged 16 years and over (seasonally adjusted), normalized by the population.[4] Throughout the paper, recessions are referred to by their trough year, e.g., the recession that began in December 2007 and ended in June 2009 is referred to as the 2009 recession. Because the monthly employment data are "noisy," the data are logged and band pass filtered to remove only fluctuations at frequencies higher than 18 months (business cycle fluctuations are traditionally defined as those between frequencies of 18 and 96 months).[5] On the x-axis of each figure, the trough of the recession, as identified by the NBER, is indicated as date 0; we plot data for two years around the trough date. The shaded regions indicate the NBER peak-to-trough periods. Employment is normalized to zero at the trough of each recession. Hence, the y-axis measures the percent change in employment relative to its value in

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[3]The 1980 recession is omitted since it is followed closely by a recession beginning in 1981, limiting our ability to study its recovery.

[4]Data are taken from the Labor Force Statistics of the CPS, downloaded from the BLS website (bls.gov/data/). See Appendix A for detailed description of all data sources. Employment data at the aggregate and occupational level are available dating back to 1959. Issues with the early CPS data, especially during the 1961 recession, are well-documented issues; see, for instance, the President's Committee to Appraise Employment and Unemployment Statistics report, "Measuring Employment and Unemployment," commonly referred to as the Gordon report. The recommendations of this report led to methodological changes adopted by the BLS in 1967 (see Stein (1967)). As such, our analysis uses data beginning in July 1967.

[5]We implement this using the band pass filter proposed by Christiano and Fitzgerald (2003), who discuss the merits of their method for isolating fluctuations outside the traditional business cycle frequencies and near the endpoints of datasets.

the NBER trough.

Figure 1 displays the 1970, 1975, and 1982 recessions. In each case, aggregate employment begins to expand within six months of the trough. The fact that employment recovers within two quarters of the turning point in aggregate output and income is typical of the business cycle prior to the mid-1980s (see for instance, Schreft and Singh (2003); Groshen and Potter (2003)).

This contrasts sharply from the 1991, 2001, and 2009 recessions. As displayed in Figure 2, these recoveries were jobless: despite expansions in other measures of economic activity (such as RGDP and real gross domestic income) following the trough, aggregate per capita employment continued to contract for many months. In 1991, employment continues to fall for 17 months past the trough before turning around; employment does not reach its pre-recession level until five years later, in 1996. In 2001, employment falls for 23 months past the trough before turning around; it does not return to its pre-recession level before the subsequent recession. Following the Great Recession of 2009, employment takes 23 months to begin recovery. Hence, the jobless recovery is a phenomenon characterizing recent recessions (see also Groshen and Potter (2003) and Bernanke (2003)).

Table 1 summarizes these differences, presenting several measures of the speed of recovery following early and recent recessions. Panel A concerns the recoveries in aggregate per capita employment. The first row lists the number of months it takes for employment to turn around (stop contracting), relative to the NBER trough date. The second row indicates the number of months it takes from the trough date for employment to return to its level at the trough. The third row lists a "half-life" measure: the number of months it takes from the trough date to regain half of the employment lost during the NBER-defined recession.

As is obvious, there has been a marked change in the speed of employment recoveries. Averaged over the three early recessions, employment turns around approximately four months after the NBER trough date; in the recent recessions, the average turnaround time is 21 months. Averaged over the early recessions, employment returns to its trough level within approximately 10 months. Over the last three recessions, this value is 54 months, taking almost 6.5 years to return to its trough following the Great Recession. Finally, while it takes *at most* 27 months from the trough date to regain half of the employment lost in the three early recessions, it takes *at least* 38 months in the recent recessions; indeed, employment never regained half of its loss following the 2001 recession, and has yet to do so after the Great Recession.

This contrasts with the nature of recoveries in aggregate output. Panel B presents the same recovery measures for per capita RGDP; to obtain monthly measures, we use the monthly data of Stock and Watson (see Appendix A for details). Given the NBER Dating Committee's emphasis on RGDP and real gross domestic income in determining cyclical turning points, it is perhaps not surprising that aggregate output begins recovery on the NBER trough dates (see nber.org/cycles/recessions_faq.html). This is true for both the early and recent recessions, as

Figure 1: Aggregate Employment around Early NBER Recessions
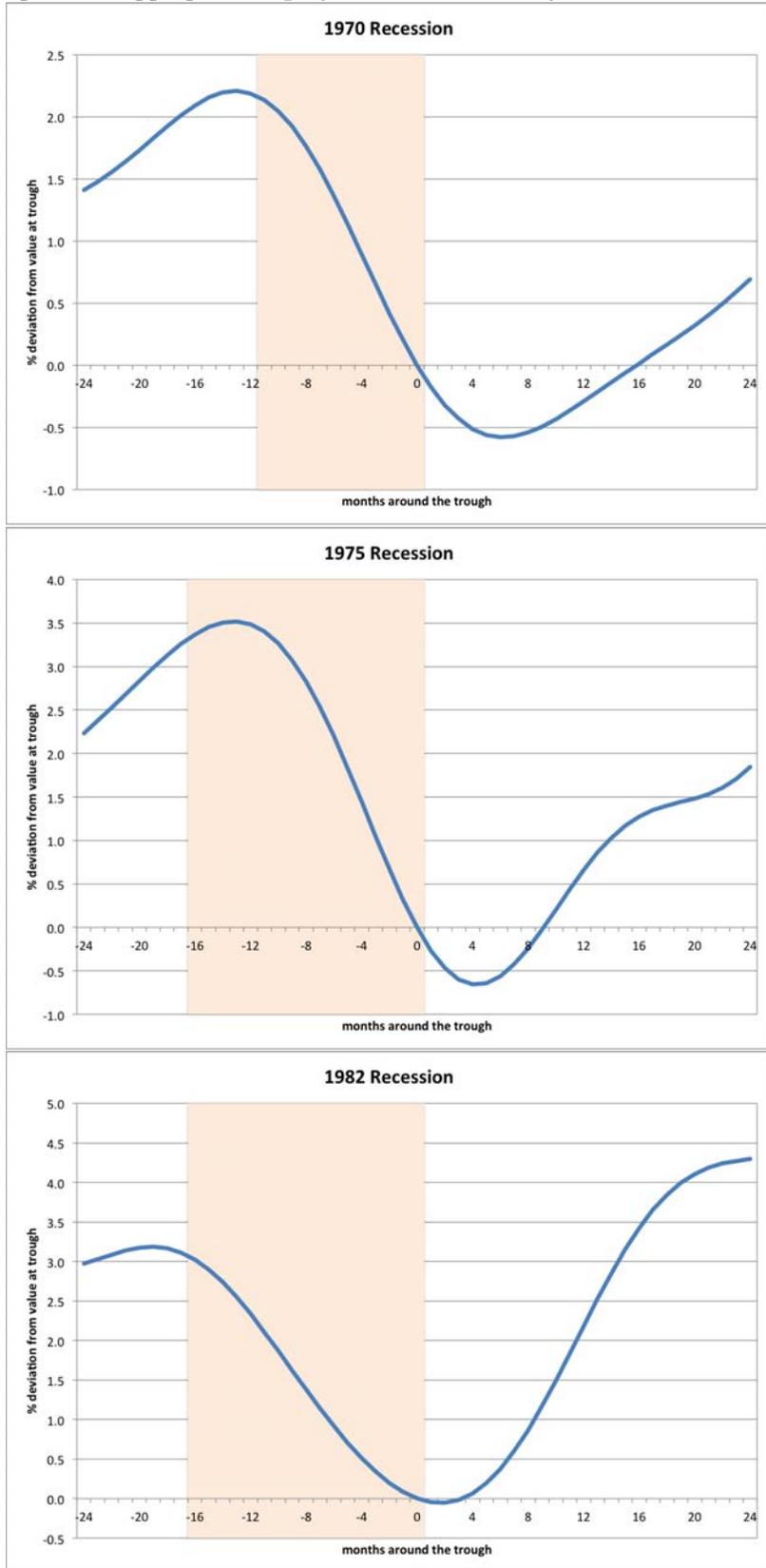
Notes: Data from the Bureau of Labor Statistics, Current Population Survey (CPS). See Appendix A for details.

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Figure 2: Aggregate Employment around Recent NBER Recessions
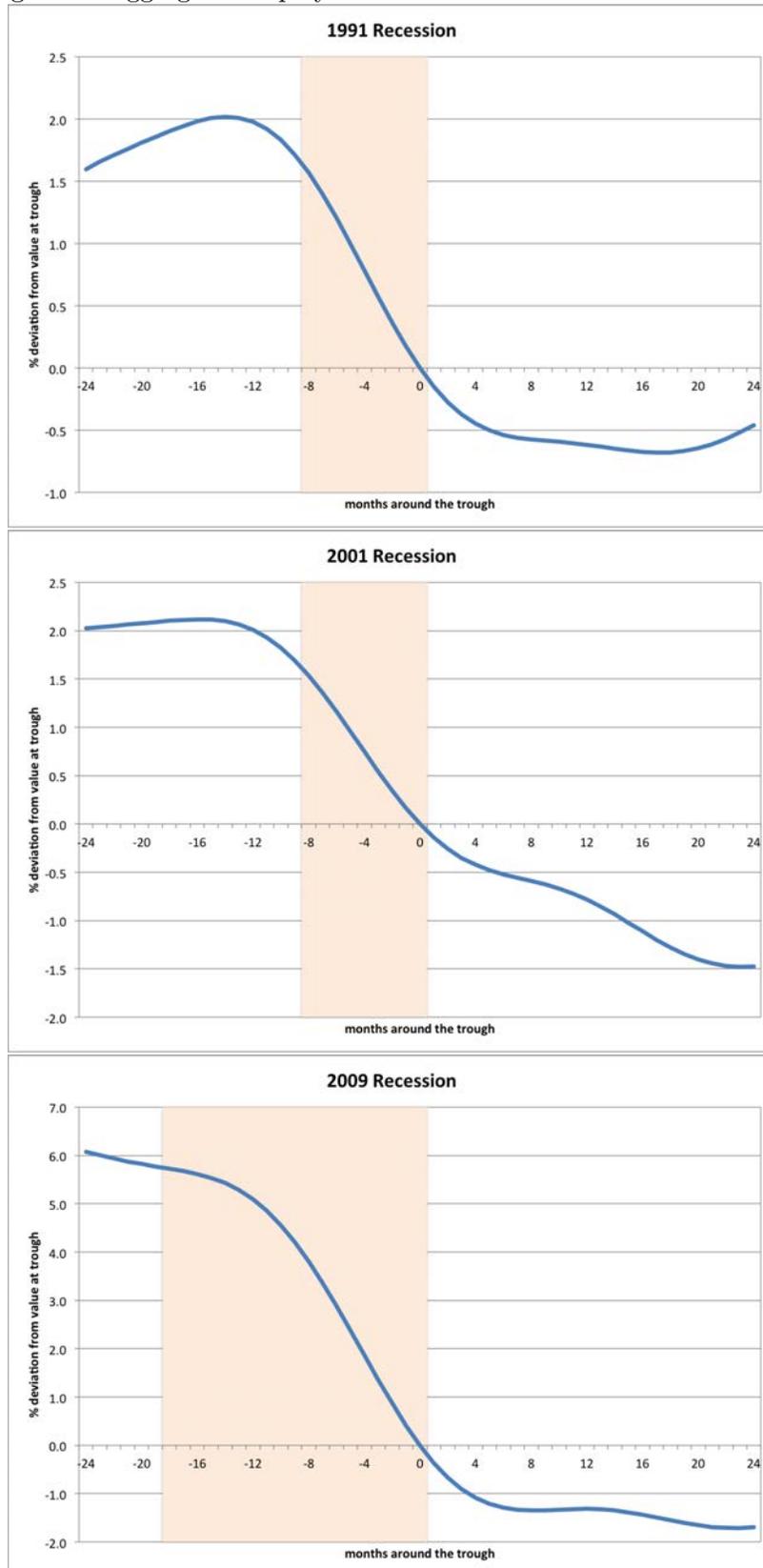
Notes: Data from the Bureau of Labor Statistics, Current Population Survey (CPS). See Appendix A for details.

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Table 1: Measures of Recovery following Early and Recent Recessions

	Early			Recent		
	1970	1975	1982	1991	2001	2009
A. Employment						
months to turn around	6	4	2	17	23	23
months to trough level	16	10	4	31	55	76
half-life (in months)	27	23	10	38	NA	NA
B. Output						
months to turn around	0	0	0	0	0	0
months to trough level	0	0	0	0	0	0
half-life (in months)	7	10	5	9	3	15

Notes: Data from the CPS; Bureau of Economic Analysis, National Income and Product Accounts (NIPA); and James Stock and Mark Watson. See Appendix A for details.

indicated by the first two rows of Panel B. In the early recessions, it takes on average seven months from the trough date for output to regain half of its recessionary loss; in recent recessions, the average time taken is nine months, only slightly greater.[6] Hence, there has been no marked change in the speed of recovery for aggregate output across early and recent recessions. The differences in the speed of recovery in employment following recent recessions—without corresponding differences in the recovery speed of output—characterize the jobless recovery phenomenon.

2.2   Job Polarization

The structure of employment has changed dramatically in the past 35 years. One of the most pervasive aspects of change has been within the occupational skill distribution: employment has become polarized, with employment share shifting away from middle-skill occupations towards both the high- and low-skill tails of the distribution (see, for instance, Acemoglu and Autor (2011), and the references therein).

To see this, we disaggregate total employment by occupational groups. Appendix A discusses the occupational classification in detail; Appendix B discusses robustness of our results to alternative classifications used in the literature. For brevity, we include a summary here. Following Acemoglu and Autor (2011), we delineate occupations along two dimensions: "cog-

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[6]Because the monthly RGDP estimates of Stock and Watson are "noisy," the data are band pass filtered to remove fluctuations at frequencies higher than 18 months (as with the employment data) in producing the half-life statistics.

Figure 3: Percent Change in Employment Shares by Occupation Group
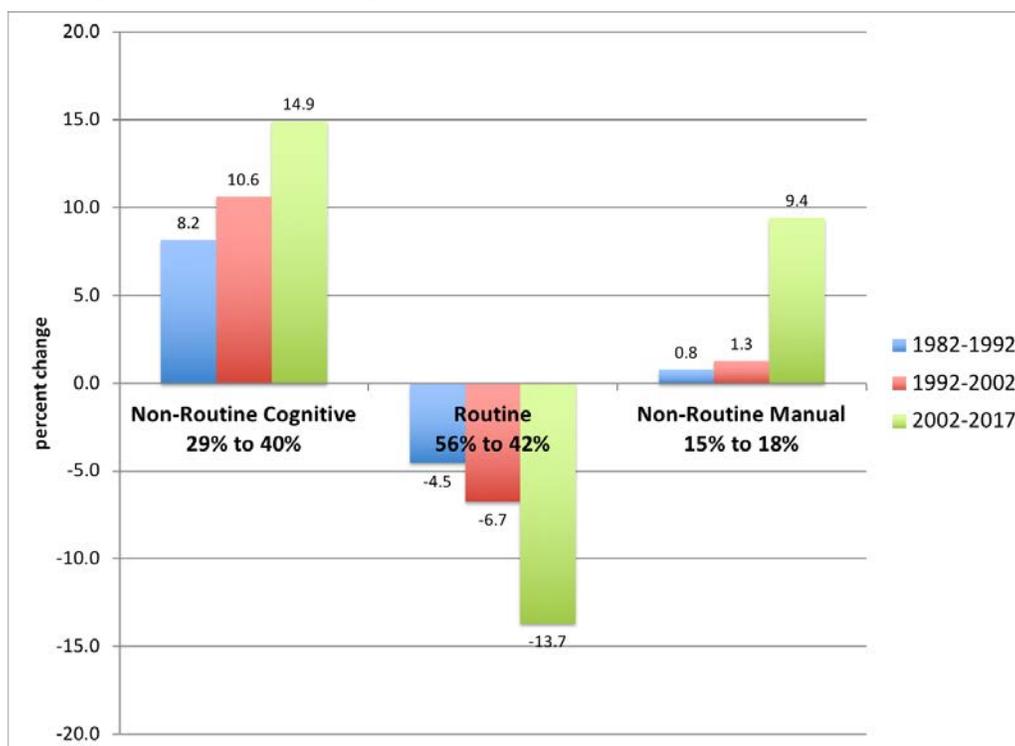
Notes: Data from the CPS. See Appendix A for details.

nitive" versus "manual", and "routine" versus "non-routine". These delineations are based on the skill content of the tasks performed in the occupation. The distinction between cognitive and manual jobs is straightforward, characterized by differences in the extent of mental versus physical activity. The distinction between routine and non-routine jobs is based on the work of Autor et al. (2003). If the tasks involved can be summarized as a relatively small set of specific activities accomplished by following well-defined instructions and procedures, the occupation is considered routine. If instead the job entails a larger number of tasks requiring flexibility, creativity, problem-solving, or human interaction skills, the occupation is non-routine.

In this delineation, non-routine cognitive occupations include managerial, professional and technical workers, such as physicians, public relations managers, financial analysts, computer programmers, and economists. Routine cognitive occupations are those in sales, and office and administrative support; examples include secretaries, bank tellers, retail salespeople, travel agents, mail clerks, and data entry keyers. Routine manual occupations are "blue collar" jobs, such as machine operators and tenders, mechanics, dressmakers, fabricators and assemblers, and meat processing workers. Non-routine manual occupations are service jobs, including janitors, gardeners, manicurists, bartenders, home care aides, and personal care workers.

These classifications correspond to rankings in the occupational wage distribution. Non-

routine cognitive occupations tend to be high-skill occupations and non-routine manual occupations low-skilled. Routine jobs—both cognitive and manual—tend to occupy the middle of the occupational wage distribution (see, for instance, Autor (2010), Firpo et al. (2014), and Goos et al. (2014)). Given this, we combine the routine cognitive and routine manual occupations into one group.[7]

Figure 3 displays data relating to job polarization. We present data by decade, as is common in the literature (see, for instance, Autor (2010)), except the final bar covering the period 2002–2017. Each bar represents the percent change in an occupation group's share of total employment, from the starting year to the terminal year, using annual averages. Over time, the share of employment in high-skill (non-routine cognitive) and low-skill (non-routine manual) jobs has been growing. This has been accompanied by a hollowing out of the middle-skill, routine occupations. Hence, there has been a polarization in employment away from routine, middle-skill jobs toward non-routine cognitive and manual jobs. In 1982, routine occupations accounted for approximately 56% of total employment; in 2017, this share has fallen to 42%.

3   Linking the Two Phenomena

3.1   Occupational Employment: Long-Run Dynamics

As discussed above, job polarization involves the long-term decline in employment in routine occupations as a share of total employment. This declining share can be due to decreases in routine employment (in the numerator), increases in non-routine employment (denominator), or both. We find an important change in the dynamics of routine employment during the job polarization era. Given our interest in jobless recoveries in per capita aggregate employment, documented in subsection 2.1, the decline of *per capita employment in routine occupations* is the primary object of interest throughout our analysis. We ask how this process has unfolded over time: whether the losses have occurred gradually, or whether it is "bunched up" within certain time intervals. Figure 4 displays time series for per capita employment in the three occupational groups of Figure 3 at a monthly frequency, from July 1967 to December 2017.

As is evident from the figure, both of the non-routine occupational groups are growing over time. Per capita employment in non-routine cognitive occupations displays a 59 log point increase during this period. After declining from 1967 to 1973, non-routine manual employment displays a 17 log point increase. Recessions have temporarily halted these occupations' growth to varying extents, but have not abated the upward trends.

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[7]For brevity, the analogs of all of our figures with the routine occupations split into two groups can be found in an earlier version of this paper, available at http://faculty.arts.ubc.ca/hsiu/research/polar20120331.pdf. None of our substantive results are changed when considering the routine cognitive and manual occupations separately.

Figure 4: Employment in Occupational Groups: 1967 – 2017

Notes: Data from the CPS. See Appendix A for details.

This stands in stark contrast to the routine occupational group. In per-capita terms, routine employment was relatively constant until the late-1980s, and has fallen 29 log points from the local peak in 1990 to present.

The growth of per capita employment in non-routine jobs (coupled with the lack of growth in routine jobs) makes it clear that the *share* of employment in routine occupations has been in decline since at least 1967. Hence, what differentiates the job polarization era that began in the 1980s is the obvious acceleration in the relative decline of routine employment. This acceleration is due to the fact that per capita routine employment is disappearing in *level* terms.

What is equally clear in Figure 4 is that routine job loss has not occurred steadily during the past 35 years. The decline in routine occupations is concentrated in economic downturns. This occurred in essentially three steps. Following its peak in 1990, per capita employment in these occupations fell 3.5% to the trough of the 1991 recession, and a further 1.8% during the subsequent jobless recovery. After a minor rebound, employment was essentially flat until the 2001 recession. In the two year window around the 2001 trough, this group shed 6.2% of its employment, before leveling off again. Routine employment has plummeted again in the Great Recession—11.3% in the two year window around the trough—with no subsequent recovery.

To state this slightly differently, 88% of the 29 log point fall in per capita routine employment that occurred from 1990 to present occurred within a 12 month window of NBER recessions (six months prior to the peak and six months after the trough). Hence, this stark aspect of job polarization is observed during recessions.

3.2 Occupational Employment: Business Cycle Snapshots

In the job polarization era, per capita employment in routine occupations disappeared during recessions. Moreover, as Figure 4 makes clear, prior to the disappearance of routine occupations, routine employment always recovered following recessions. In this subsection, we investigate whether this change in the dynamics of routine employment has contributed to the jobless recoveries following the three most recent recessions. This is quantitatively plausible since routine occupations account for a substantial fraction of aggregate employment.

To do this, we "zoom in" on recessionary episodes; Figures 5 and 6 plot per capita employment for the routine and non-routine occupational groups around NBER recessions. These figures are constructed in the same manner as Figures 1 and 2.[8]

Figure 5 displays the early recessions of 1970, 1975, and 1982 and their subsequent recoveries. Contractions in employment are clearly observed in the routine occupations. In the non-routine occupational group, employment was either flat or growing during these recessions and recoveries.

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[8]For the analogous figures with the non-routine cognitive and non-routine manual groups displayed separately, see Appendix B.

Figure 5: Occupational Employment around Early NBER Recessions
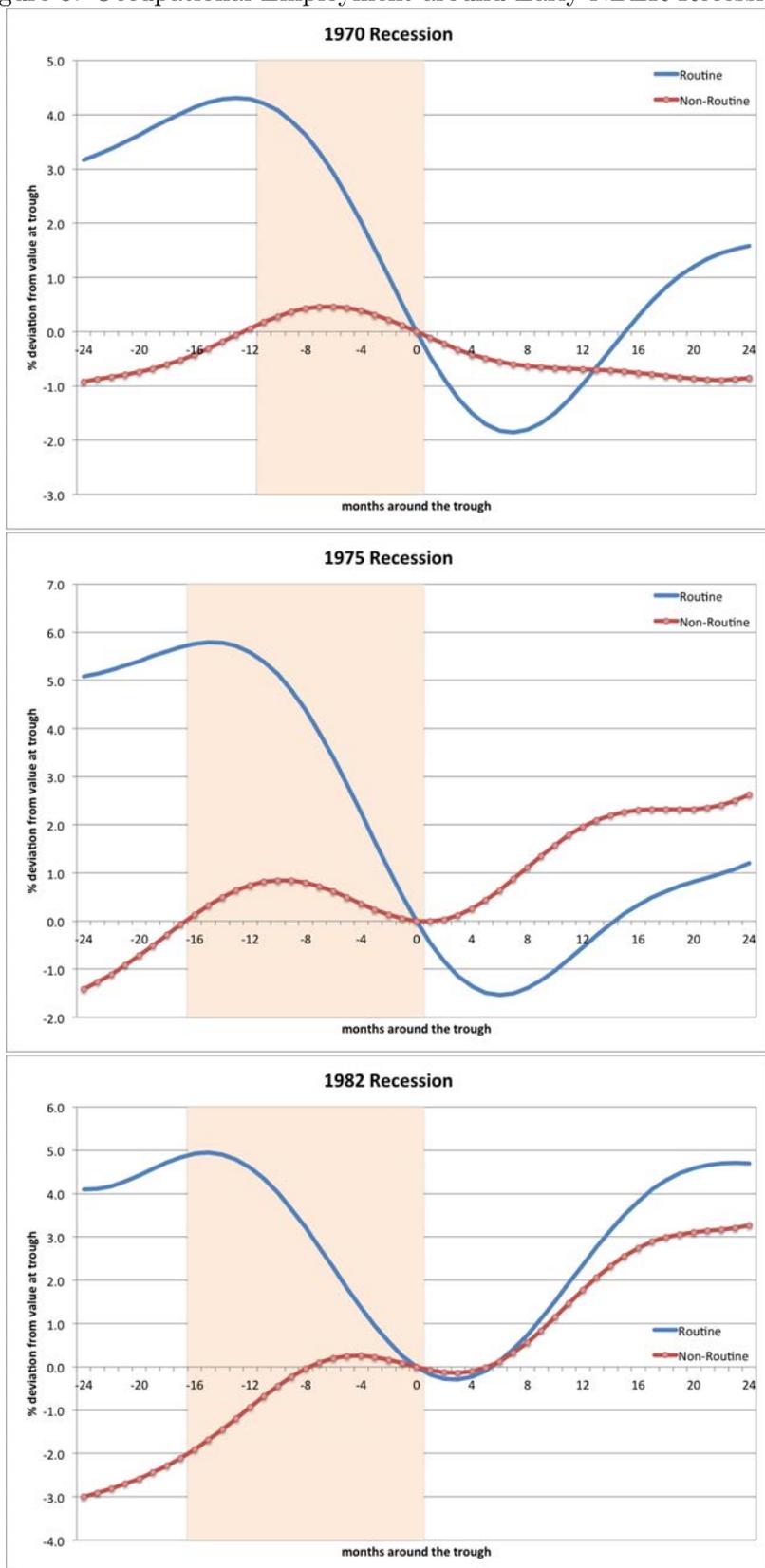
Figure 6: Occupational Employment around Recent NBER Recessions

Hence, the contractions in per capita aggregate employment displayed in Figure 1, are due almost exclusively to the routine occupations; this is true, despite the fact that routine occupations account for only 58% of total employment, averaged over the 1967–1982 period. Measuring f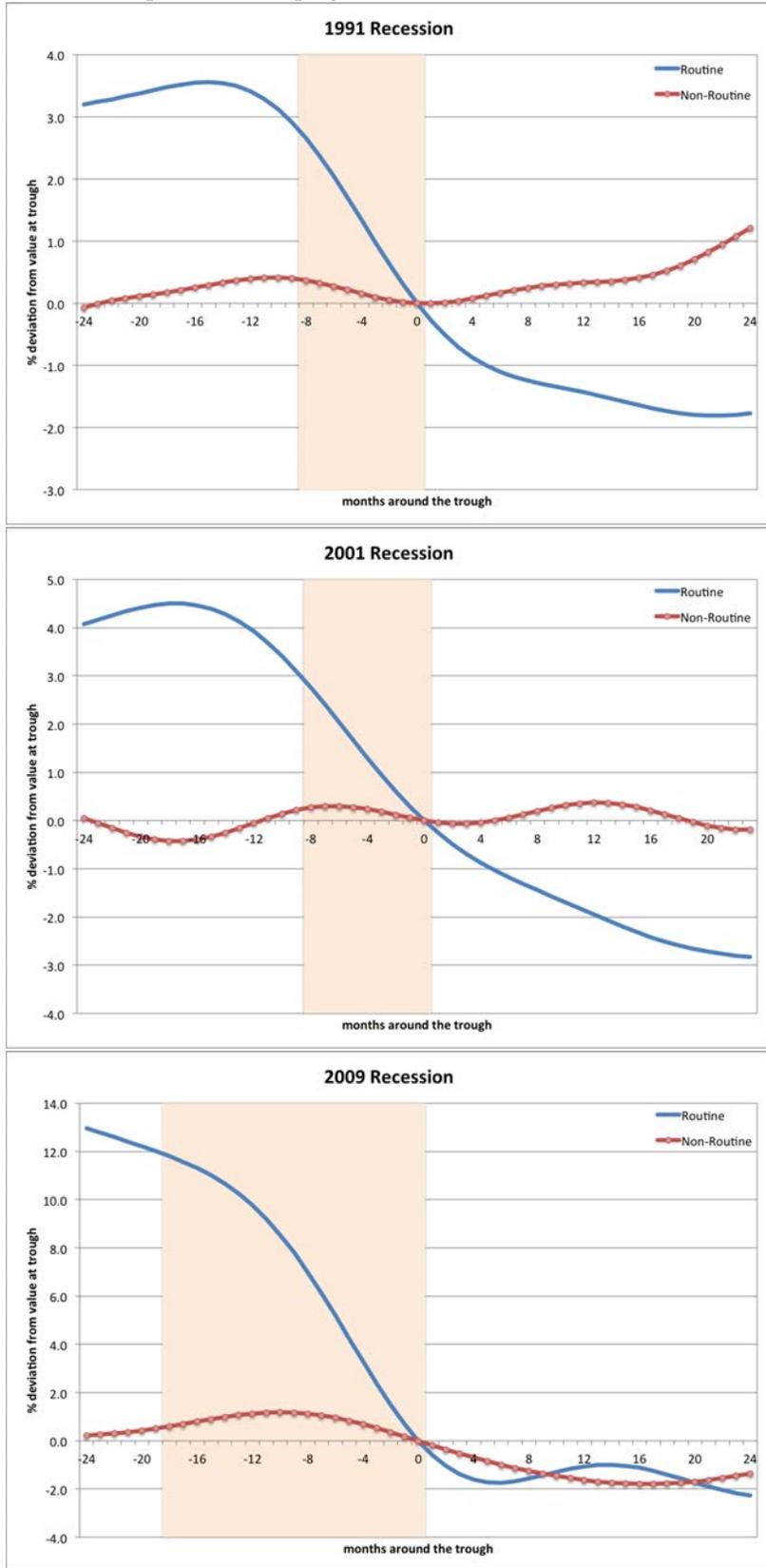rom NBER peak to trough, 97% of all per capita job loss in both the 1970 and 1975 recessions was accounted for by job loss in routine occupations. In the 1982 recession, job loss in routine occupations accounted for 145% of the aggregate, as employment actually grew in the non-routine group.

Moreover, no jobless recoveries were observed in the routine occupational group in these early episodes. Following these recessions, routine employment begins recovering within 7 months of the trough. This mirrors the lack of jobless recoveries at the aggregate level displayed in Figure 1. Comparing Figures 1 and 5, it is clear that the cyclical dynamics of aggregate employment in the 1970, 1975, and 1982 episodes are driven by the dynamics of routine employment.

Comparing Figures 2 and 6, it is again clear that the recession and recovery dynamics of aggregate employment in 1991, 2001, and 2009 mirror the dynamics of routine employment. Consider, for instance, the 1991 recession displayed in the uppermost panels. In the 15 months prior to the trough, per capita aggregate employment falls by 2.0%, and falls a further 0.5% during the 24 month window after the recession displayed in Figure 2. Figure 6 indicates that this pattern is not exhibited in non-routine occupations. During this time window, per capita non-routine employment rises, with only a mild (0.4%) contraction and clear recovery beginning on the NBER trough date.[9] Only routine employment exhibits the same pattern as in the aggregate, with a 3.5% fall in the 15 months prior to the trough, and a further 1.8% decline in the 24 month recovery period.

Indeed, Figure 6 indicates that routine occupations experience jobless recoveries in all three of the recent episodes. Per capita routine employment experience clear contractions during each recession. As with the early episodes, these occupations account for the bulk of the contraction in aggregate employment. In the 1991, 2001, and 2009 recessions, routine jobs account for 89%, 91%, and 94% of all job loss, respectively. This is despite the fact that routine occupations account for approximately 51% of total employment, averaged between 1983 and 2011 (two years following the 2009 recession).

More importantly, routine occupations show no recoveries in Figure 6. As discussed above, per capita employment in routine occupations falls a further 1.8% in the 24 months following the end of the 1991 recession. A similar picture emerges for the 2001 recession: large employment losses leading up to the trough are followed by a further 2.8% loss afterward. In 2009, these occupations are hit especially hard, falling 11.8% from the NBER peak to trough, and a further

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[9] We note, however, that the "average" recovery of non-routine employment following the three recent recessions is slower than that of the early recessions. This is due, in part, to the fact that non-routine employment actually grew during the 1982 recession, and to the slow recovery following the Great Recession; we return to this latter point below.

2.3% in the two years after. Indeed, per capita routine employment shows no recovery to date, down 3.9% from the recession's trough to December 2017.

To summarize, jobless recoveries are evident in only the three most recent recessions and are only clearly evident in routine occupations. In this occupational group, employment never recovers—in the short-, medium- or long-term. These occupations are disappearing.[10] By contrast, non-routine occupations either experience no contractions or only mild contractions during recessions, and no jobless recoveries afterwards. In this sense, the jobless recovery phenomenon is accounted for by the disappearance of routine jobs.

3.3 A Counterfactual Exercise

To make this final point clear, we perform a simple accounting exercise to investigate the role of the disappearance of routine employment in accounting for jobless recoveries. This is informative since recessions in aggregate employment are due almost entirely to recessions in routine occupations, as discussed above. We ask what would have happened in recent recessions if the post-recession behavior of employment in routine occupations had looked more similar to the early recessions. Would the economy still have experienced jobless recoveries in the aggregate?[11]

For the 1991, 2001, and 2009 recessions, we replace the per capita employment in routine occupations following the trough with their average response following the troughs of the 1970, 1975, and 1982 recessions. We do this in a way that matches the magnitude of the fall in employment after each recent recession, but follows the time pattern of the early recessions. In particular, we ensure that the turning point in routine employment comes 5 months after the trough, as in the average of those recoveries. We then sum up the actual employment in non-routine occupations with the counterfactual employment in routine occupations to obtain a counterfactual aggregate employment series. The behavior of these counterfactual series around the recent NBER trough dates is displayed in Figure 7. Further details regarding the construction of the counterfactuals is discussed in Appendix C.

Figure 7 makes clear that had it not been for the disappearance of routine jobs that occurs during recessions, we would not have observed jobless recoveries. Aggregate employment would have experienced clear turning points 5, 5, and 7 months after the troughs of the 1991, 2001, and 2009 recessions, respectively. In the 1991 and 2001 recessions, employment would have exceeded its value at the NBER-dated trough within 10 months. In the case of the 2009 recession, recovery back to the trough level would have taken 18 months. This is due to the fact that the

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[10]For further analysis of this process, in terms of worker gross flows (job creation/separation, occupational switching), see Cortes (2016) and Cortes et al. (2016).

[11]In spite of the results presented in subsection 3.2, we note that the answer to this is not immediate since, in the jobless recovery period, routine jobs account for only 50% of aggregate employment. Reversing jobless recoveries in routine employment may not be quantitatively important enough to reverse them in the aggregate.

Figure 7: Actual and Counterfactual Employment around Recent NBER Recessions
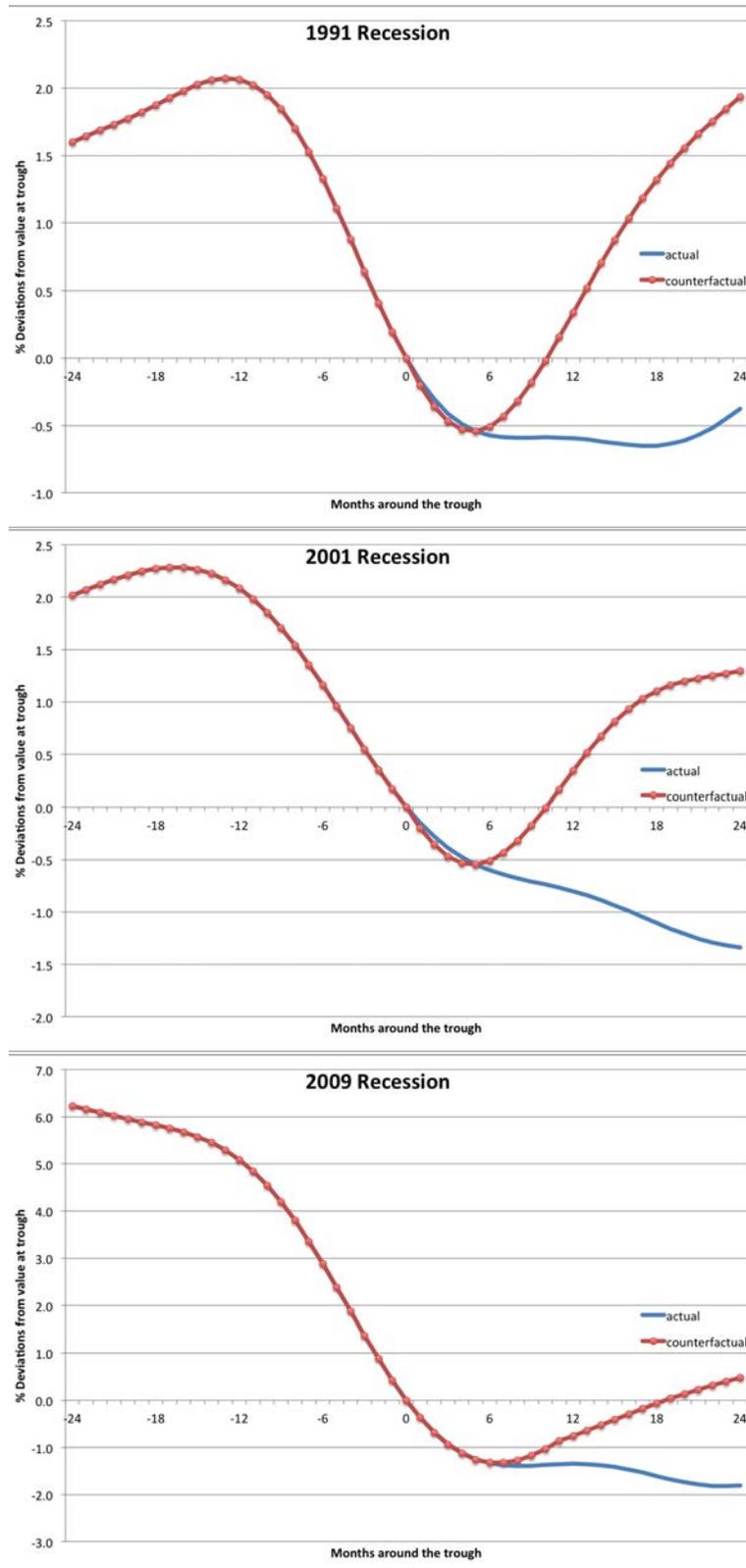
Notes: Actual data from the CPS. Counterfactual data obtained as the sum of actual non-routine employment with counterfactual routine employment; see Appendix C for details.

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most recent, and far more severe, recession was experienced more broadly across occupations, and because routine employment represents a shrinking share of total employment over time. Interestingly, while employment in non-routine occupations suffered only mild contraction during the recession (falling 1.1% in the ten months prior to the trough), it continued to contract by 1.8% in the sixteen months following the NBER trough date. Hence, the malaise in the labor market following the 2009 recession is not solely accounted for by routine occupations—not surprising, given the nature of the Great Recession. Nonetheless, the counterfactual exercise indicates that employment would have recovered, as opposed to declining in the 24 months following the end of the recession.

Finally, we note again that jobless recoveries cannot be accounted for by a change in the post-recession behavior of employment in non-routine occupations. This is, perhaps, not surprising given that the dynamics of non-routine employment play little role in the that of aggregate employment during recessions, as discussed in subsection 3.2. Nonetheless, we have performed the same counterfactual as above, but replacing the employment response in non-routine occupations following the recent recessions with their average response following the early recessions. Though not displayed here for brevity, we find that this generates no clear recovery in aggregate employment beyond its trough value in any of the recent episodes. By contrast, aggregate employment recovers beyond its trough value within 10, 10, and 18 months in the 1991, 2001, and 2009 episodes, respectively, in the counterfactual with routine employment.

3.4   Further Discussion

Here we offer a few points of clarification regarding job polarization and jobless recoveries by discussing the role of the goods-producing industries and educational composition in accounting for these two phenomena. Appendix B contains additional discussion on the robustness of our key results to further disaggregation of routine occupations into cognitive and manual components, and alternative categorizations of routine occupations.

3.4.1   Manufacturing and Construction

This paper emphasizes the recession and recovery dynamics of routine employment. Given this, it is possible that our emphasis on routine occupations is simply a relabeling of dynamics in the cyclically sensitive goods-producing industries, namely manufacturing and construction. This, however, is not the case.

Consider the three early recessions of 1970, 1975, and 1982. Taking a simple average across these recessions, manufacturing and construction accounted for 82% of the aggregate per capita employment lost from NBER peak to trough. Averaging across the three recent recessions of 1991, 2001, and 2009, 50% of total job loss was accounted for by these industries. Hence, while

the goods-producing industries account for a disproportionate fraction of recessionary job losses, it is clear that a significant fraction occurs in service-production as well, and especially recently. But as discussed in subsection 3.2, routine occupations accounted for 113% and 91% of aggregate job loss when averaged across the three early and three recent recessions, respectively. Hence, while categorizing across goods- and service-producing industries provides a useful distinction in studying cyclical fluctuations in employment, a more valuable categorization exists in distinguishing between routine and non-routine occupations: recessionary job loss is experienced across all industries, namely in routine occupations across industries.

More specifically, it is possible that the phenomena of job polarization and jobless recoveries simply reflect the employment dynamics of manufacturing and construction. In manufacturing, it is well-known that employment is more "routine-intensive" compared to the economy as a whole; following the Great Recession, for instance, the routine occupation share of manufacturing employment is 68%, as compared to 44% economy-wide. Moreover, employment dynamics in manufacturing, during both early and recent recessions, follow a similar pattern to that of routine occupations (across all industries). Manufacturing employment displayed strong cyclical rebounds prior to the mid-1980s; in the three recent recessions, employment has failed to recover following rebounds in manufacturing (and aggregate) output.

We first note that job loss in manufacturing accounts for only a fraction of the job loss in routine occupations. Across all industries, routine employment has fallen 29 log points from 1990 to present, as displayed in Figure 4. In levels, this reflects a per capita employment loss of 0.081. But manufacturing aside, all other sectors of the economy have also experienced a pronounced loss of routine jobs. Routine employment in sectors outside of manufacturing has fallen 22 log points during the same period. This represents a per capita employment loss of 0.051. Hence, manufacturing accounts for only $0.03/0.081 = 37\%$ of the observed routine job loss. This point has also been made by Autor et al. (2003) and Acemoglu and Autor (2011), who demonstrate that job polarization is due largely to shifts in occupational composition (away from routine, towards non-routine jobs) within industries, as opposed to shifts in industrial composition (away from routine-intensive, towards non-routine-intensive industries).

Secondly, jobless recoveries experienced in the past 35 years cannot be explained simply by jobless recoveries in the manufacturing sector. While the post-recession behavior of employment in manufacturing mimics that of routine occupations, it plays only a small part in generating jobless recoveries. This is because manufacturing accounts for a quantitatively small share of total employment (approximately 18% in the mid-1980s and less than 10% at present). To demonstrate this, Figure 8 performs the same counterfactual exercise for the manufacturing industry as Figure 7 does for routine occupations. In each of the three jobless recoveries, we replace the employment response in manufacturing following the trough with their average response following the troughs of the early recessions. We then sum up the actual employment in

non-manufacturing industries with the counterfactual employment in manufacturing to obtain a counterfactual per capita aggregate employment series.

Figure 8 displays the behavior of these counterfactual series around the 1991, 2001, and 2009 NBER trough dates. Eliminating the jobless recovery in manufacturing implies that following the 1991 recession, aggregate employment returns to its level at the trough after 23 months, as opposed to the 31 months observed in the data. This is still appreciably longer than the average of 10 months required in the early recoveries. Following the 2001 and 2009 recessions, altering the recovery in manufacturing has even less impact. Aggregate employment would still have been below the value at the trough, a full 24 months after the recession ended. Jobless recoveries would still have been observed following each recessionary episode. This evidence is consistent with the findings of Aaronson et al. (2004), who find that jobless recoveries cannot be explained by "structural change" at the industry level.

Finally, we note that neither phenomena are due to employment dynamics in construction. Of the total job losses in routine occupations from 1990 to present, only 6% are accounted for by construction. And while not displayed here for brevity, we have performed the same counterfactual experiment for the construction industry that Figure 8 does for manufacturing. Following each of the recent recessions, replacing the employment response in construction with their average response following the early recessions has essentially no effect on per capita aggregate employment. Construction plays essentially no role in accounting jobless recoveries since the industry accounts for a very small share (approximately 5%) of total employment.[12]

3.4.2 Education

Here, we clarify the role of education in accounting for the decline of routine employment and jobless recoveries. The share of low educated workers in the labor force (i.e., those with high school diplomas or less) has declined in the last 35 years, and these workers exhibit greater business cycle sensitivity than those with higher education. It is thus possible to conjecture that the terms "routine" and "low education" are interchangeable. In what follows, we show that this is not the case.

In particular, it is true that education is correlated with occupation. However, as discussed in Acemoglu and Autor (2011), educational attainment is more closely aligned with the distinction between cognitive versus manual occupations, with high (low) educated workers tending to work in cognitive (manual) jobs. As such, job polarization – the disappearance of employment in *routine* occupations relative to *non-routine* occupations – cannot be explained simply by the change in educational composition. Consider the case of high school graduates, who make up

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[12]See also Charles et al. (2018) for a discussion of housing and manufacturing employment during the most recent business cycle boom and bust.

Figure 8: Actual and Counterfactual Employment around Recent NBER Recessions: the Manufacturing case
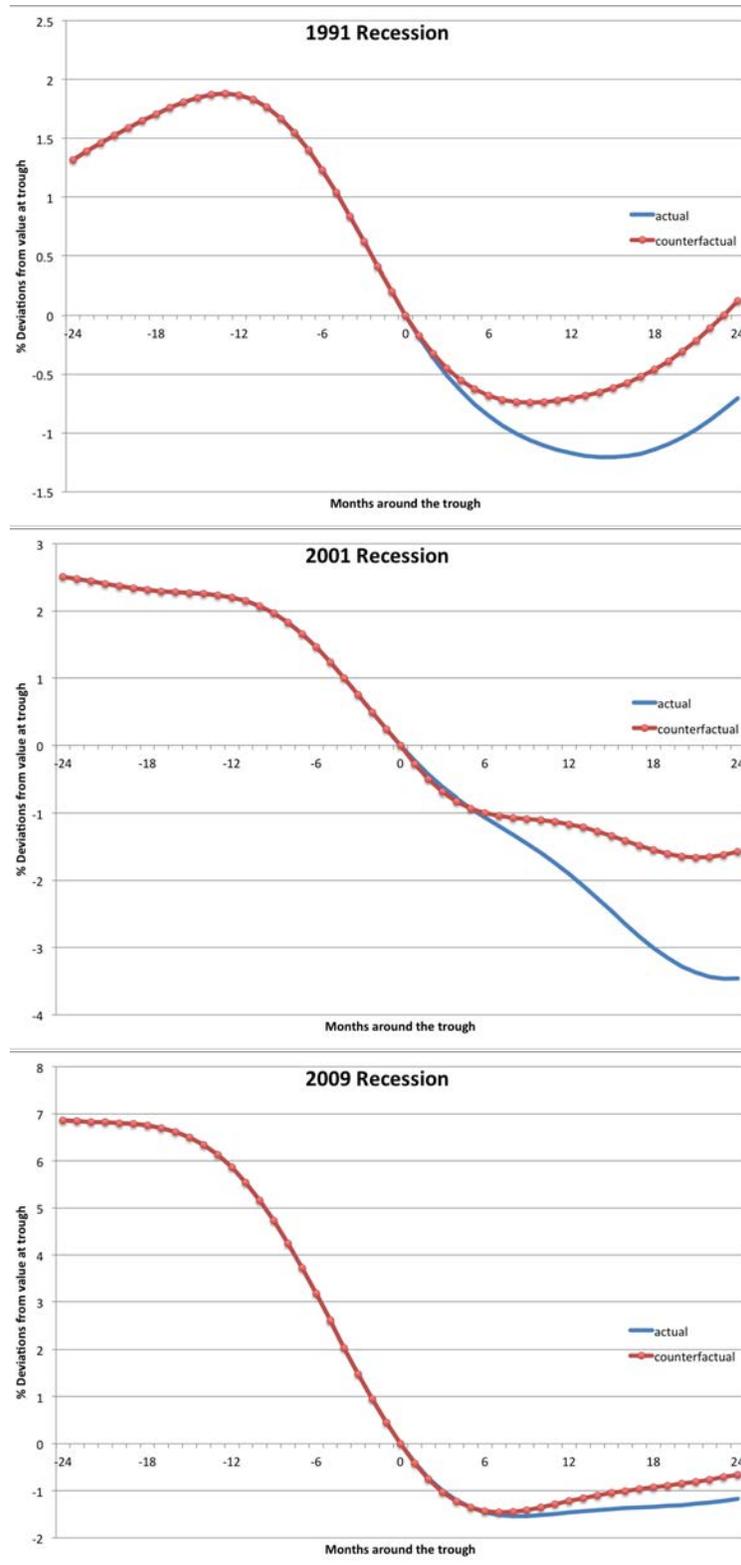
20

the majority of low educated workers. In levels, their per capita employment has fallen 0.059 from 1990 to present. However, this fall is highly concentrated, with 91% of the loss occurring in routine occupations. In contrast, employment among high school graduates in non-routine jobs has remained essentially constant, falling by only 0.008 during the polarization period.[13]

Similarly, jobless recoveries are not simply a phenomenon reflecting the post-recession dynamics of low education employment. In particular, business cycle fluctuations for high school educated workers differ greatly across occupational groups. For these workers, per capita employment in routine occupations fell 3.6%, 4.0%, and 13.2% in the 1991, 2001, and 2009 recessions, respectively. And indeed, it is this group that is disappearing and not recovering: averaged across the three recessions, employment is down a further 1.5% from the level at the NBER trough, a full 24 months into the economic recovery. By contrast, employment of high school graduates in non-routine occupations experience extremely mild contractions – of 0.9%, 0.2%, and 0.5% in the three recent recessions – and no long term disappearance. Thus, among these low educated workers, jobless recoveries are only to be found in routine occupations.

4   Further Evidence

In Section 3, we exploit time series variation across the pre- and post-job polarization eras to demonstrate the role of the decline in routine occupations in jobless recoveries: prior to the long-run decline in per capita routine employment, jobless recoveries did not occur; jobless recoveries emerge since the decline in employment in these occupations. In addition, the role attributed to routine employment dynamics is not simply a proxy for industrial shifts, or the changing educational composition of the economy.

Here we provide additional evidence and discuss related literature regarding the role of routine job loss in jobless recoveries. We begin with state-level evidence for the US, and conclude with evidence from an international sample of industrialized economies that have undergone job polarization in the past 30 years.

State-level evidence   We ask whether the pre- and post-polarization differences of Section 3, observed in the aggregate, are evident at the finer US state level of aggregation. Unsurprisingly, there is a great deal of heterogeneity in economic performance across the 50 US states; as a result, recessions at the macro level are not reflected in output and employment statistics for

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[13]The importance of the routine/non-routine distinction is further illustrated by the "some college" group – those with more than high school attainment, but less than a college degree. Per capita employment in this group has risen 7% since 1990. However, it has only risen in non-routine occupations (by 24%); routine employment has actually fallen 7% for the some college group, reflecting polarization among these relatively high educated workers. See also the discussion in Autor et al. (2003).

Table 2: Employment Recoveries at the State Level

	25th %-ile	Median	75th %-ile
A. 1982			
Routine Share of Total Loss	0.51	1.10	1.39
Total Recovery vs Loss	0.83	1.56	2.42
Routine Recovery vs Loss	0.93	1.41	2.18
B. 2009			
Routine Share of Total Loss	0.83	0.93	1.10
Total Recovery vs Loss	-0.38	-0.25	-0.01
Routine Recovery vs Loss	-0.53	-0.18	0.02
Counterfactual Recovery vs Loss	0.95	1.28	1.44

Notes: Actual data from the CPS; counterfactual described in Appendix D.

all states.[14] As such, we focus on the two largest recessions—the 1982 and 2009 "episodes"—to maximize power of the pre- and post-polarization comparison.

We use state-level data on RGDP and per capita employment. In a manner analogous to the NBER Dating Committee, we determine whether a state experienced a recession coincident with the macro-level episode and, if so, assign state-specific peak and trough dates. Overall, we identify 34 states as experiencing recession during the 1982 episode, and 35 states during the 2009 episode (the specific states and details of approach are discussed in Appendix D).

Subsection 3.2 demonstrates that recessionary contractions in per capita employment in the aggregate are due almost exclusively to routine occupations. This is true at the state level as well. The first row of Table 2, Panel A considers this for the 1982 recession, using the fraction of total job loss that is accounted for by job loss in routine occupations. Given the distribution of outcomes across states, we report the median fraction along with the interquartile range. For the median state that experienced recession during the 1982 episode, 110% of the state's per capita employment contraction was due to routine job loss. This fraction ranges from 51% at the 25th percentile to 139% at the 75th percentile.

Moreover, state-level employment recovered following the cyclical trough in the 1982 episode. Row 2 reports the ratio of per capita employment gain in the two years following the trough, relative to the state's peak-to-trough employment loss. For the median state, per capita employment gains were 156% of its losses during the recession, with interquartile range of 83% – 242%. Prior to the job polarization era, employment recovered following recessions, in the aggregate and at the state level.

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[14]For instance, the oil and gas boom meant North Dakota avoided recession during the 2009 episode.

Importantly, this recovery was accompanied by recovery of employment in routine occupations. Row 3 of Table 2 reports the same ratio as in the second row, but only for routine employment. At the median, (two-year) per capita routine employment gains were 141% of losses incurred during recession. Indeed, out of the total employment gained in the two years following the median state's trough, 134% of it was accounted for by gains in routine occupations. This last result is not reported in the table since the analogous statistic cannot be reported for the post-polarization episode, as will become clear below.

In the 2009 episode, again, the bulk of total employment lost at the state level is accounted for by routine employment. The first row of Panel B indicates that for the median state, 93% of its per capita employment contraction was due to routine job loss. This corresponds closely to the value of 94% observed at the national level.

At the national level, the recovery was jobless and this is true at the state level as well. The second row of Panel B considers the ratio of a state's employment gain in the two years following recession, relative to its recessionary loss. The interquartile range is *negative*: for most states, total per capita employment *continued to decline* after the recession ended. Gains were experienced in only 8 states in the two years following their cyclical trough, and in no state did per capita employment return to its pre-recession peak.

Moreover, this lack of recovery in total employment is mirrored by a lack of recovery in routine employment. Row 3 of Table 2, Panel B reports the ratio of per capita employment gain in routine occupations during the two years after the trough, relative to routine employment loss in the recession. Again, for the majority of states routine employment continued to decline following the end of the recession.

To quantify the role of routine employment dynamics in the 2009 jobless recovery at the state level, we conduct a counterfactual exercise similar to those of subsection 3.3 for the aggregate economy. We ask what would have happened in the 2009 episode if the post-recession behavior of routine employment had resembled that following the 1982 recession. To do this, we replace the ratio of per capita routine employment gains following the trough relative to losses during the 2009 recession, with the analogous ratio observed in 1982. We then sum up the actual employment in non-routine occupations with the counterfactual employment in routine occupations to obtain a counterfactual total employment at the state level, two years following the trough (see Appendix D for a more detailed description).

Had states' employment in routine occupations recovered as they did following the 1982 recession, there would not have been jobless recoveries following 2009. The final row of Table 2 reports the ratio of counterfactual per capita employment gain in the two years following the trough, relative to the state's (actual) peak-to-trough employment loss. For the median state, per capita employment gains would have been 128% of its losses during the recession. This ranges from 95% at the 25th percentile to 144% at the 75th percentile.

International evidence Goos et al. (2014) (hereafter, GMS) document the pervasiveness of job polarization in Western European countries, in data beginning in the 1990s. Building on this, we consider whether the nature of economic recoveries has changed in these countries.

Of the 16 countries studied by GMS, we are able to obtain quarterly data for aggregate employment and RGDP for 14 of them (with Greece and Luxembourg being the exceptions), from 1971 to 2012. From this data, we generate business cycle peak and trough dates to identify the onset and end of recessions (see Appendix D for details). Observations are grouped together based on their timing relative to 1990 which, following GMS, we use to delineate the onset of job polarization in our sample. We then test whether there has been a change in the nature of employment recoveries relative to output recoveries across time periods. We cannot measure the joblessness of recoveries based on speed, since employment fails to meet standard recovery criteria in an appreciable number of episodes. As such, we use a measure of the strength of recovery within a fixed time window: the four quarter growth of employment (and output) following recession, normalized by the employment (output) that was lost during the recession.[15] In all of our analysis, employment and output are expressed in per capita terms.

Panel A of Table 3 presents the results of this analysis. The first two columns of the first row presents the strength of employment recoveries, averaged across the pre-1990 and post-1990 recession episodes, respectively. There has been a marked fall in the recovery of employment since job polarization. In fact, while employment would expand (on average) following early recessions, employment now continues to decline during the first four quarters of recovery. The rightmost column tests the null hypothesis of equality of means across periods, relative to the alternative hypothesis that there has been a fall in the strength of recovery since 1990. For employment, the null is rejected at the 5% level.

By contrast, there has been essentially no change in the strength of output recoveries. The null hypothesis of equality of means across periods cannot be rejected at standard significance levels. Moreover, in terms of point estimates, the fall in the strength of output recoveries across time periods (0.094) is an order of magnitude smaller than the fall for employment (2.18).

To put these results in perspective, Panel B of Table 3 repeats this analysis for the 11 postwar US recessions considered by Gali et al. (2012). Whereas employment would rebound following early recessions, it now continues to decline during recovery. Again, there has been a clear fall in the strength of employment recoveries since 1990, that is significant at the 1% level. By contrast,

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[15]Note, this measure differs from that of Gali et al. (2012) who simply consider employment and output growth in the four quarters after recession, and ask whether these have changed since 1990. Normalization is important is because the severity of recessions has varied over time. To see why this matters, consider two examples. In Recession 1, employment falls 5% during the recession and expands 5% during the first year of recovery; in Recession 2, employment falls 1% during the recession and expands 1% during the first year of recovery. By simply measuring post-recession growth, the recovery from Recession 2 would be deemed weak or jobless relative to Recession 1, even though both regained all of their recessionary losses in the same amount of time. In order for recovery growth rates to be meaningful, they must be compared to the size of loss during recession.

Table 3: Employment and Output Recoveries: Pre- and Post-Job Polarization

| | means | | $H_0 : pre = post$ |
	pre-1990	post-1990	p-value
A. International			
employment	+1.44	−0.73	0.036
	(5.18)	(2.44)	
output	+1.61	+1.51	0.445
	(1.09)	(2.12)	
B. United States			
employment	+0.41	−0.45	0.006
	(0.45)	(0.15)	
output	+1.94	+1.76	0.424
	(0.90)	(2.08)	

Notes: International data from Federal Reserve Bank of St. Louis, Federal Reserve Economic Data; and International Monetary Fund, International Financial Statistics. U.S. data from the CPS and NIPA. See Appendix A for details.

there is no statistically significant evidence for a change in the strength of output recovery over time. Hence, in both the US and the international sample, the job polarization era has realized the emergence of jobless recoveries.

Subsequent literature   Since the first working paper version of this study was written in 2012, a number of papers have extended our results along several dimensions.[16] Furukawa and Toyoda (2013) replicate our findings linking job polarization and jobless recoveries in Japan. Gaggl and Kaufman (2015) develop a methodology to categorize occupations, involving the estimation of a dynamic factor model on occupational data. This allows for the classification of occupations—based not on tasks, but solely on the time series properties of occupational employment—into two groups that "almost perfectly coincide with 'routine' and 'non-routine' occupations," and the identification of group-specific structural breaks in employment. Their analysis finds a "strong tie between the well documented polarization trend and employment dynamics over the business cycle ... aggregate employment per capita would have recovered significantly more strongly in the absence of the observed structural change around 1990."

Burger and Schwartz (2018) also consider the link between the disappearance of routine jobs and jobless recovery among US states, though their methodology differs from that presented

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[16]While we focus our discussion on empirical work related to this paper, we note that a number of papers have studied the quantitative theoretical link between polarization and business cycle dynamics; see, for instance, Kopytov et al. (2018).

above. They identify recessions using data on personal income and GDP, and consider a larger number of state-level episodes, including those that do not correspond to recessions at the national level. Their probit analysis finds strong and statistically significant evidence that "routine-replacing technological change has contributed to the jobless recovery phenomenon." Specifically, the greater the long-run (as obtained from the HP-filtered trend) decline of routine employment share at the onset of recession, the greater the probability of jobless recovery.

A number of papers have also explored our hypothesis in cross-country data. Gaggl and Kaufman (2015) consider a sample of sixteen (non-US) industrialized economies using the EU KLEMS database. As with the results reported above, international comparisons are hindered by the lack of comprehensive occupation-level data, and the task content of occupations, as in the US; as such, Gaggl and Kaufman (2015) consider polarization dynamics by delineating employment across high-, middle-, and low-skill groups. They find that employment recoveries have become slower relative to output recoveries during the (country-specific) job polarization era, though the slowdown is not as pronounced as in the US. Graetz and Michaels (2017) consider industry-level (as opposed to occupation-level) data in the same international sample. They find that since 1985, industries that are more routine-intensive did not experience significantly slower employment recoveries than less routine-intensive industries. This is in contrast to their findings for the US, where cross-industry variation in routine-intensity does explain variation in the joblessness of recovery. As such, we conclude that the link between jobless recoveries and the disappearance of routine employment as a worldwide phenomenon deserves further study, and would benefit from the compilation of internationally comparable data on occupational tasks and employment.

5   Conclusions

In the last 35 years the US labor market has been characterized by job polarization and jobless recoveries. In this paper we demonstrate how these are related. We first show that the loss of middle-skill employment in routine occupations is concentrated in economic downturns. Second, we show that the disappearance of routine employment accounts for jobless recoveries. This is based on the fact that almost all of the contraction in aggregate employment during recessions can be attributed to job losses in routine occupations (that account for a substantial fraction of total employment), and that jobless recoveries are observed only in these disappearing jobs since polarization began. Moreover, the role attributed to routine employment dynamics is not simply a proxy for the role of industrial shifts, or the changing educational composition of the economy. We supplement the aggregate evidence with state-level evidence from the US, and evidence from a sample of international countries that have undergone job polarization. In all cases, we find clear evidence for the link between job polarization and jobless recoveries.

Appendix: For Online Publication

A   Data Sources

A.1   US Macroeconomic Data

The population measure is the civilian non-institutional population, 16 years and over, taken from the *Current Population Survey*, Bureau of Labor Statistics. Aggregate employment is total employment within this population. Estimates of RGDP at a monthly frequency are those of James Stock and Mark Watson (http://www.princeton.edu/ mwatson/mgdp_gdi.html). These data end in June 2010; data from July 2010 are interpolated from quarterly RGDP data, taken from the *FRED* Database, Federal Reserve Bank of St. Louis.

In Subsection 3.4, data for industrial employment are from the Current Employment Statistics survey of the BLS, taken from the *FRED* Database. Aggregate employment refers to "all employees: total nonfarm," manufacturing employment is "all employees: manufacturing," and construction employment is "all employees: construction." Data for employment delineated by education and occupation are from 1989 to 2012 and were obtained from the Basic Monthly Files of the CPS, from the NBER website.

A.2   Employment Data by Occupation

We consider an occupational classification system that provides ease of data access and replication, and allows for the most comprehensive time series coverage possible, extending back to 1967. Beginning in 1983, our classification is based on the categorization of occupations in the 2000 Standard Occupational Classification system. Specifically, data for January 1983 to December 2013 are taken from *FRED*. Non-routine cognitive workers are those employed in "management, business, and financial operations occupations" and "professional and related occupations". Routine cognitive workers are those in "sales and related occupations" and "office and administrative support occupations". Routine manual occupations are "production occupations", "transportation and material moving occupations", "construction and extraction occupations", and "installation, maintenance, and repair occupations". Non-routine manual occupations are "service occupations".

Data on employment at the occupational group level from July 1967 to December 1982 is taken from the *Employment and Earnings*, Bureau of Labor Statistics, various issues. Non-routine cognitive workers are those employed in "professional and technical" and "managers, officials, and proprietors" occupations. Routine cognitive workers are those classified as "clerical workers" and "sales workers". Routine manual workers are "craftsmen and foremen", "operatives", and "nonfarm labourers". Non-routine manual workers are "service workers". "Farm workers" (farmers, farm managers, farm labourers and farm foremen) are excluded from the employment data at the occupational level.

Finally, we note that employment at the occupational group level displays a break between 1982 and 1983. This is due to the extensive reclassification of occupations undertaken with the 1980 Census codes (see, for instance, Rytina and Bianchi (1984) and Meyer and Osborne

(2005)), and implemented in the CPS beginning in January 1983.[17] As such, we have adjusted the data prior to 1983 to remove the discontinuity. Because the adoption of the 1980 occupation codes occurs only one month from the start of the recovery following the 1982 recession (NBER trough date on November 1982), the timing of the break does not affect our analysis regarding the nature of recoveries in employment.

A.3   Section 4 Data

High frequency state-level data does not exist for both pre- and post-polarization periods. As such, we use annual data on RGDP from the Regional Economic Accounts of the BEA (bea.gov/data/gdp/gdp-state). Per capita employment data are obtained from the CPS. In terms of international data, quarterly RGDP the quarterly data for aggregate employment and RGDP are from the OECD, and were obtained from the *FRED* Database. For 13 of the 14 countries, aggregate employment refers to civilian employment; the exception is Belgium, where only total employment is available. To derive per capita measures, data for adult population to were taken from the IMF, *International Financial Statistics*.

B   Robustness

B.1   Classifying Routine Occupations

Here we demonstrate that the key results of our analysis are robust to various definitions of per capita employment in routine occupations. Specifically, we show that the key "staircase" pattern of routine employment observed in the past 25 years that is responsible for both of our findings is a robust feature of the data.

The job polarization literature considers a number of alternative methods to classify employment at the occupational level. Perhaps the most comprehensive is that of Autor and Dorn (2013), who first take the Census Occupation Codes from 1970, 1980, 1990, and 2000 and map them into a single, consistent set of occupation codes. This "crosswalk" of occupation codes is based on the work of Meyer and Osborne (2005). These consistent occupations are then allocated to occupational groups. They generate six broad categories based on an occupation's degree of emphasis on abstract (i.e., cognitive), routine, and manual tasks: (1) *Managers / Professional / Technician / Finance / Public Safety*, (2) *Production / Craft*, (3) *Transport / Construction / Mechanic / Mining / Farm*, (4) *Machine Operators / Assemblers*, (5) *Clerical / Retail Sales*, and (6) *Service*.

Autor and Dorn (2013) find that groups (2) through (5) are those with routine task usage greater than the average across all occupations. Hence, one definition of routine occupations would be these occupational groups. And indeed, our classification system is one in which routine occupations are essentially identical to such a definition. Specifically, our non-routine cognitive occupations are group (1), routine manual occupations are groups (2) through (4), routine cognitive occupations are group (5), and non-routine manual occupations are group (6).[18] Hence, redoing our analysis defining routine occupations as Autor and Dorn (2013)'s

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[17]This is true of any occupational classification system, including the one we consider and that of Autor and Dorn (2013).

[18]In particular, using their consistent occupation codes, we find that of the 330 occupations considered by Autor

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groups (2) through (5) generates essentially identical results.

A second alternative definition can be derived from the routine task-intensity index, or *RTI*, derived in Autor and Dorn (2013). Conceptually, the *RTI* identifies those occupations that have the greatest routine task emphasis relative to abstract and manual tasks. Based on this measure, routine occupations are those in groups (2), (4) and (5); despite the fact that occupations in group (3) involve more routine task emphasis than the average, they are not considered routine based on the *RTI* because of their high degree of manual tasks.

The first panel of Figure 9 displays the dynamics of our benchmark measure of per capita routine employment since the job polarization era.[19] The second panel displays the measure based on the *RTI*. As is obvious, both measures display the key staircase pattern with routine employment loss concentrated in recessions.

The third panel of Figure 9 further demonstrates robustness; in this case we remove the construction-related occupations from our baseline measure of routine occupations. This is motivated by the fact that construction is highly sensitive to the business cycle, and has experienced no long-run decline as a share of total employment. Again, we find that key staircase pattern observed in the other measures of per capita routine employment remain.

Finally, the fourth and fifth panels plot the per capita employment dynamics of routine cognitive and routine manual occupations, respectively, since the job polarization era. As is clear, both cognitive and manual occupations are disappearing over time, and job loss in both groups is concentrated in recessions.

## B.2   Business Cycle Snapshots: 3 Occupational Groups

Figure 10 plots per capita employment for the routine, non-routine cognitive, and non-routine manual occupational groups around NBER recessions.

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and Dorn (2013), the two classification systems differ with respect to the routine/non-routine delineation for only 15 occupations.
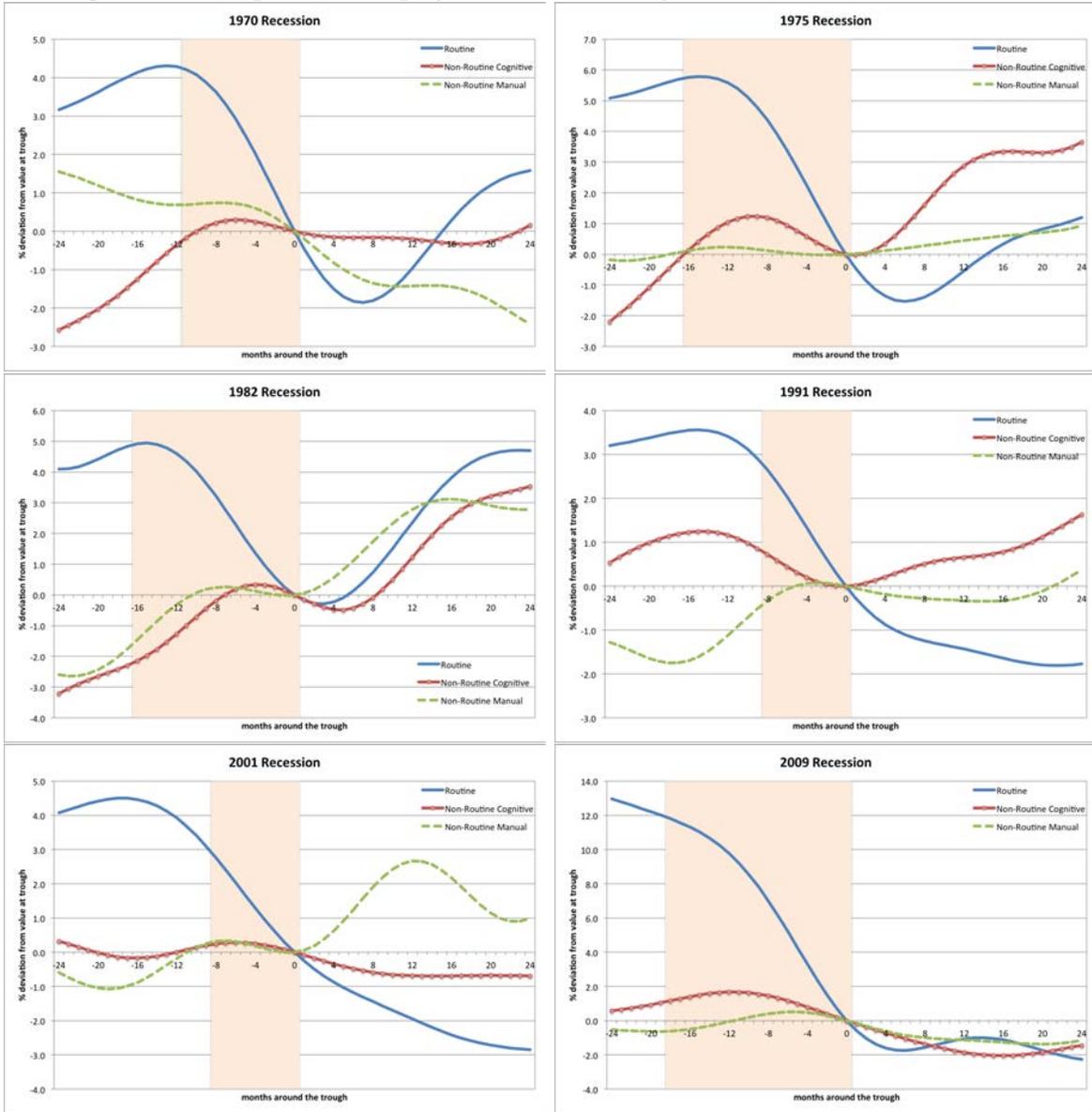
[19] Again, a measure based on Autor and Dorn (2013)'s groups (2) through (5) would be essentially identical.

Figure 9: Employment in Routine Occupations, Various Definitions
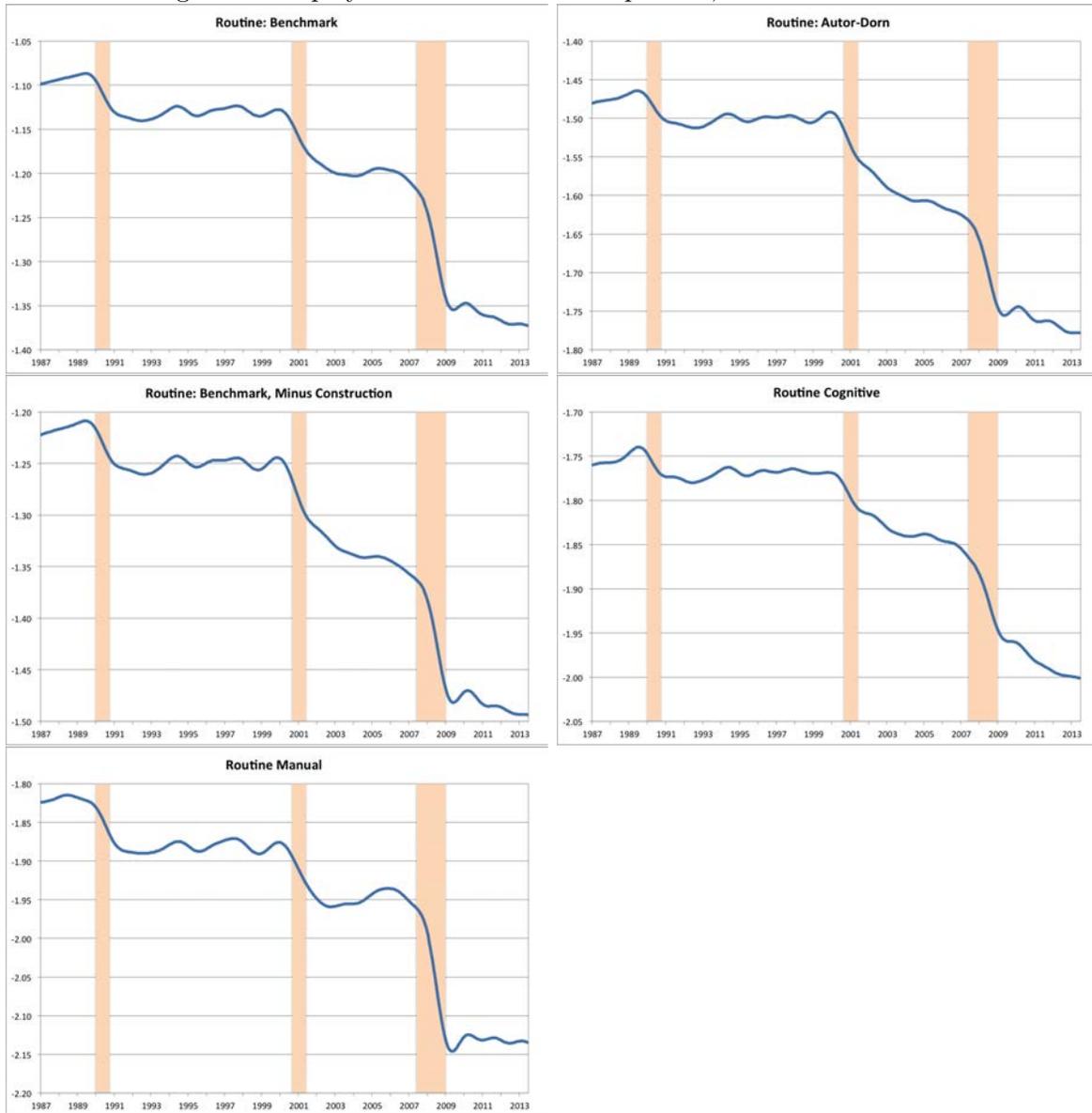
Notes: Data from the Bureau of Labor Statistics, Current Population Survey. See Appendix A for details.

Figure 10: Occupational Employment around Early and Recent NBER Recessions

Notes: Data from the Bureau of Labor Statistics, Current Population Survey. See Appendix A for details.

C Counterfactuals

Using the data for routine occupations displayed in Figure 5, we derive the percentage deviation in employment for the 24 months following the trough of each of the early recessions. We then take the average of these deviations and refer to this as the "average response" of routine employment during early recoveries. This is displayed as the (last half of the) solid line in the upper-left panel of Figure 11. In the 1991, 2001, and 2009 recessions, we replace the post-trough dynamics of routine employment with a re-scaled version of the average response. In particular, we re-scale the average response to match the magnitude of the fall in actual routine employment within the first 5 months of the trough. We choose 5 months, since this is the turning point of the average response.

The counterfactual for routine employment is displayed for the example of the 2009 recession as the hatched line in the upper-left panel of Figure 11. Because the actual fall after the 2009 trough was greater than that in the average of the early recessions, the average response had to be magnified. After 11 months, the average response turns positive. The magnification factor would then imply a very sharp rebound in the counterfactual. Hence, to be conservative, we set the counterfactual for months 12 through 24 to be exactly the average response. In the cases of the 1991 and 2001 recessions, the average response fell more sharply than did actual routine employment. In these cases, the counterfactual was derived by attenuating the average response by the appropriate factor. To be conservative on the strength of the recovery, after the average response turns positive, we maintained the attenuation factor.

These counterfactuals in log deviations were then used to derive counterfactuals for routine employment levels. These were then added to the actual employment levels in non-routine occupations to obtain counterfactual aggregate employment series. These counterfactuals in the aggregate were then expressed as log deviations from their value at the recession troughs to obtain Figure 7.

Finally, in the upper-right, lower-left panel, and lower-right panels of Figure 11, we present the results of the same counterfactual experiment for the 1970, 1975, and 1982 recessions. These panels demonstrate that the nature of the early recoveries – which were not jobless – are not fundamentally altered by the exercise. That is, they continue to display recoveries in aggregate employment with roughly the same magnitude and timing.

Figure 11: Constructing Counterfactual Employment
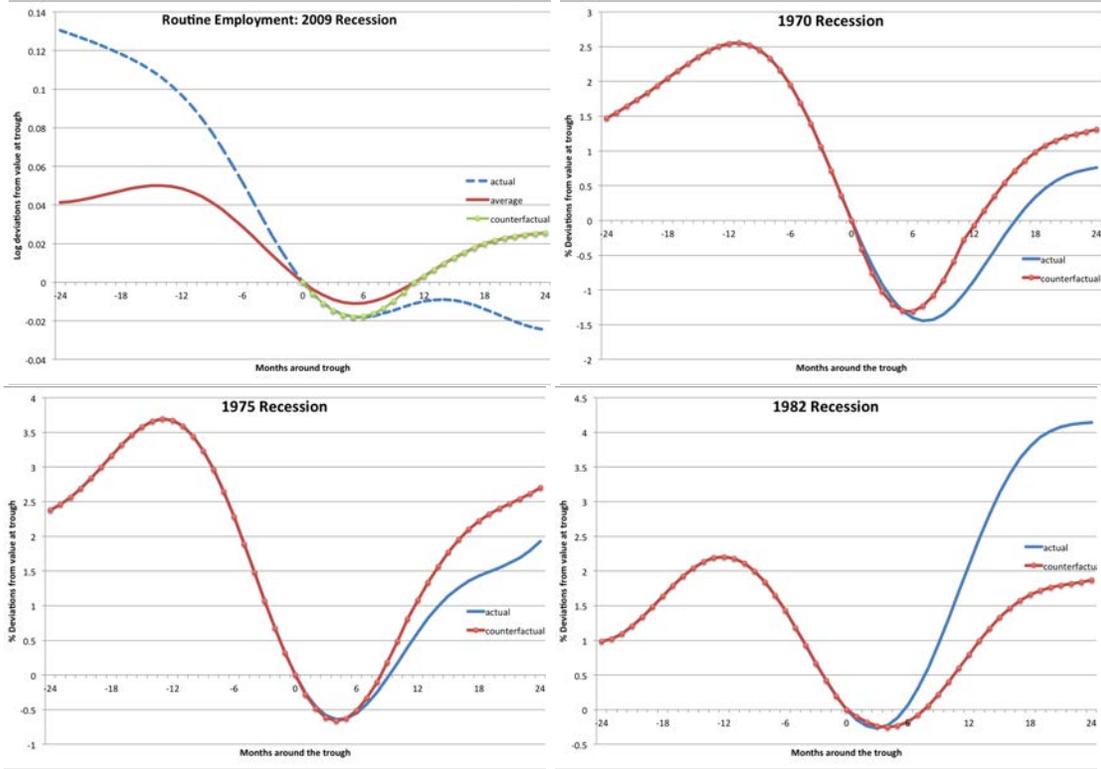
D   Section 4 Details

We do the following to identify recessions at the US state level. For the 1982 episode, we look
for a peak in per capita RGDP that occurs on or after 1980 (to account for the "double dip"
recessions experienced at the aggregate level), and a subsequent decline that troughs during
the period 1981-83. For the 2009 episode, we look for a peak in per capita RGDP that occurs
on or after 2005, and a subsequent decline that troughs during 2008-10. If these conditions
are satisfied, we further verify that (total) per capita employment exhibits a decline during the
state-specific recessionary episode. If recessions are observed in both output and employment,
the state is deemed to have experienced a recession coincident with the macro level episode.

For the 1982 episode, we identify the following states: Alabama, Arizona, Arkansas, Cal-
ifornia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota,
Mississippi, Missouri, Montana, Nebraska, Nevada, New Mexico, North Carolina, North Dakota,
Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas,
Utah, Vermont, Washington, Wisconsin. In all cases, the peak occured in 1981 and the trough
in 1982, except: Iowa, Louisiana, Nebraska, North Dakota, South Dakota and Wyoming (trough
1983), Michigan and Oregon (peak 1980), Texas (peak 1982, trough 1983).

For the 2009 episode, we identify the following states: Alabama, Arizona, Arkansas, Cal-
ifornia, Colorado, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas,
Kentucky, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nevada, New
Hampshire, New Jersey, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South
Carolina, Tennessee, Utah, Vermont, Washington, Wisconsin, Wyoming. In all cases, the peak

occured in 2008 and the trough in 2009, except: Alabama, Arizona, California, Florida, Georgia, Illinois, Indiana, Iowa, South Carolina, Utah, Wisconsin (peak 2007), Arkansas, Kentucky, Nevada, New Hampshire, Rhode Island, Tennessee (peak 2006), Delaware (peak 2006, trough 2008), Michigan, Ohio (peak 2005).

For the counterfactual, we take the ratio of a state's routine employment gain in the two years following the 2009 recession relative to its recessionary loss, and replace it with the same ratio it achieved following the 1982 recession. We multiply this proportion by the level of (per capita) routine employment at the peak to obtain a counterfactual level of routine employment two years after the trough. Adding this to the level of non-routine employment two years after the trough, we obtain a counterfactual value of (per capita) total employment two years following the 2009 recession for each state.

The following are the list of cyclical peak and trough dates for each country, used in the international analysis. *Austria*: (1974:III, 1975:II), (1992:III, 1993:I), (2000:IV, 2001:III), (2008:II, 2009:II). *Belgium*: (2002:IV, 2003:II), (2008:II, 2009:II). *Denmark*: (1992:III, 1993:II), (2008:I, 2009:II). *Finland*: (2007:IV, 2009:II). *France*: (1980:I, 1980:IV), (1992:I, 1993:II), (2008:I, 2009:II). *Germany*: (1974:II, 1975:II), (1982:I, 1982:III), (1986:IV, 1987:II), (1992:I, 1993:II), (1995:III, 1996:I), (2002:III, 2003:II). *Ireland*: (1990:IV, 1991:II), (2007:IV, 2009:IV). *Italy*: (1974:III, 1975:II), (1981:IV, 1982:III), (1992:II, 1993:III), (2008:I, 2009:II). *Netherlands*: (2001:IV, 2003:II), (2008:II, 2009:II). *Norway*: (1980:I, 1980:III), (2002:II, 2003:II), (2008:I, 2010:III). *Portugal*: (1983:II, 1984:II), (1992:I, 1993:II), (2002:I, 2003:II), (2008:I, 2009:I). *Spain*: (1980:II, 1981:II), (1992:I, 1993:II), (2008:I, 2009:III). *Sweden*: (1992:I, 1993:I), (1995:IV, 1996:II), (2008:I, 2009:III). *United Kingdom*: (1979:IV, 1981:I), (1990:II, 1991:III), (2008:I, 2009:II).

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