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The Twenty-four Hour Economy or Rolled-up Sidewalks: Trends in Work Timing and Their Causes

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Abstract

We demonstrate nearly steady trends from 1973–2023 in the U.S. in the timing of when people work for pay, away from evening and night hours toward "usual" daytime hours. Much of the trend is related to increased real incomes, with rising educational attainment, the changing composition of the (declining) manufacturing industry, and the increased wage premium for undesirable work times—evenings and nights—that we document accounting for the rest. The trend exists in all major industries except retail, in which changes in technology biased work away from daytime hours. It was accelerated by the sharp increase in telework that occurred after the Covid pandemic, an increase that was especially concentrated during daytime hours. While we observe the same phenomenon in France from 1966 to 2010, we do not in the U.K. from 1974–2015, arguably because of the very sharp decline in unionization in the U.K. and the changes in retailing.

JEL classification

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Keywords

work timing, Covid, time use, home work

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I. Introduction

The amount of time that people supply to paid employment has been a central focus of research in labor economics for 70 years (Long, 1958; Mincer, 1962; Killingsworth and Heckman, 1986; Beffy et al., 2019, and immense numbers of others). This includes detailed studies of both the extensive margin of work (labor-force participation) and the intensive margin (hours of work by labor-force participants). There has been remarkably little research on the timing of work, for example, on the days of the week on which work occurs (but see Mueller, 2001; Hamermesh and Biddle, 2025). Also, other than one older study (Hamermesh, 1999) nothing appears to have been done on the time of the typical workday when paid work is performed.

This paucity of research and knowledge is surprising given the likely importance of work timing in people's preferences. Because of desires to coordinate schedules to facilitate socializing with others, including family members, while away from work; because of the dangers of working and commuting in the dark; and because of people's desires to bunch work hours, workers' preferences will affect the timing of work. So too, cost minimization will lead employers both to try to satisfy these preferences and to structure the timing of production to minimize non-labor costs and to attract customers as efficiently as possible. Clearly, the timing of work is affected by behavior on both sides of the labor market. It has also long been of concern for policy, as evidenced by mandated premium pay and even total prohibitions on work at unusual times (see ILO, 2013).

Our purpose here is several-fold. First, we document trends over the past half century in the U.S. in the distribution of paid work across the typical day (that is, trends in the percentage of workers on the job during each hour of the day), providing the first evidence of how this dimension of work timing has changed since the early 1990s. Contrary to a widespread impression that the 21st century has seen the emergence of a "24/7 economy," we find a general decline in the share of the workforce on the job in the late evening and pre-dawn hours, which represents a long continuation of the trend through 1991. There has also been a steady increase in the share of work performed during the 8AM-4PM period. Second, we investigate the extent to which these trends arose from changing industrial structures and/or changes in the education level and demographics of the workforce. Thirdly, we offer evidence in support of the hypothesis that these long-term trends are a result of the rise in workers' real incomes over the fifty-year period. We also examine how the sharp increase in telework after the Covid pandemic altered the timing of work.

In Section II we discuss Rosen's (1986) model of implicit markets for workplace amenities as a framework for analyzing the determinants of the distribution of paid work across hours of the day. Section III describes the American datasets and the measures that we have constructed to document changes over time in the timing of work, while Section IV presents aggregate trends in the data. Section V considers the extent to which the changes have been due to the changing demography of the workforce, rising education levels, and/or changes in industrial structure, and how much can be attributed to these factors. Section VI considers the role of changing earnings inequality in relation to work timing. Section VII shows that similar trends in work timing occurred in most industries, with the striking exception of the retail sector; and it examines and explains why retail differed. Section VIII asks whether the Covid pandemic and the concomitant and lasting increase in telework altered the distribution of work timing, while Section IX looks at evidence from the United Kingdom and France, the only other countries with time-diary data adequate to reveal longer-term trends in work timing.

II. Theoretical Framework

Rosen's (1986) model of implicit markets for job amenities provides a useful framework for analyzing changes over time in the distribution of work across hours of the day. Following Winston (1982), let a particular hour of day be denoted by t (t = 1, ..., 24), and assume that each worker i has the utility function $V_i = \sum_t U_{it}((1 - L_{it}), C_{it})$, where L_{it} is an indicator equaling 1 if person i works at time t, 0 if not, and C is the amount consumed at t. For simplicity, assume that utility is intertemporally additively separable, and that leisure and consumption are separable at each t. We assume that the dU_t/dL_t differ at different times t for an individual worker and differ across workers for the same t. Work at certain times can be normal or inferior, with the disutility of work at a given t rising or falling relative to the disutility of work at some arbitrarily chosen t' as real income rises.

Each firm j is assumed to have a profit function $\prod_j(a_{j1}N_1, a_{j2}N_2, \dots, a_{j24}N_{j24}; w)$, where N_t is the number of workers employed at time t, a_{jt} is the contribution of a worker at time t to firm j's profits, and w is the average wage of workers employed by the firm. Assume that firms offer jobs as a package consisting of a "shift," a continuous bundle of hours such as "9 to 5", and a daily payment for that shift.[1] Along with differences in the Π_j, variations in the pattern of the a_{jt} across firms will generate heterogeneity in firms' valuations of different shifts of the same length. The pattern of a_t for a given firm depends on its production technology and on the distribution of consumers' preferences for the firm's product (e.g., when consumers prefer shop for food, eat a meal out, or go to the gym).

This setup leads to an equilibrium with workers matched to firms based on both workers' and firms' objective functions: Workers whose disutility of work at time t is lowest will work in firms at which the a_{jt} are highest, other things equal. Each job is characterized by a daily wage, with a potentially different daily wage for each shift. If we assume away worker fatigue from longer shifts, a single implicit market wage for each hour w_t can be derived by comparisons of the daily wages for various shifts. The values of these implicit hourly wages will depend on the distributions of preferences for work time across individuals and over all times t and of the a_{jt} coefficients across firms.

Define the vector θ_t of wage differentials such that $w_t = [1+ \theta_t]w_a$ where w_a is the average of the hourly w_t over the day. There is no single hour, or set of hours, that is preferred by all workers. Rather, we assume that some t' are viewed as predominantly undesirable, in the sense that $\theta_{t'} > 0$. We further assume that preferences over work time are unchanging (which does not rule out the existence of income effects), and that, in general, work at undesirable hours is an inferior good, while the income effect on work at desirable hours is non-negative. Given these assumptions, we can identify as undesirable in a cross section those hours during which workers with lower incomes will be more likely to be working, since workers with higher incomes sacrifice some of their earning power to avoid working at those times.

[1] The assumption that a daily work shift is continuous does little violence to the facts—split shifts are quite rare in the U.S. economy. This could be due, for example, to fixed costs of starting and stopping shifts, from both the worker's and firm's points of view.

Next, assume that the technology of the timing of work has exhibited only neutral changes over time, that is, the a_{jt} have changed proportionately. Given that, if the average worker's earnings have been rising, we should find a declining share of the total work performed economy-wide at those hours that workers typically view as inferior. Below, we document that this decline in work at undesirable hours has been a long-term trend, and we present evidence for our maintained hypothesis that much of this decline is due to rising average real earnings.

Assuming neutral technical change across hours of the day, we can also relate changes in wage inequality to changes in the distribution of work timing. Assume that the income elasticity of demand for the amenity, work at desirable times, is constant across workers with different earnings. If the returns to skill increase, so that wage inequality rises, we should expect workers whose earnings are rising relatively to exhibit the greatest increase in the demand for work at those times. Thus, we should see relative increases in the fraction of work at inferior times performed by lower-wage workers, and relative increases in the fraction of work performed at superior times by higher-wage workers.

III. Data and Construction of Measures of Timing

To analyze changes in the timing of work from 1973 to 2004 we use data from the "Work Schedule" supplements to the May Current Population Survey (CPS) conducted in 1973, 1976-1981, 1985, 1991, 1997, 2001, and 2004. These Supplements asked respondents about the usual starting and ending times on their main jobs. Using this information, for each worker i in year s we construct the series L_{its}, t=1 . . .24, each member of which equals one if the person was at work during the hour centered at time t, and zero otherwise.[2] Respondents who were self-employed or reported earning no income from their job were excluded from the samples, as were those who did not report either a start time or end time for their job.[3]

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[2] For example, when we refer to Hour 15, we mean the segment of time from 2:31PM-3:30 PM. For convenience we denote 3PM-6PM as covering the four hours 2:31PM-6:30PM.

[3] In the survey years 1991 and before, approximately 10 percent of respondents did not answer one or both of the start time/end time questions. We applied an imputation procedure that used the one reported value (start time or end time) and information on usual hours worked on the main job to these observations. The average L_{ts} values were almost unaffected by these imputations. Starting in 1997, respondents were allowed to answer that they did not have a regular starting and ending time; about 25 percent of respondents chose this option. For these cases we imputed start and end

Averaging the L_{its} over individuals for each year creates the series L_{ts}, an estimate of the fraction of the workforce that was on the job during hour t in year s.

We use data from the American Time Use Survey (ATUS) to construct these L measures annually for 2003-23. ATUS time diaries divide each respondent's day into "episodes," stretches of time devoted to the same activity, note the starting and ending times of each episode, and show the episode's activity using a detailed coding system.[4] We define each respondent's workday as an episode or series of adjacent episodes coded as involving a work-related activity.[5] Also, if there was an "eating" episode that was bracketed by work-related episodes, that episode was considered part of the workday. Once a respondent's workday was thus defined, the starting and ending times of this workday were used to define the L_{its} for that respondent. As with the CPS data, we exclude self-employed individuals. The subsamples of the annual ATUS have 1,500 to 3,000 observations, compared to the typical May CPS Supplement with 35,000 to 50,000 observations.[6]

To separate economic from other factors that might affect the trends and distribution of timing we create several standard demographic variables from the May CPS Supplements and the ATUS. These include whether the worker is black or Hispanic; the worker's gender, age, education, and marital status. We also created fourteen major industry categories that we define consistently over the entire period: Primary; construction; manufacturing; transport; communications/utilities; wholesale; retail; food

times using information they reported on the "shift" that they worked on their regular job. The use of imputed values, however, had almost no discernable effect on the annual average L_{ts} values. We therefore chose to work only with observations having valid reported values for both start and end time.

[4] For a detailed description of the ATUS, see Hamermesh et al. (2005).

[5] Specifically, activities coded as 50101 ("work, main job"), 50103-50289, and 059999 (various work-related activities such as "security procedures as part of job" and "eating and drinking as part of job"). Episodes coded as 50102 (Work, other jobs) or any of the "Other income earning activities" codes are not considered part of the workday to be consistent with the CPS Supplement.

[6] Because of the differences in sample sizes across years, for each year the observations are reweighted to so that the effective number of observations is the same across years.

establishments; finance, etc.; health services; education; other services; police/fire; other government. Finally, in most of the CPS Supplements and the entire ATUS we observe weekly earnings.

Changes over time in the length of the average working day necessarily lead to changes over time in the L_{ts}. Since we are primarily concerned with changes in the relative desirability to firms and workers of work at various hours of the day, we adjust the L_{ts} values so that they reflect the percentage of the workforce that would have been on the job during hour t had the length of the average workday remained as it was in 1973.[7] We denote these adjusted measures as L'_{ts}.

Figure 1A shows the values of the hourly L'_{ts} measures, averaged over the CPS samples from 1973 to 2004, beginning on the left with hour 24 (midnight). The figure is not surprising: the percentage of employees at work during the stereotypical "9 to 5" workday is very high, over eighty percent until the 5PM hour. On each side of the standard workday, the L' values taper off, settling in these data at around 10 percent over the Midnight-5AM period.

There are sharp differences between the CPS samples and the ATUS samples in both the type of data and the methods used to derive the L' values. In Figure 1B we thus compare the distribution of the L'_t values across hours of the day in the 2004 May CPS Supplement to two distributions from the average of the 2003-2005 ATUS samples, one based on all diaries, and one based only on weekday diaries. The three distributions all have the basic bell shape, but the ATUS distributions are below the CPS distribution during the standard workday, and above it during the 6PM-10PM period. The distribution from the ATUS sample that excludes weekend days is closer to the CPS distribution. A likely reason for this is that CPS respondents, asked about when work "usually" started, think of their work on a weekday. Still, the two series differ by as much as five or six percentage points at some hours. Because of this, we take three steps. First, because of the greater similarity of the "weekdays only" distribution in the ATUS to the CPS

[7] We multiply each year's L_{ts} series by the ratio of average daily hours in 1973 to average daily hours in that year. We define a person's workday as the number of one-hour segments in which any work took place. This overstates the actual workday, as it counts as whole hours some hourly segments in which the person may have worked fewer than 60 minutes. This should not matter, however, since the difference between the average working day (weekly hours divided by days worked) reported in the CPS and the average as we measure it remains relatively unchanged over time.

distribution, we use that sample to examine changes over 2003-23. Second, we conduct most of the analyses separately on the CPS 1973-2004 and the 2003-23 ATUS. Third, in portraying trends over the fifty-year period, we focus on changes rather than levels, for example, portraying the trend over the 2001-23 period by splicing the 2001-04 change from the CPS to the 2003-23 change from the ATUS.

In Section II, we argued that the assumption that undesirable hours are inferior and that desirable hours are normal implies that workers with higher incomes will be more likely to be represented among employees working at the desirable hours and less likely to be among those working at undesirable hours. One obvious correlate of income is education level. Figure 2 shows for the combined CPS and ATUS samples the distribution of the educational attainment of workers across hours of the day. Each line in the Figure corresponds to the share of workers at a given educational level: less than a high school diploma, a high school diploma only, some years of college but no bachelor's degree, and a bachelor's degree or more. The Figure demonstrates that workers with less education are more likely to be at work in the least desirable hours, and workers with the most education more likely to be working at the more desirable hours, in line with common intuition. For example, the share of high school dropouts actively at work is above its sample average from Midnight-4AM, and below it at the remaining hours. The share of workers with only a high school diploma is above its average from Midnight-7AM and otherwise below it. College graduates are overrepresented in the hours from 8AM-10PM. The Figure supports the idea that late evening and pre-dawn morning hours are relatively undesirable, and that work at those times is inferior.[8]

One can draw a similar inference from Figure 3, which depicts the average age of the workforce across hours of the day. It is below its overall average of 39.8 from 7PM-4AM and differs by almost five years from its peak to its trough at around 9 PM. The role of age in explaining this pattern is less clear than that of education, as other factors affecting preferences—circadian rhythms that vary with age, marital status, the desire to be with family during childrearing ages, etc.—might also affect preferences for work

[8] Note that, like all else in this study, the results apply to broad aggregates of workers. There may be nonlinearities or even reversals in these relationships, as in the interesting result (Frederiksen et al 2025) that top managers are more likely to work nights that lower-level managers.

time. Still, Figures 2 and 3 bolster the assumption that late evening and predawn hours are relatively undesirable.

IV. Aggregate Trends in the Timing of Work

Figure 4 provides a concise visual summary for each sub-period of the changes over time in the percentage of the workforce at work at each hour of the day for all 24 hours, calculated using the L'_t measures. Because we hold constant the length of the workday, the changes must sum to zero. Starting values for the first sub-period average the measures for 1973, 1976, and 1977, and the ending values are averages of the measures in the 2001 and 2004 CPS surveys. Starting values for the second sub-period are averages from the ATUS from 2003 to 2007, and the ending values are averages from 2017-23 (with 2020 and 2021 omitted). For example, the Figure shows that the share of the workforce on the job at the 4AM hour fell by a little more than one percentage point from the early 1970s to the early 2000s, and rose by about half a percentage point over the next 20 years.

The graph shows two trends that were ongoing over the entire fifty-year period: (1) a steady decline in the percentage of workers on the job in the evening and "graveyard shift" hours, 8PM-2AM; and (2) an increasing percentage working in the 9AM-3PM period, i.e., during the traditional workday. In the first sub-period there was a decline in the percentage at work in the predawn period 3AM, with that percentage holding steady over the second sub-period. The modal workday moved somewhat earlier over the first sub-period, with increases in the percentage working at 7AM and 8AM and decreases at 5PM and 6PM, while the shift of workers to earlier morning hours partly reversed in the second sub-period.

Figure 5 shows these trends in another way. We divide the day into eight three-hour segments, with the line L68, for example, describing the average of the L' for hours 6AM, 7AM, and 8AM. The ordinate shows the difference between this average L' in the year on the x-axis and its value in 2004. Figure 5A shows the trends for the four "off-peak" segments spanning 6PM to 4AM. In the off-peak times, L'_{1820}, L'_{2123}, and L'_{242} have clear downward trends. Figure 5B shows that the average L'_t value over hours 9, 10, and 11 was slightly more than two percentage points higher in the early 2020s than in 2004.[9] During peak worktimes, L'_{68} trends strongly up in the first sub-period before leveling out; L'_{911} and L'_{1214} move together on what appears to be an upward trend, and L'_{1517} shows no obvious trend.

Compared to 1973, an increased percentage of employees in the U.S. now work during the prime hours 9AM to 4PM, while a considerably smaller share now works during the undesirable hours 10PM-4AM. Some of these changes seem small when expressed as percentage points, but they are substantial when measured against the L' levels observed during the 1970s. Looking at the 11PM hour, for example, there was a decline of about four percentage points over the fifty-year period in the share of the workforce on the job; but in the 1970s, only about 15 percent of employees worked during that hour, so the decline was over 25 percent.[10] Thus, whatever is meant by references to the emergence of a "24/7 economy" in recent decades, the evidence clearly demonstrates that it cannot be taken to mean that an increasing share of workers is on the job during nighttime hours.

V. Decomposing Trends in Work Timing

Can the trends in work timing displayed in Figure 5 can be explained by changes in the characteristics of the workforce and the structure of industry? We estimate 24 regressions, one for each hour of the day, with an L'_t value as the dependent variable. On the right-hand side we include a trend term and demographic variables (indicators for decennia of age, for gender, race (black or non-Hispanic white), Hispanic ethnicity, and whether married), indicators for the four education categories, and controls for the 14 major industry categories. We then use Gelbach's (2016) method to measure how much of the raw trend in the fraction of employees at work at each hour can be explained by changes in each of these three classes

[9] Points are plotted using the CPS samples for 1973, the average of 1976-78, the average for 1979-81, 1985, 1991, 1997, and 2001. For the ATUS samples we use the average of each three-year period from 2003-23.

[10] Because the CPS Supplements do not include information on the timing of second jobs, we cannot examine how the fifty-year trends in work timing would change if we had data on those jobs. The ATUS does, however, allow that comparison. The diurnal pattern of second jobs is similar to that of main jobs. It does not change much from 2003-23; and, in any case, with a relatively small amount of work performed on second jobs, including it in the analysis hardly affects patterns depicted in Figure 5.

of variables, and how much remains unexplained. We estimate these regressions separately for the two sub-periods, 1973-2004, and 2003-23, i.e., on the CPS data and then on the ATUS data.

First, it is worth documenting some of the more substantial changes over the period in the nature of the workforce and the industrial structure of the U.S. economy. The average age increased steadily throughout the half century, from 37.1 years in 1973, to 40.2 in 2004, to 41.7 in the 2020s. The educational attainment of the labor force also increased dramatically: From 1973 to 2004, the share of the sample with a college degree rose from 15.6 percent to 20.4 percent, over the next 20 years it increased even more rapidly, reaching 46.4 percent by the 2020s. Mirroring this was the decline in the share with a high school diploma or less, from 68 percent in 1973 to 51.3 percent in 2004 to 31.4 percent in the 2020s. Men comprised 60 percent of the 1973 sample, but only 53 percent in the samples in 2004 and the 2020s.

In 1973 the largest major industry category was manufacturing, employing 26.7 percent of workers, compared to 15 percent in 2004. The decline moderated over the next 20 years, with 11.7 percent of employees working in manufacturing in the 2020s. Major industry categories that grew over the period were healthcare (rising from 6.4 percent to 10.4 percent of the sample in the first sub-period, increasing slightly thereafter) and “other services” (all private-sector service workers except those in education and health) which grew from 11.4 percent of the 1973 sample to 24.1 percent in the 2020s.

Figure 6 displays results of the decompositions for the 1973-2004 CPS. The white bars ☐ on the left of each small graph show the total changes over the period in the fraction of employees working at the hour. Adjacent to them the black bars ■ show the changes after accounting for all the covariates in the model. The results of the decompositions are depicted in the subsequent three bars: The center bars show the changes in the fraction working accounting only for changes in the demographics; the fourth bars depict the trends accounting only for changes in the educational attainment of the labor force; the final, right-hand bars show these changes accounting only for changes in industrial structure.[11]

To illustrate using work at midnight, the raw change over these 30 years is a drop of -0.022 in L'_{24}. The second bar shows that, had the measured demographics, educational attainment, and industry mix of the labor force not changed over this sub-period, the decline still would have been -0.016. The value shown by the third bar, -0.018, implies that most of the "explained" part of the decline in the fraction at work (0.004 of the 0.006 portion of the trend explained by changes in the covariates) was due to changes in the demographic covariates. The trend illustrated by the final bar is the same as the "raw" trend (the first bar), indicating that none of the downward trend in work at hour 24 was due to changes in the industrial mix at essentially the one-digit level. In short, the closer a column's value is to the value for the raw trend, the less that those column's covariates contributed to the raw trend.

From Midnight-3AM there is always a significant and meaningful trend, whether raw or conditional. Changes in the X's contribute from 1/3 to ½ of the overall negative trend, with changes in the demographic mix being the main driver and with changes in the industry mix of lesser importance.[12] Changes at 5AM are tiny, while in the early morning hours of 6AM-8AM the trends are positive and would have been even more positive if the X's had not changed. The 8PM-11PM hours are like the Midnight-4AM hours: large declines in work at these times as percentages of those working, with half or more of the change remaining accounting for the X's. Had the industry mix not changed, the reductions at these hours would have been still larger.

From 8AM-2PM the raw trends are small relative to the means of L'_t. shown in the previous figures). Had there been no change in the X's, however, the trends would have been negative. This pattern continues in the early afternoon, with (larger) observed positive trends that would have been negative had there been no changes in the X's. Changing demographics played a larger role than increasing education in

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[11] Appendix Tables A1 and A2 present the coefficient estimates underlying Figures 6 and 7 along with the means of time worked over each of the two sub-periods.

[12] Further analysis, not reported in the table, shows that age seems to be the main demographic driver. The aging of the labor force led to some of the reduction in work at these hours and at 4AM.

driving the positive trend; again, the changing industry mix played almost no role. Changing demographics exerted considerable negative influence on work at 5PM, while changes in education and the industrial mix worked the other way. Still, the results for these hours, when taken in conjunction with the results at 6AM and 7AM, indicate a trend towards shifting the standard workday earlier, even with the X's held constant.

Figure 7 shows analogous results for 2003-23. From 11PM-4AM there is a continuation of the trends of the previous 30 years, with meaningful declines in work at Midnight and 1AM unrelated to changes in the X's, and smaller declines 2AM-3AM, about half of which are due to rising educational attainment. At 5AM and 6AM there are upward trends that would have been nearly twice as large had educational attainment not risen; similarly, potential positive changes in the percentages at work at 7AM and 8AM were very much dampened by rising educational attainment. (Recall that the increase in educational attainment was more rapid during this second sub-period.)

There were increases in the percentages of workers on the job during the morning hours of the traditional workday, about half of which were driven by rising education. In the early afternoon the share of the workforce on the job also increased, again largely due to changes in educational attainment. From 6PM-8PM there was a decline in the fractions at work, which would have been larger but for changes in educational attainment, suggesting that the more educated are not averse to working these early evening hours. Changes in the industrial mix had no discernable impact on this pattern. From 9PM-11PM the predicted decline in work is unessentially unaffected by the covariates.

Overall, the decompositions provide evidence supporting the "rising real income" hypothesis. In both periods, trends away from work at the undesirable late evening and pre-dawn morning hours are largely unexplained by changes in the X's, but the portions that are explained can be linked to the rising age (in the first sub-period) and education (in the second) of the workforce—both observables being positively correlated with increases in full income. Also, throughout the period we observe more work during the traditional 9AM-5PM workday, partly related to rising educational attainment. Changes on the labor demand side, as captured by changes in the industrial mix, had little impact on the timing of work, at least in the aggregate. Clearly, the sharp decline in total manufacturing employment contributed very little to the decline in night work and the shift to more work at "prime" hours.

The broad indicators of industrial affiliation that we have used were necessitated by the sparseness of industry cells in the ATUS. We can disaggregate further by industry using the much larger CPS samples. We thus construct a set of 38 indicators, including 17 two-digit manufacturing industries, and re-estimate the models covering 1973-2004. The results (described by Appendix Table A3, analogous to Appendix Table A1) suggest that shifts across manufacturing industries during this period did account for some of the 31-year trends in work timing. Nonetheless, even with this additional disaggregation the three sets of controls—demographics, education, and more detailed industries—rarely accounted for even half of the set of 24 trends that we have identified.[13]

We have also examined the role of immigrants, with information available only beginning in these data with the 1997 CPS. While immigrants are more likely than otherwise identical (demographics and industrial affiliations) workers to be on the job evenings/nights, accounting for them does not alter the inferences about aggregate trends at each hour of the day. We also consider geography, including indicators for four major regions and location in different parts of a metro area (center city vs. suburb). These also do not change the inferences. Similarly, the trends in working time at different times of day are similar across regions and within metro areas.[14]

Another possibility is that the estimated trends reflect the sharp diminution of the role of trade unions in the American economy. Data on union membership are not available for the entire sample period, but we can perform the same analyses as above using the ATUS 2003-23, over which union incidence fell

[13] For 1976-2004 we can consistently disaggregate industries to create 162 indicators of industrial affiliation (excluding the two percent of observations for which the cells had fewer than 500 occupants). Re-estimating the model described here demonstrates that this much finer disaggregation produced results very similar to those based on the 38 industries. We can conclude that the small extent to which changes in industrial structure contributed to changing work time during this period was due mainly to changes in the mix of manufacturing industries.

[14] Women are less likely to be working evenings/nights than men, with the differences during daytime hours being proportionately smaller. The rise in female participation accounts in the decompositions summarized in Figures 6 and 7 for a very small part of the trend. Information on the presence of young children is only available from 1985. Re-estimating the models from that date including an indicator for young children leaves the central results essentially unchanged.

by nearly 1/3. Including an indicator of each worker's union membership does not alter the trends in work timing observed in the ATUS (shown in Figure 7). Union members are, however, much more likely than demographically identical other workers to be working at night, even accounting for their industry.

VI. Earnings Inequality and Changes in the Timing of Work

The rise in earnings inequality, driven in part by a rise in the return to human capital, is one of the most discussed and documented labor-market trends of the past half century (e.g., Juhn et al, 1993; Lemieux, 2006; Hoffmann et al., 2020). We have hypothesized that the general trend away from work at undesirable hours is due to the general rise in workers' real incomes. The increase in earnings inequality suggests another test of this hypothesis: we should see relative increases in the fraction of work at inferior times performed by lower-wage workers, and relative increases in the fraction of work performed at superior times by higher-wage workers.

To construct an earnings variable for testing this hypothesis, we regress the logarithm of weekly earnings on a quadratic in usual weekly hours, then measure earnings as the residual from this regression. (Removing the effect of hours on weekly earnings is necessary because workers with longer work hours will be higher up in the earnings distribution and also mechanically will be more likely to be on the job at any given hour of the day.)[15] For each year in the sample, we define earnings quartiles in two ways: (1) Based on the predicted values from a regression of the hours-adjusted earnings measure on the demographic and educational variables; and (2) Based on the residuals of those regressions. Then we estimate regressions for the 24 L'_t variables, allowing a different trend for each quartile. We do this separately for the two definitions of quartiles and the two sub-periods.

For each hour in the CPS 1985-2004 Figures 8A and 8B plot the differences between trends in the fourth and first quartiles, and those between the third and first quartiles, for predicted earnings and then for earnings residuals. Figures 9A and 9B do the same things for the ATUS 2003-23. The figures also show

[15] The starting year for these tests is 1985, because in 1973 about 20 percent of the observations had no earnings variable, and the earnings variable was not present again in the May CPS supplements until 1985. We use quartiles rather than the more common quintiles or deciles because of the small sizes of the ATUS samples.

90-percent confidence bands around the differences in the estimated trends. For example, a negative value of the fourth-quartile trend differential at the late evening or predawn morning hours would support the hypothesis. It would indicate that the share of fourth (top)-quartile earners among the people working in those hours declined over the period relative to the share of first (bottom)-quartile earners on the job during those hours.

The hypothesis is very strongly supported in the first sub-period, whether we define quartiles by predicted or residual earnings, although the pattern of shifts away from undesirable hours toward desirable hours is more dramatic in residual earnings than in predicted earnings.[16] Indeed, the top-bottom difference is statistically significantly negative at evening and night hours and significantly positive at peak daytime hours. The results are less clear in the ATUS data; but even during 2003-23 we observe a significant negative difference in the representation of top- compared to bottom-quartile earners at evening and nighttime hours. The diminished relation between the differences at the earnings quartiles in the latter period is consistent with the adjusted earnings differentials having risen less rapidly then. There was a trend difference of 0.37 log points per year in the 4th-1st quartile difference in the first sub-period, 0.25 log points per year in the later period, 0.21 log points in the difference in trends of the 3rd-1st quartile difference in the first sub-period, but only 0.02 log points in the later period.

Unlike the earlier period, the pattern shows up more clearly for 2003-23 in quartiles defined by predicted earnings, and it all but disappears for quartiles defined by residual earnings. A possible explanation for this difference is that during the second period the growing distaste for work at bad hours fueled by rising real full incomes increased the shift premium (θ) for those hours. Because the residual includes any premium that might be associated with working during undesirable hours, this biases our test against finding support for the "rising real income" hypothesis, because it mechanically moves those with less human capital who work undesirable hours into higher residual earnings quartiles.

[16] If instead of predicted or residual earnings quartiles we examine the differences based on full earnings (after an adjustment for weekly work hours), the results look quite similar to those shown in Figure 6A.

If this discussion is correct, we should have seen a rise in the relative earnings accruing to work at night compared to work at usual work times. To shed additional light on this hypothesis, consider the double-difference:

$$(1)\ \ D^2 = \{[W^*_{tLate} - W^*_{tEarly}]_{OffPeak} - [W^*_{tLate} - W^*_{tEarly}]\}_{Peak}\ ,$$

where W^* is the residual from the regressions described above (so that all observable differences have been removed), Late is post-2000, and Early is pre-2000. We treat the four hours 3AM-6AM as off-peak, the hours 9AM-4PM as peak. The calculations yield D^2 = 0.0300 (s.e. = 0.0019). The increase of three percentage points in θ, the premium for night work, over this period is consistent with night work's inferiority and with our finding that inequality in predicted earnings mattered more in the later period. This estimate is identified assuming that all relevant trends in covariates have been accounted for. For that reason this estimate—of the change in a compensating wage differential—circumvents the well-known difficulties in estimating levels of those differentials (e.g., Kostiuk, 1990).

VII. Changes in Work Timing in Sub-aggregates: The Surprising Retail Sector

If the aggregate trends are driven largely by rising incomes, we should observe similar trends within each industry.[17] Figure 10 presents evidence on this point, showing changes in the timing of work over the first sub-period in four of the larger major industries in our sample: manufacturing, health care, education, and all other private-sector services. For each hour we plot the ratio of the average of L'_t in the 2001 and 2004 samples to the average over the 1973, 1976, and 1977 samples. The similarities across industry are obvious. As a comprehensive test of the similarity across industries of the changes in work timing, we construct $L_t'_{2000s}/L_t'_{1970s}$ at each hour for the eight largest industries in the sample, which include on average

[17] This conclusion is even stronger if we assume that the a_{jts} of the theoretical model changed only proportionately within an industry.

83 percent of all workers, then calculate correlations between the 24 values of the ratio for each pair of industries. We also do this for the second sub-period.[18]

In both sub-periods, changes in work timing in seven of the eight industries are similar, with the retail sector being the outlier. There the changes in the timing of work ran counter to the aggregate trend, at least up until the middle of the 2010s.[19] Figure 11A is based on the CPS data and shows how the L'_t values changed from the 1970s to the early 2000s in other industries and retail. Figure 11B shows changes between the 2003-2007 samples and the 2012 to 2016 samples (the latter being when the unusual work timing trends in retail ceased). In Figure 11A, the line for "All Other Industries" shows the move away from late night and pre-dawn work, including 9PM-5AM, when the percentage of retail employees at work was increasing. The L'_t in retail saw their largest increases from 5AM-8AM and declined significantly at the 3PM-6PM period.[20] In Figure 11B for the later period, trends in the percentages at work each hour in retail still differ from those in the rest of the economy, with further declines at the 4PM-6PM period and further increases from 7AM-10AM.

The Rosen (1986) model suggests that, if the general trends in work timing are due to a rising distaste for work at undesirable hours driven by rising real incomes, the divergent behavior of the retail sector must be due to sector-specific shocks to labor demand, that is, changes in the relative productivity of work at different times of the day. A survey of the evolution of the retail sector in the U.S. over the past 50 years suggests two possible sources for these sector-specific shocks: (1) a trend towards extended operating hours of retail outlets; and (2) changes in how goods move from producers to retail shelves.

[18] The industries are manufacturing; health care; education; construction; retail; food and beverage; finance, insurance, and real estate; and miscellaneous services. For the second sub-period, the earlier L'_t values are averages of the 2003-2007 sample values: the later L'_t values averages of those from the 2017-2019 and 2022-2023 samples.

[19] In the first sub-period, of the 21 correlation coefficients not involving retail, 16 are positive and significant, while the two that are negative are not significant. In the second sub-period, the correlations between industries other than retail are weaker but still generally positive.

[20] The graphs integrate approximately to zero—if the number of employees at work during a certain hour grew more quickly than overall employment in the sector, the line will be above zero; at hours for which the number of employees grew more slowly than overall employment in the sector the line will be below zero.

In the mid-20th century the typical weekday operating hours for retail outlets were 10AM-5PM or 10AM-6PM. This had been the situation until the first Walmart stores were established in the early 1970s with doors open from 9AM-9PM. By the late 1980s almost 1000 Walmart stores observed these hours (Sloane, 1988), and by 2007 there were over 2200 Walmart supercenters open 24 hours a day. Another rapidly growing general merchandise chain, Target, generally kept outlets open from 7AM to 10PM and had over 1000 locations by 2001. At the other end of the establishment-size spectrum, the "7-11" convenience store chain opened its first 24-hour outlet in 1986; by 2016, 90 percent of the over 150,000 members of the National Association of Convenience Stores were open 24 hours a day (Anzilotti, 2016). This trend toward longer retail operating hours, including 24-hour operation, obviously increased the percentage of retail employees working in the late evening and predawn morning hours.[21]

The past 50 years also saw significant changes in retail distribution linked to the rise of "big box" retail, the increasing share of retail sales and employment accounted for by national retail chains.[22] During the post-war decades up to the 1970s, most goods came to retail stores from wholesalers' warehouses or direct from manufacturers. Starting in the 1980s major retail chains began building their own "distribution centers" (DCs), which received goods directly from manufacturers and then repackaged them for shipment to individual stores, often in trucks owned by the retail chain. The DCs employed "crossdocking," which saved on storage costs by moving goods quickly from incoming trucks to trucks bound for retail outlets, and which worked more effectively if the DC was operating continuously.[23] The move to the DC model in retail was facilitated by innovations in the areas of IT and communications, including UPC technology.

[21] We believe that this trend was a response to changing consumer preferences regarding the best time to shop, driven in part by changes in family structure and rising labor force participation of women. Census data show that in 1970 41 percent of U.S. households were headed by either a single working adult or two working spouses, meaning that in such households there was likely no non-working adult to do the shopping during traditional weekday retail hours. This had risen to 50 percent by 1980 and 55 percent by 1990, before leveling off for the next few decades (Ruggles et al. 2025).

[22] These trends are documented in Basker et al. (2012), Doms et al. (2004), Foster et al. (2016); Hortaçsu and Syverson (2015), and Jarmin et al. (2009).

[23] By 1990, Walmart had 14 DCs employing around 500 workers each and operating two shifts; it is now standard for retail DCs to operate 24 hours a day. By 2010, Walmart had more than 60 DCs, and Target had over 30.

Holmes (2001) and Basker et al. (2012) have shown that adoption of such IT technologies benefited retail chains with large establishments more than small retailers, giving such firms a competitive advantage.[24]

Given the DC model of retail distribution, large retail outlets generally receive daily truckloads of merchandise to be placed on shelves for consumers. A large operations research literature on optimal restocking plans describes the costs and benefits of hiring labor to handle restocking in the late night and early morning hours.[25] This restocking strategy is more cost effective for stores that receive more frequent deliveries, such as big-box retailers (Holmes, 2001). In short, from the 1990s on, new technologies aided the rise of big-box retail and the widespread adoption of the DC model in retail, creating an increased demand for labor at late night and early morning hours.

The changes in retail distribution have empirical implications that can be examined in our data. First, if the adoption of the DC model, which involved large retailers having their own trucking fleets, was quantitatively important, we should see a rise in the number of truck drivers classified as retail employees. The CPS samples show a statistically significant positive trend in the percentage of truck drivers employed in retail. In the ATUS samples, the broader occupational category of "transportation and materials moving occupations," includes both the drivers employed by retail chains and the DC employees.[26] Again, retailers employed an increasing percentage of these workers over the second sub-period. Finally, if the move by

[24] Sources for this account of the DC system include Lichtenstein (2009, pp. 36-44, 251); Vance and Scott (1994, pp. 71-72, 92-94); Walmart annual reports, and MMPVL (2025).

[25] Munoz et al. (2024) survey this literature, noting that, "Traditionally, retailers have relied on daytime shelf-stocking systems as a strategy to reduce instances of out-of-stock products. These systems typically involve assigning stockers to day shifts that align with the store's operating hours …. However, this approach comes with inherent limitations …. With numerous products to handle and customers making purchases simultaneously, stockers find themselves navigating through a crowded sales floor with limited maneuvering space … (and) it becomes impractical to fulfill all replenishment requirements and prevent instances of shelf out-of-stocks during store hours …. To address (these issues) certain retailers have implemented night-time shelf stocking systems (which) involve assigning a dedicated team of shelf stockers to shifts outside of regular store operating hours (e.g., from 10 pm to 8 am)." Most large grocery stores now restock at night, as do Walmart, Home Depot, and Target.

[26] Emy Sok of the BLS confirmed that truck drivers and DC workers employed in a retail chain are coded as working in the retail industry in the CPS and the CPS-derived ATUS.

many retailers to 24-hour distribution were quantitatively important, we would see a corresponding increase in work during nighttime and early morning hours by truck drivers. This is exactly what the data show.

Another implication is that certain sub-sectors in retail—those in which these technical changes might be expected to be greater—would show more positive trends toward late-night and early-morning work. The data prevent too deep an examination of this idea, but we can consistently disaggregate the retail sector into three sub-sectors: Department stores, etc., grocery stores, etc., and other retail. This last comprises two-thirds of the sample, making the first two groups quite sparsely populated in the ATUS data. Re-estimating the models separately for each group shows that the trends in all three mirror that in the entire sector. Nonetheless, the trend toward night work is strongest in department stores and weakest in groceries. In groceries, however, there is a strong positive trend toward early-morning work. These findings are consistent with the importance of both changes in shopping patterns and technical changes in the former, with technical change mattering less in groceries.[27]

Demographic and technological changes altered the a_{jt} in the retail sector in ways that led firms to demand more labor during undesirable hours of the day, while over the same period people's distaste for work at those hours was increasing with the rise in real incomes. Thus, the logic of the Rosen model suggests that a medium- to long-run effect of the labor demand shock to retailing would be a rising supply price for the labor retailers sought to hire during undesirable hours. If this explanation were correct, we would observe a relative increase in wages of retail workers on the job at these undesirable hours compared to the relative wage of those working at more desirable hours, all compared to workers in other industries.

We can test this description of a technological shock that induced a bias toward work in one industry at undesirable work times by calculating the triple-difference:

$$(2)\quad D^3=\{[W^*_{tLate}-W^*_{tEarly}]_{OffPeak}-[W^*_{tLate}-W^*_{tEarly}]\}^R_{Peak}-\{[W^*_{tLate}-W^*_{tEarly}]_{OffPeak}-[W^*_{tLate}-W^*_{tEarly}]\}^O_{Peak},$$

[27] The classifications for department stores are *ind*>=5380 & *ind*<=5391 in the ATUS, *ind1990*=591-600 in the CPS. The classifications for groceries are *ind*=4970-4971 in ATUS, *ind1990*=601 in the CPS.

where W^* is the residual from the regressions described in Section VI (so that demographic differences have been removed), and the superscripts R and O refer to retail and other industries respectively. As in Section VI, we treat the four hours 3AM-6AM as off-peak, the hours 9AM-4PM as peak.

In fact, the estimate of D^3 is -0.042 (s.e. = 0.004), opposite what would be expected from the simple story of the shift of retail employment toward off-peak hours. This estimate is almost equal, but opposite in sign, to the rise in the premium for night work overall during this period shown in Section VI. With retail employment decreasing over this period as a fraction of total employment, however, the number of night workers economy-wide accounted for by this shift in timing in retail did not need to increase. If, as seems likely, the supply of low-skilled potential night workers particularly to retail were very elastic, and the demand for lower-skilled night work were not expanding economy-wide, we would not see the emergence of a wage premium for night work in retail compared to that for all night work. [28]

VIII. Work Timing and the Aftermath of Covid

The biggest shock to labor markets worldwide since 2003, when the ATUS was first fielded, has been the Covid pandemic and its aftermath. Since the initial lockdowns in 2020, its major impact has been the sharp rise in work performed at home (telework) rather than at a workplace. Research suggests that by 2023 approximately 25 percent of employees worked from home (Pabilonia and Redmond, 2024; Buchman *et al.*, 2025), although different surveys suggest a range of estimates.[29] Work from home has demonstrated effects on productivity, on the role of managers, and on managerial expertise (Fang *et al.*, 2025).

Our question here is different: To what extent did the growth of telework alter the timing of work? On the one hand, telework might give employees more flexibility in the times at which they accomplish the tasks implicit in their jobs, yielding greater freedom to schedule themselves in ways that enhance their well-

[28] Interestingly, the overall cost to retailers of securing workers at undesirable hours may have been increasing in recent years. In 2015 Walmart began closing supercenters from 11PM-7AM. Night restocking continued, but many overnight workers moved to other shifts. Saving on labor costs was one reason cited for the move. By the end of 2023, many other retailers had announced that they had no plans to return to 24-hour service after having reduced operating hours during the pandemic. Articles in the business press reporting this phenomenon invariably cited the difficulty of staffing late shifts as a major reason for the decision. (See, e.g., Nguyen, 2024).

[29] See Oettinger (2011) for a discussion of the history of teleworking in the U.S. in the latter part of the 20th century.

being, including coordinating leisure time activities with friends and family members. On the other hand, because a firm's employees are no longer physically together, the need to coordinate activities might lead to less flexibility of hours because of the increased difficulty of coordination.

All the research on the impact of telework appears to assume that workers are either at the workplace on a given day or not (and presumably at home). For each of the work activities included in the ATUS (and used above to measure the amount of work performed at each hour of the day), the ATUS also indicates where the episode of work was located physically. This included the workplace, home, and a wide variety of miscellaneous locations (e.g., bars, coffee shops, in an automobile), which we aggregate as other locations. In constructing the measure of telework, if the worker performed any work at home in a 60-minute interval (e.g., 2:31PM-3:30 PM, hour 15 of the day), we treat that hour as indicating telework. If no work was performed from home in the hour, but some was performed at the workplace, the rest somewhere else, we treat the hour as having been spent at the workplace.[30]

As in most of the discussion above, we examine only weekday work hours. The top panel of Table 1 shows the average number of hours worked (the sum of the L'_t used above) by all workers in the ATUS pre-Covid and then separately for each post-Covid year. Except for 2021, the average numbers of hours worked that are implied by our calculations of working at each hour of the day are within 0.5 standard deviations of the average from 2003-19. More important, the calculations show the expected jump in $\sum h_t$, hours of work at home on an average weekday, with the total tapering off between 2021 and 2023 but remaining much higher than before the pandemic. By the end of this period more than 20 percent of all work time still occurred at home.

Since the pandemic particularly removed white-collar workers from their workplaces, the bottom panel of Table 1 presents the same information for people with at least a college degree. As expected, the share of telework rose more among them than among all workers, so that in 2021 46 percent of all work

[30] This is a fine point, since less than 5 percent of work episodes in the ATUS occurred at two different places.

was from home. By 2023 this share had diminished, but remained far above the pre-Covid share and far above the share among all workers.

Figure 12 shows the estimates of coefficients on indicators of the post-Covid period in our sample (2021-23) from a set of 24 regressions of L'(t) (of 24 regressions of h(t)) on the same covariates as in the regressions discussed in Section V, and including a linear trend term as in those estimates. Each regression also includes a measure of the average of $\sum L^{'}(t)$ in the year (of $\sum h_t$ in the year). The coefficients thus essentially are separate intercepts for the post-Covid years describing work time at each hour. The estimates for all work show that, even accounting for the trends shown in Section V, there was an additional fillip to total work during the daytime hours, along with relative reductions in work in the evenings and at nights. The crucial point to note is that, as implied in the previous sections, the distribution of the $L^{'}_{t}$ post-Covid was more compressed into prime working hours than it had been before the pandemic. The compression was roughly the same among college graduates and other workers.

With the huge increases in the amount of work performed at home, it is unsurprising that home work increased at each hour of the day (as demonstrated if $\sum h_t$ is not included in the equations). With its inclusion, however, as the coefficients on the post-Covid indicator for home work by all workers, and by college graduates show, the distribution of work at home became more concentrated in prime hours, having shifted relatively away from work outside prime hours. This relative shift in the distribution of work at home was especially pronounced among college graduates. Overall, the estimates provide no evidence that workers used the freedom of being at home to spread their work schedules more evenly. Indeed, they performed a greater share of their work at home more during daytime hours than before, suggesting the importance of coordination with co-workers when not at the workplace and perhaps too the role of coordinating leisure with family and friends. This was especially true for college grads, although they did do relatively more of their total work late into the night (9:31-1:30).

IX. Other Examples: The United Kingdom and France

The results for the U.S. document a remarkable set of trends in work timing, suggesting a continuing movement to more desirable times of day. We have argued that this implicit enhancement of workers' welfare has chiefly resulted from workers' using their greater full incomes to "purchase" schedules that yield greater well-being. The U.S. is, however, only one "laboratory" in which to examine the phenomenon of the changing timing of work. Regrettably, no other country has so long, so large, and so nearly continuous sets of cross-section data that allow comparison to another "laboratory." The U.K. and France do, however, provide discontinuous time-diary surveys covering at least 40 years and having sufficient sample sizes to allow useful comparisons even at times when few people are working, with episode data available from the Multinational Time Use Study (https://www.timeuse.org/mtus).

A. The U.K., 1974-2015

In 1974-75, 1983-84, 1987, 2000-01, and 2014-15 various organizations fielded large-scale time-use surveys (complete daily diaries). Daily rosters of time spent in large numbers of activities are readily available. These are like those from the ATUS used above, except that each episode must begin at a five-minute point (e.g., 1:35, 12:05) rather than having a variable start and stop time. We treat as an episode of work any ten-minute interval in which the diarist is listed as having "meals at work," in "travel as part of work, work breaks, or other time at workplace," or in paid work, either at the workplace or at home. (Paid work accounts for 74 percent of these intervals and a much greater percentage of the total time classified as work.) As in both U.S. datasets, we use only weekdays and only work on the main job. The five surveys contain 6,502, 2,465, 4,399, 4,203, and 3,007 usable observations on workers respectively.

The cross-section patterns are unsurprisingly very much like those in the U.S., although on average somewhat lower at off-peak hours than in the CPS and higher than in the ATUS. Figure 13 is constructed similarly to Figures 5, with the changes here calculated from base period 1974-75. There is evidence of a decline in the (small) fraction of employees at work during nighttime hours, Midnight-5AM, and a rise from 6AM-8AM, just as we found for the U.S. Contrary to the U.S., there is strong evidence of a rise in the fraction of employees working in the late afternoon and evening hours, 6PM–11PM.

The time-use data files contain information on several demographic determinants, but none on the industry where an employee works. We thus cannot perform the same decompositions on these data as in

Section V. Estimating regressions of the probability of working at each hour on a time trend (year of the survey) and a broad set of controls does not alter the inferences.

Two institutional developments in the U.K. during the period covered by the data may help explain the differences between trends in work timing in the U.K. and U.S. The first is the sharper trend toward de-unionization in the U.K. We cannot account for this in the U.K. time-use datasets, since they provide no information on union status. We do know, however, that union membership in the U.K. fell from 53 percent in 1974 to just 27 percent in 1999 (Pencavel, 2004), and from 32 percent in 1995 to 25 percent in 2014 (as reported in https://www.statista.com/statistics/287232/uk-trade-union-density/). These levels and declines contrast with the much lesser extent of unionization in the U.S. and its much smaller decline between 1973 and 2023, from 25 to 11 percent membership.

No micro household data on unionization are available early in the U.K. Labor Force Survey (LFS), so we cannot examine whether at its heyday at the start of the period 1974-2014 union work at night paid a premium compared to nonunion work. We can, however, examine the extent to which union jobs offered higher shift premia using the Labor Force Survey 2008, estimating log-earnings regressions with the usual demographic controls, two-digit industry and regional indicators, a quadratic in workhours, and indicators of union status, of night work, and, the crucial measure, an interaction of union status and night work. The estimates of these last three parameters over the sample of 13,423 workers were 0.072 (s.e.=0.010), -0.135 (s.e.=0.033), and 0.100 (s.e.=0.045) respectively.

How much would night work have dropped if unionization had not fallen? Working at nights in unionized establishments yielded a pay premium over similar non-union work by otherwise identical individuals of about 10 percent in the LFS data. The data on unionization show a decline of roughly 0.23 in the fraction unionized nationwide. As a back-of-the-envelope calculation, assume that the relative price elasticity of demand for night work versus work at other times of the day is -1. If that were true, coupling the union nighttime wage premium with the decline in unionization in the U.K., night work would have dropped by about 2 percentage points in the U.K. between 1974 and 2015, about the size of the actual drop that occurred in the U.S. (Figure 4).[31] (Obviously, if the cross-wage elasticity were smaller, the simulated drop in nighttime work implied by the time-diary data would have been smaller.)

A second possible cause is the repeal in 1994 of a law that required retail stores in England and Wales to close at 8PM on all but one day of the week.[32] In 1997, Tesco, the U.K.'s largest retailer, opened its first 24-hour outlet, and it operated over 300 such outlets by the mid-2010s, with other major U.K. retail chains following suit. Interestingly, as in the U.S., U.K. retailers began to cut back on 24-hour operation in the late 2010s, although they continued the practice of late night/early morning restocking (Nazir, 2021).

Yet a third institutional change during this period was the enactment of a national minimum wage, effective April 1999, which started at about 50 percent of average wages. To the extent that it raised the cost of an hour of work compared to the cost of an employee, it would have reduced workhours. Why this might in turn have caused work time to spread out of the day is unclear, however.

B. France, 1966-2010

At various times France too has fielded large-scale time-diary surveys. Episode data are available from 1966, 1985, 1998, and 2010, with information on time use on 1,329, 6,650, 5,028, and 6,699 days that included some work time. Defining work as the same categories used in Sub-section A shows that 72 percent of the episodes so classified involved work on the main job (and included much more than that percentage of the time classified as work). Episodes could begin at any time of the day. As in the U.K., the diurnal pattern of work time looks very similar to that in the U.S., but with one notable and remarkable exception: In 1966 and to a lesser extent in 1985, there was a sharp drop in the fraction of workers who were working in the hour 12:31PM-1:30PM. This reflects the then widely-practiced custom of eating a major meal at home with family.

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[31] Unison (2021, p. 33) offers an example of a major British union contract specifying detailed and substantial night pay premia.

[32] The relevant portion of the legislation is at https://www.legislation.gov.uk/ukpga/Geo6/14/28/section/2/1991-02-01. Jacobson and Kooreman (2005) demonstrate that removing limits on retail opening hours in the Netherlands generated temporal shifts in the timing of consumer demand.

Figure 14 presents the single-differences from 1966 of the fractions of workers at work at each hour of the day. The crucial change driving these patters was the gradual decline in the custom of having a midday meal at home. While the custom did not disappear entirely, by 2010 79 percent of workers reported being on the job between 12:31PM and 1:30PM, compared to only 39 percent in 1966; and much of this change had already occurred by 1985.[33] In addition to this mechanical adjustment in the distribution of work timing, however, there was a substantial compression of the workday. Work at the fringes of the workday, at 7AM and 8AM, and 6PM and 7PM, diminished, while work increased around Noon and from 2PM to 4PM. While the decline in night work looks small, as a percentage of the amount of night work occurring in 1966 it was substantial. In short, the French gave up the custom of a midday meal at home, but got a more concentrated workday in exchange and obtained more time away from work at the times that we noted in the U.S. results as being inferior.

X. Conclusion

We have demonstrated a fifty-year trend toward a decreasing fraction of work time in the U.S. being performed at night, say between 10PM and 4AM, with an increased fraction now performed in "usual" daytime hours. The trend has been associated with the increased education of the work force and with the decline in the size of the youth labor force. These changes are consistent with night work being a disamenity, one that workers avoid as their full earnings increase; and they suggest that changes in technology, at least at the level of aggregated industries, have not had much effect on these trends. The exception to these trends is in retail, where demonstrable technical changes have increased the relative productivity of work at night and in the early morning. The same aggregate trends are observed in France, but they do not appear in the U.K., we believe because of the rapid de-unionization of the U.K. labor market and because of the adoption of the newer technology in retail.

Twelve percent of all American employees in 2022-23 reported working at least one hour between 10:30PM and 5:30AM on weekdays, i.e., engaging in what most people would view as nighttime work.

[33] Eating lunch in one's "workspace" has been nominally illegal in France since the early 1900s (Bruegel, 2023). Since the 1960s, however, larger employers have had to provide a cafeteria for workers wishing to remain on site.

While well below what it had been in the 1970s, and below what it was between the 1970s and 2020s, this figure still suggests that many workers are on the job at times that most workers view as undesirable. Evidence of the increasing undesirability of such work is its increased concentration among lower-skilled workers and the need for employers now to pay an increased wage premium for it.

The trend toward greater temporal concentration of work in the U.S. was not halted by the huge growth in telework occasioned by the Covid pandemic. Indeed, if anything that trend accelerated; and the especially large increase in telework among more educated workers was associated with a greater concentration of their teleworking time in prime hours than among all workers.

Despite having demonstrated both "what" has happened to work time in the U.S. and "why" it occurred, our findings leave unanswered several interesting questions. These include: 1) What are the welfare effects of the changes to work timing in the U.S.? 2) Does the market response of a higher wage premium for the undesirable night work mitigate arguments in favor of providing government or collectively bargained mandated higher pay for such work? 3) Can the strikingly different results for the U.K. be explained rather than just described?

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Table 1. Hours of Work Time Per Day, Pre- and Post-Covid, ATUS 2003-23
(Means and Their Standard Errors)

	2003-19	2021	2022	2023
		All Workers		
$\sum L'_t$	9.779	9.951	9.757	9.796
	(0.013)	(0.060)	(0.059)	(0.059)
$\sum h_t$	0.616	2.898	2.471	2.228
	(0.010)	(0.103)	(0.100)	(0.096)
		College Graduates		
$\sum L'_t$	9.953	10.167	9.837	9.783
	(0.021)	(0.081)	(0.081)	(0.082)
$\sum h_t$	1.091	4.693	3.995	3.430
	(0.019)	(0.158)	(0.153)	(0.096)

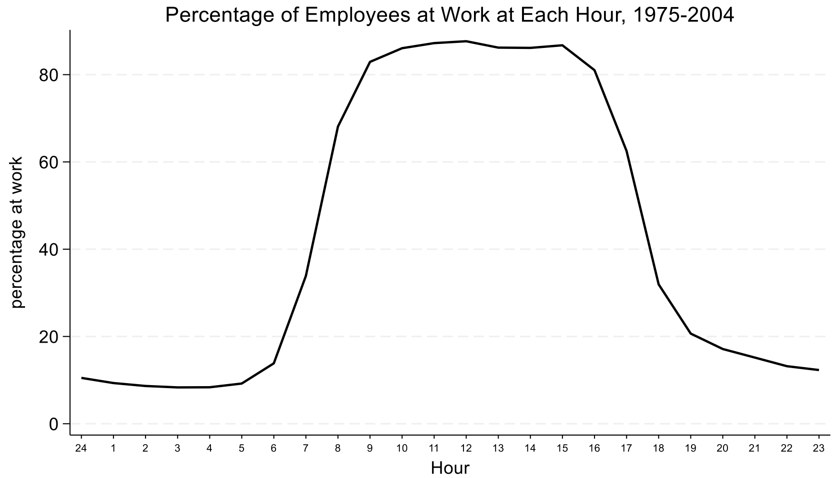


Figure 1A. Percentage of Employees at Work, CPS 1973-2004

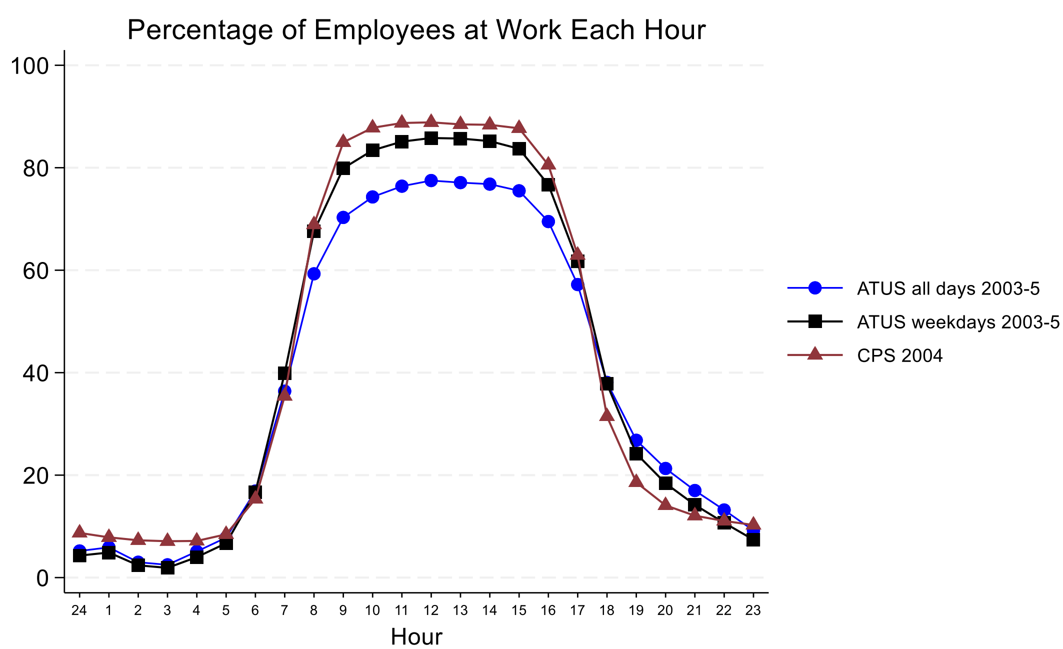


Figure 1B. Percentage of Employees at Work, CPS and ATUS around 2004

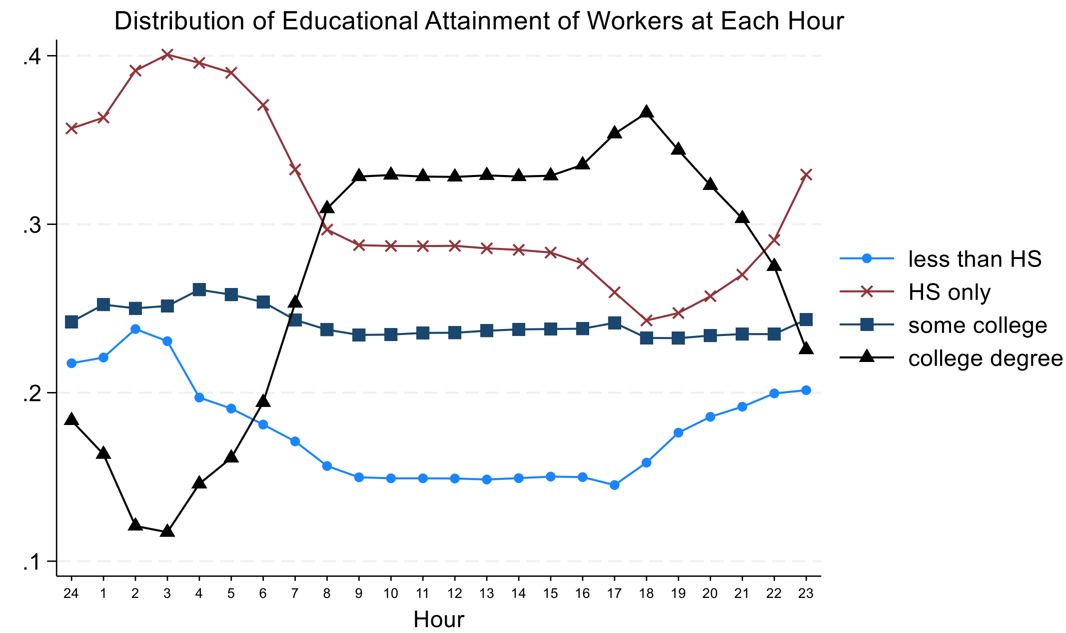


Figure 2. Educational Attainment of Employees at Each Hour, CPS 1973-2004 and ATUS 2003-23

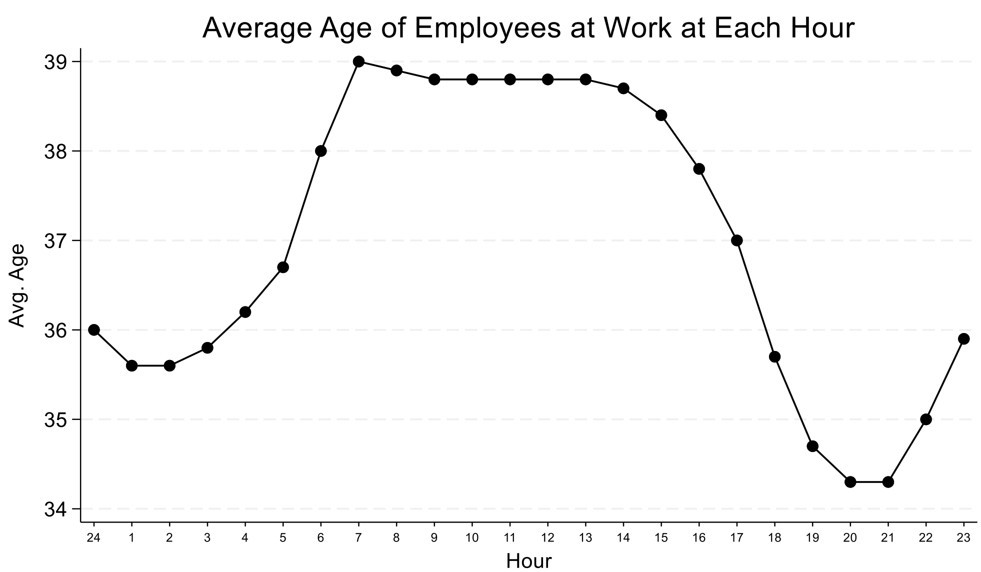


Figure 3. Average Age of Employees at Each Hour, CPS 1973-2004 and ATUS 2003-23

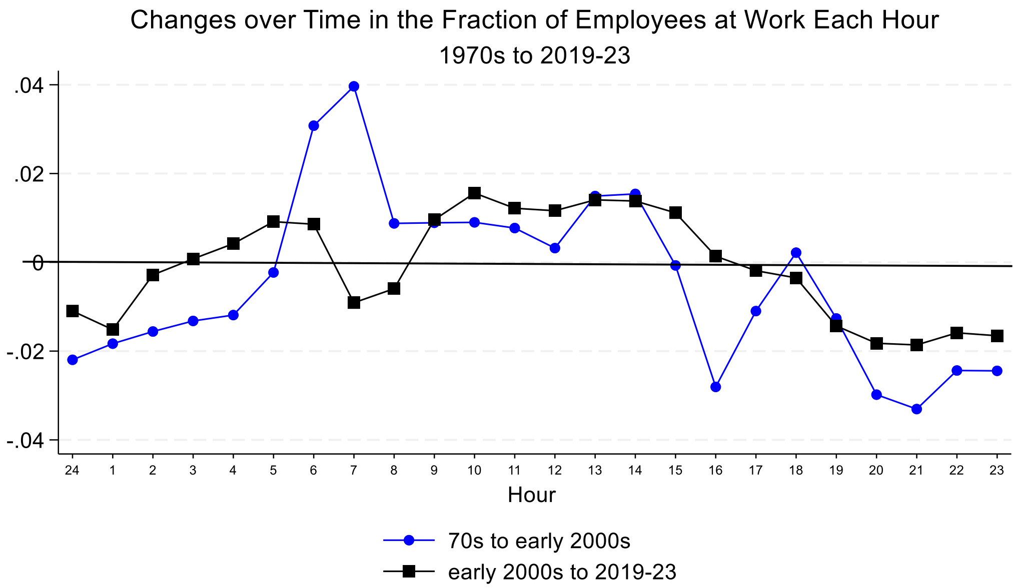
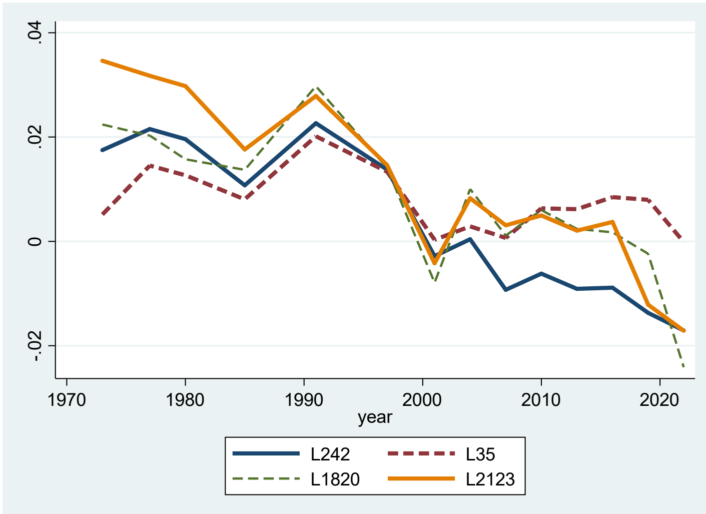
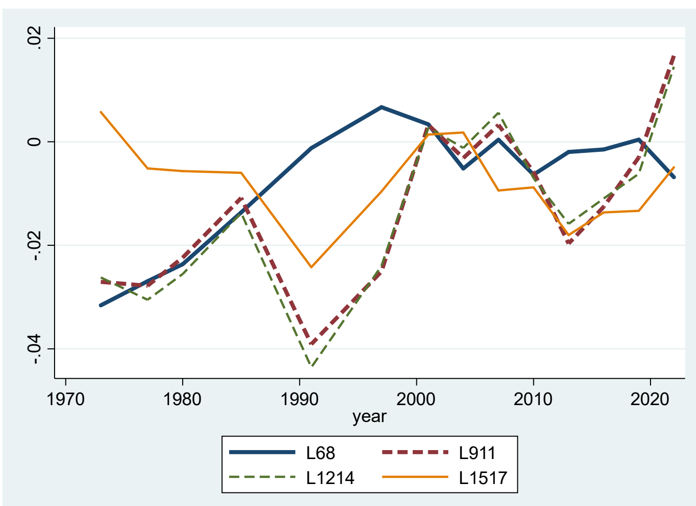


Figure 4. Changes in the Fraction of Workers on the Job at Each Hour, 1973-2023



A. Change from 2004 in Fraction of Employees at Work at Off-peak Hours



B. Change from 2004 in Fraction of Employees at Work at Peak Hours

Figure 5. Weekdays 1973-2023, Changes from 2004 in the Fraction of Employees on the Job

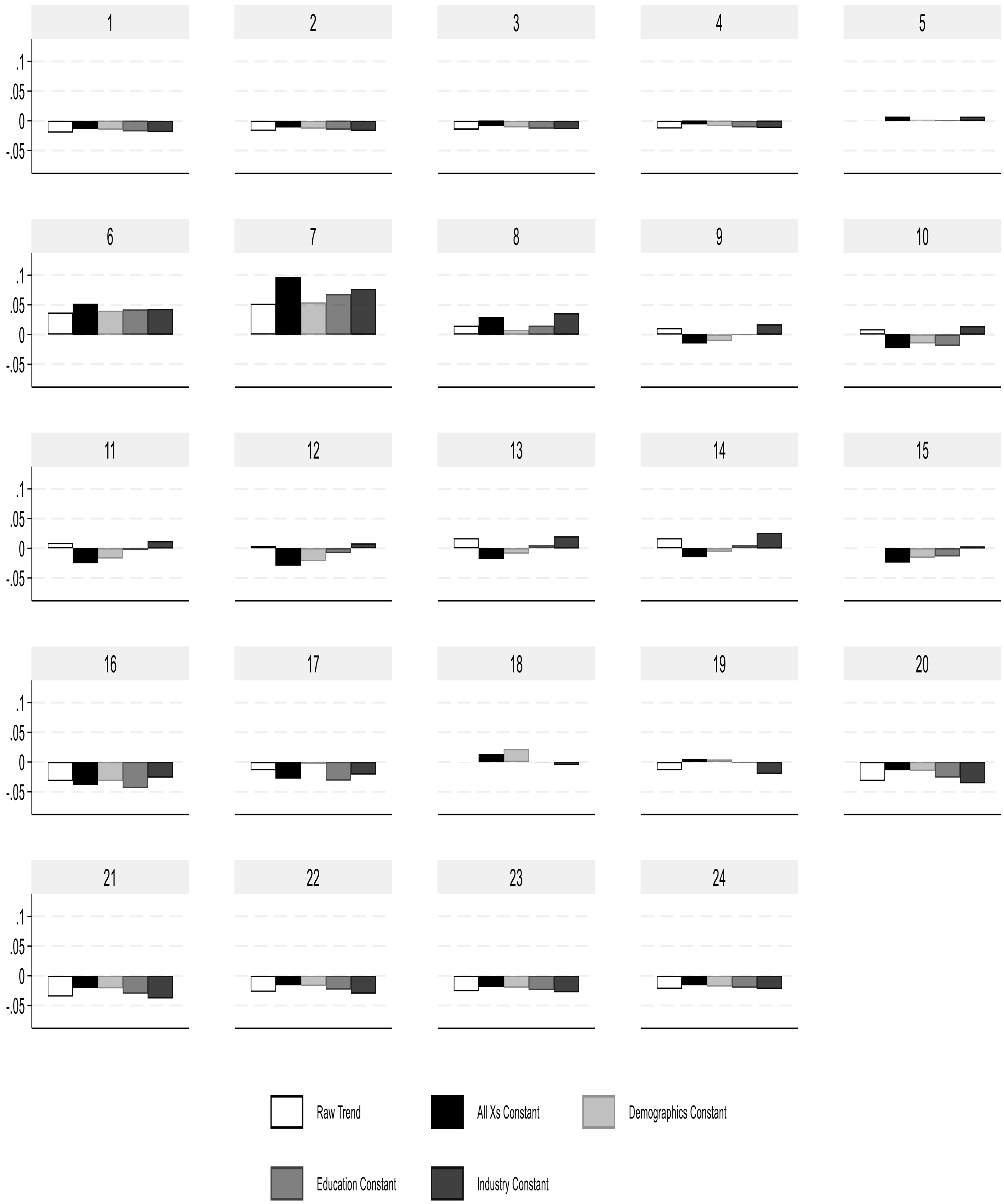


Figure 6. Raw Trends in the Fractions of Employees at Work at Each Hour of the Day and Their Decompositions, 1973-2004.

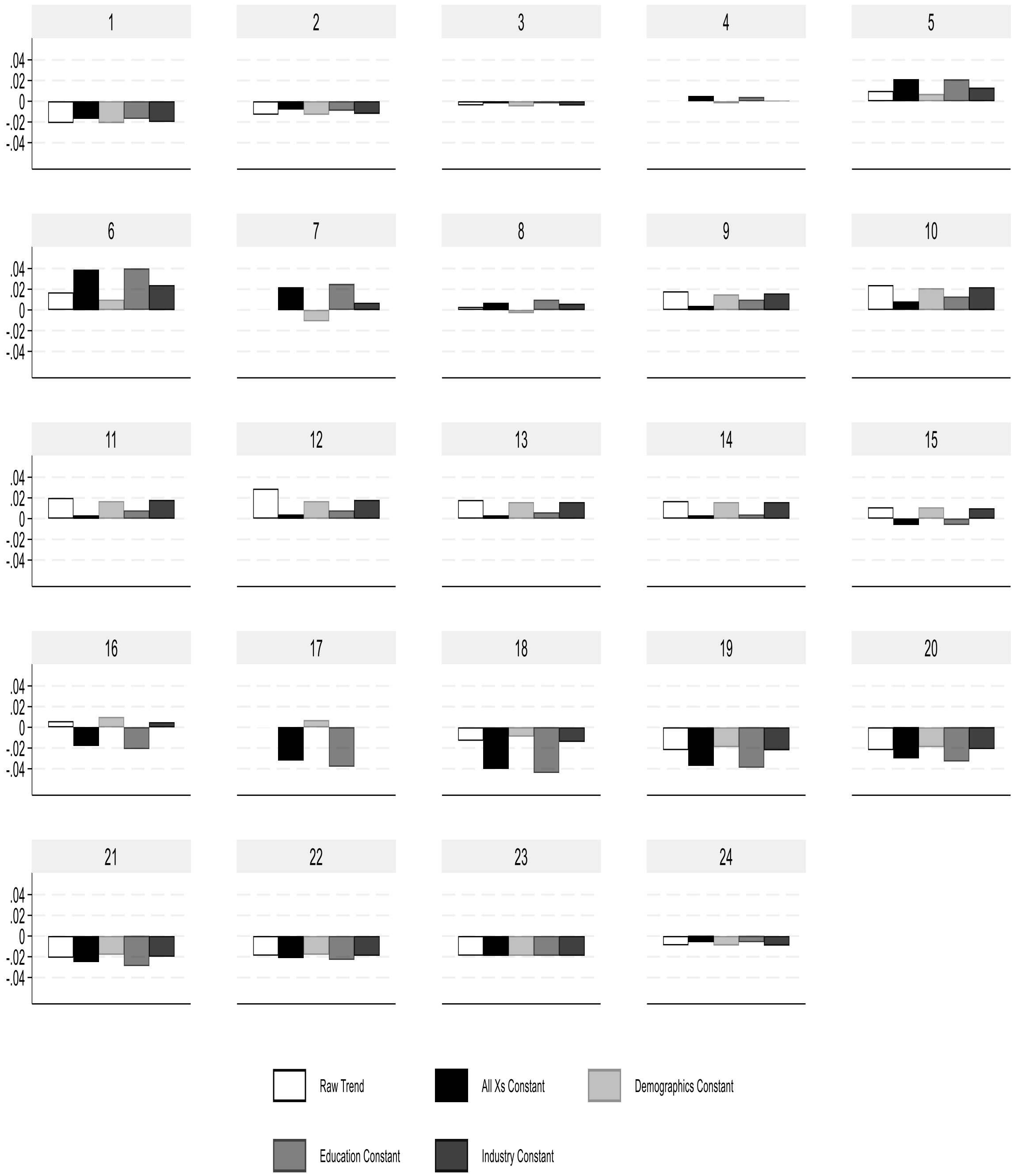


Figure 7. Raw Trends in the Fractions of Employees at Work at Each Hour of the Day and Their Decompositions, 2003-23

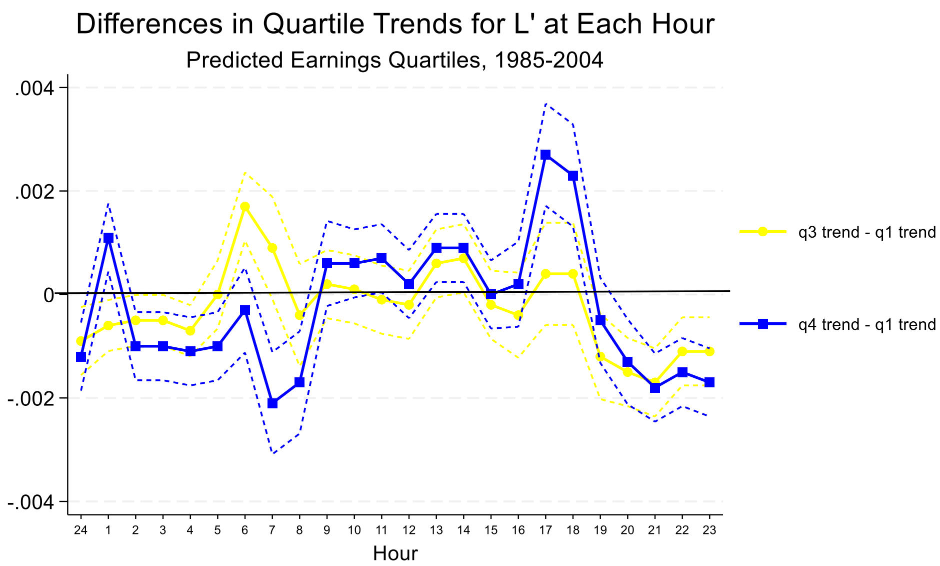


Figure 8A. Differences in Trends in the Fraction of Employees at Each Predicted Earnings Quartiles at Each Hour, 1985-2004

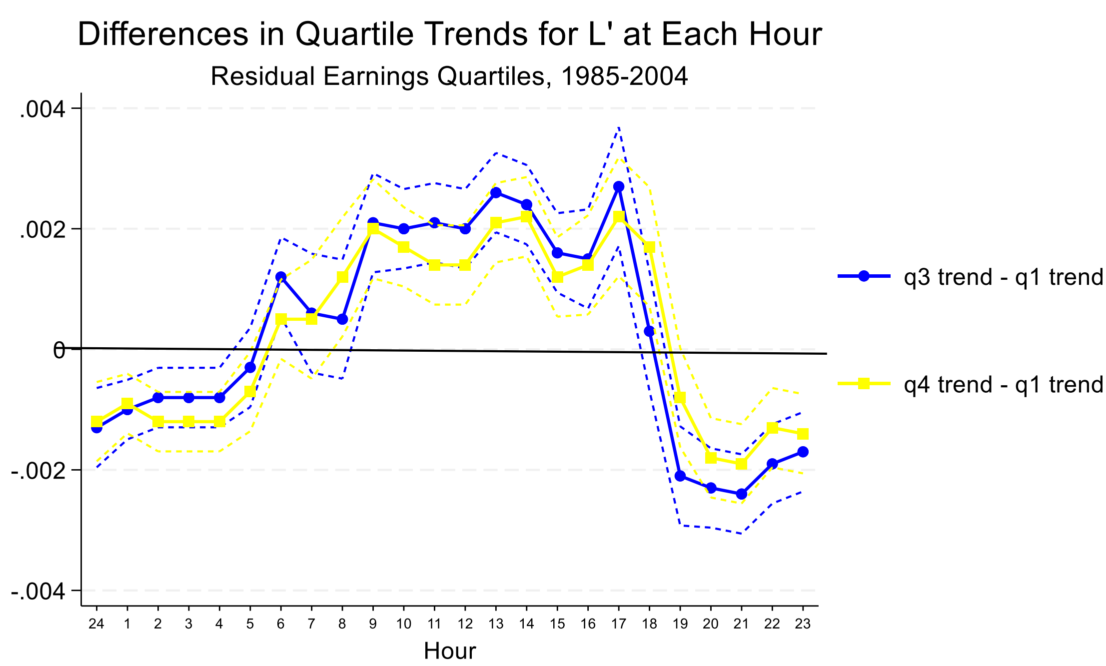


Figure 8B. Differences in Trends in the Fraction of Employees at Each Residual Earnings Quartiles at Each Hour, 1985-2004

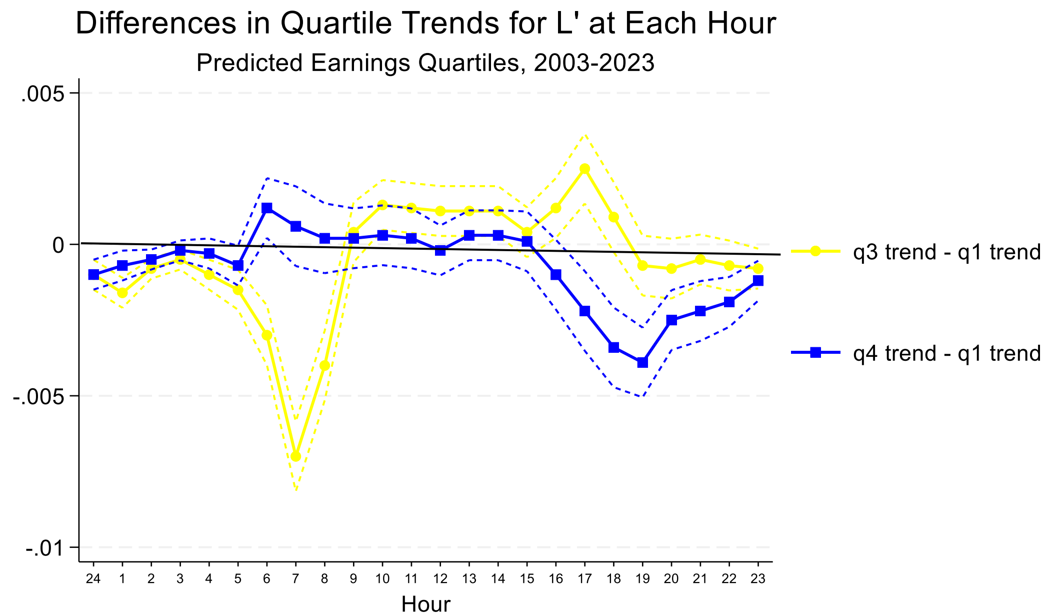


Figure 9A. Differences in Trends in the Fraction of Employees at Predicted Earnings Quartiles at Each Hour, 2003-23

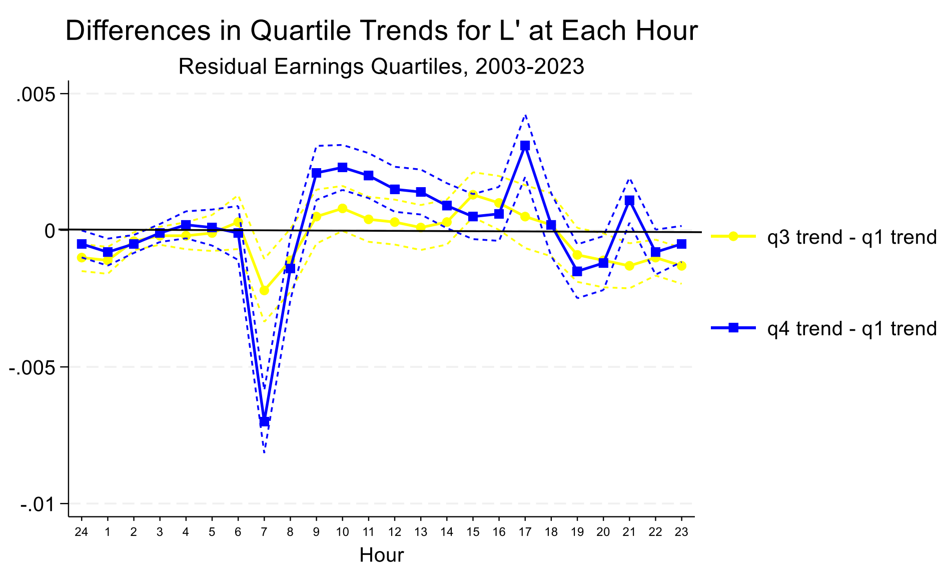


Figure 9B. Differences in Trends in the Fraction of Employees at Residual Earnings Quartiles at Each Hour, 2003-23

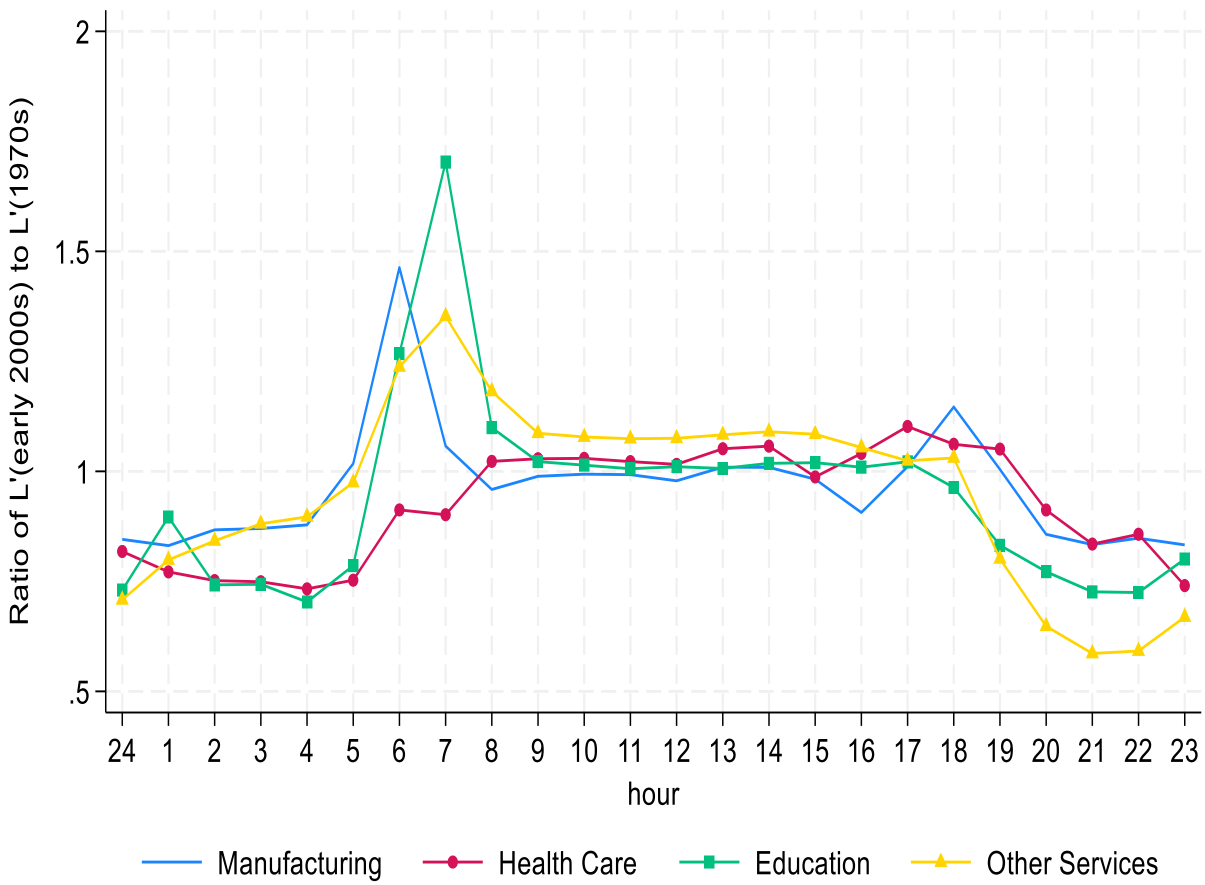


Figure 10. Changes in Work Timing at Each Hour, 1970s to Early 2000s, Four Industries

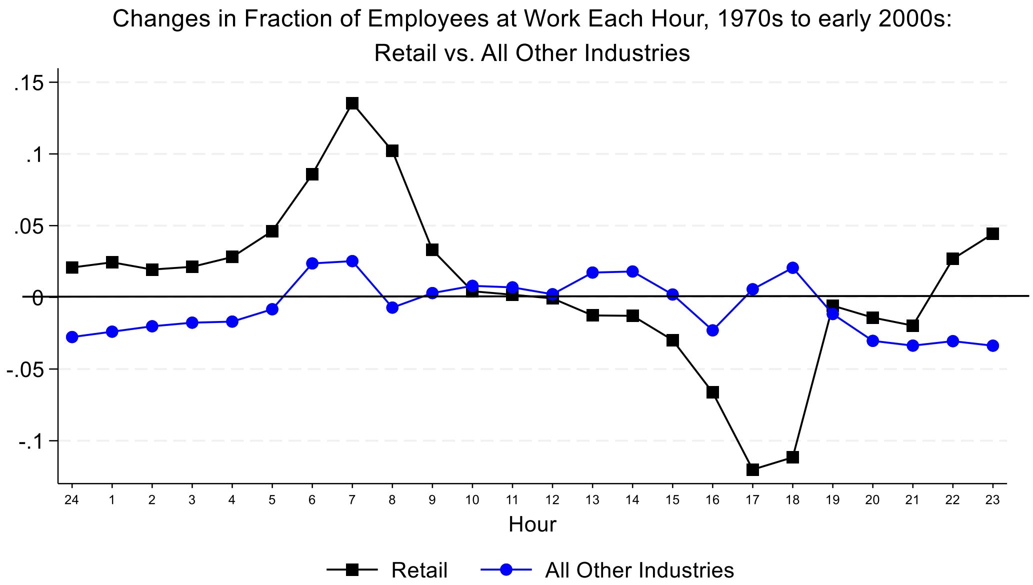


Figure 11A. Changes in the Percentage of Workers on the Job at Each Hour, Retail vs. Other Industries, 1973-2004

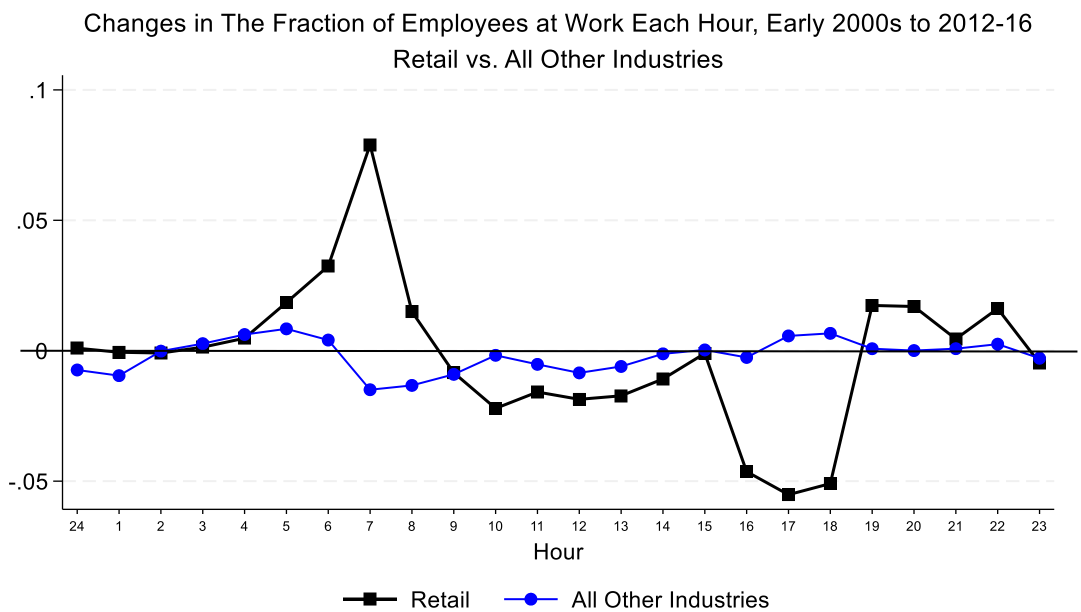


Figure 11B. Changes in the Percentage of Workers on the Job at Each Hour, Retail vs. Other Industries, 2003-2016

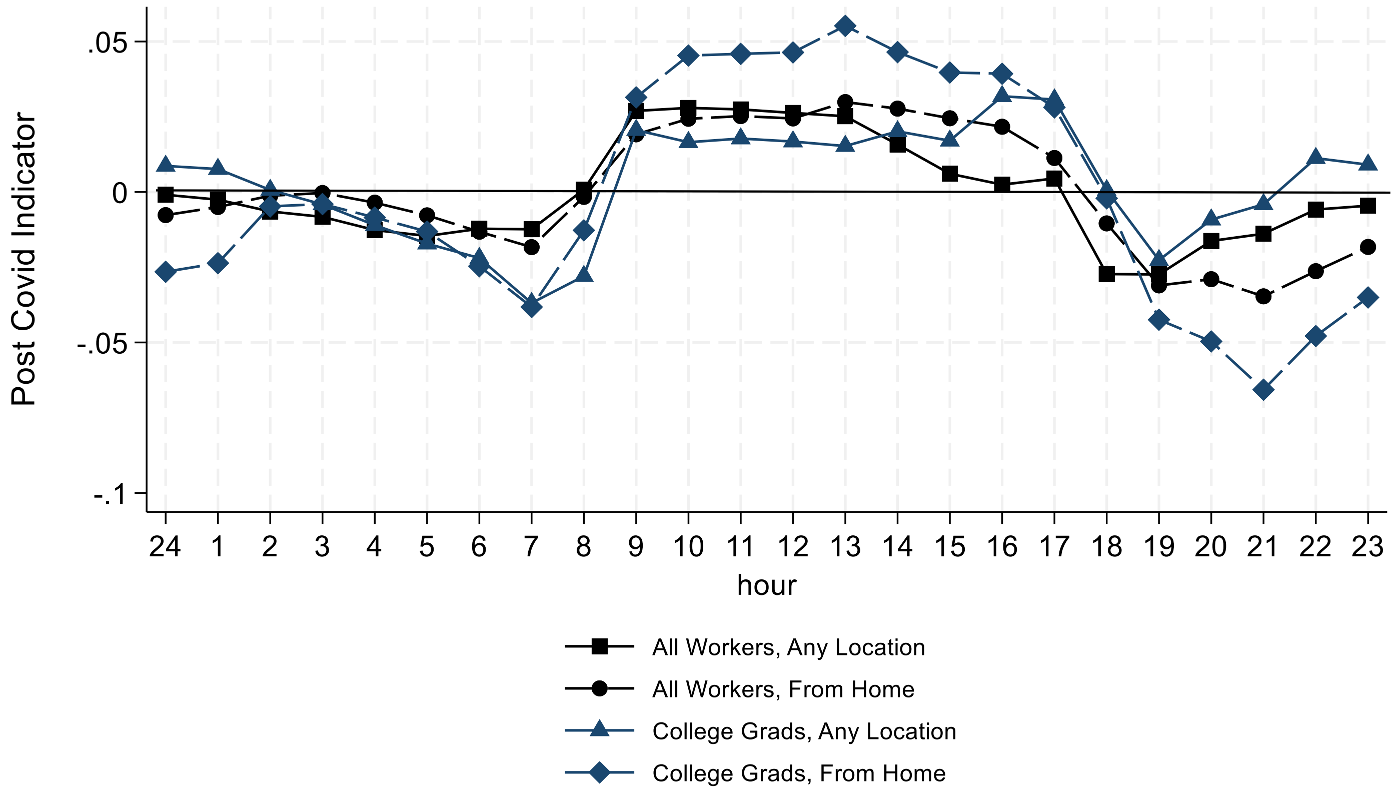


Figure 12. Single-differences of All Work (Work at Home) at Each Hour, All Workers or College Grads, Post- - pre-Covid, Adjusted for Covariates and Total Work Time (Home Work Total Time), ATUS 2003-2023

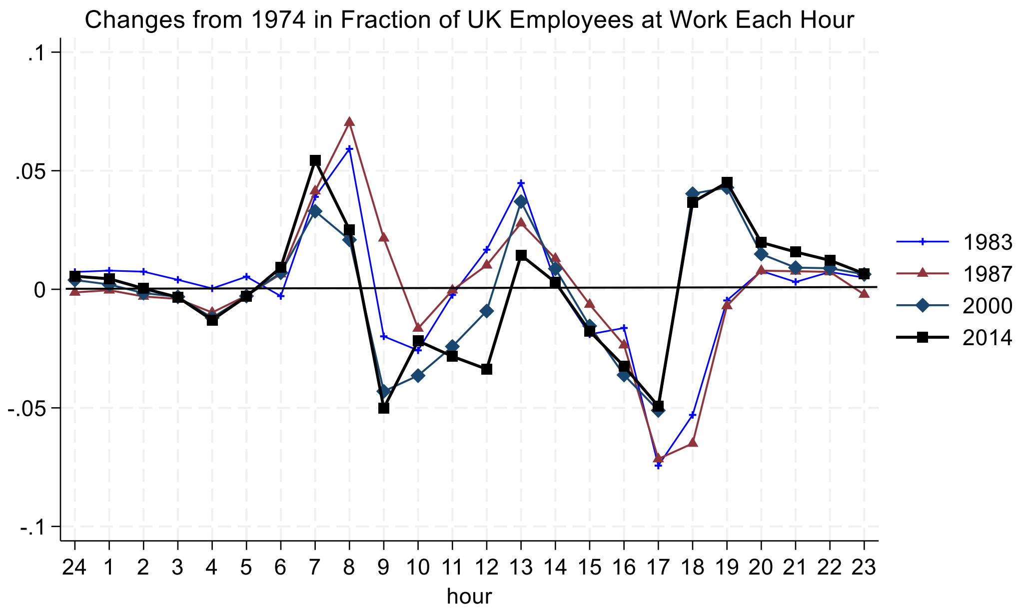


Figure 13. Change in the Fraction of Employees at Work at Each Hour, U.K., Compared to 1974.

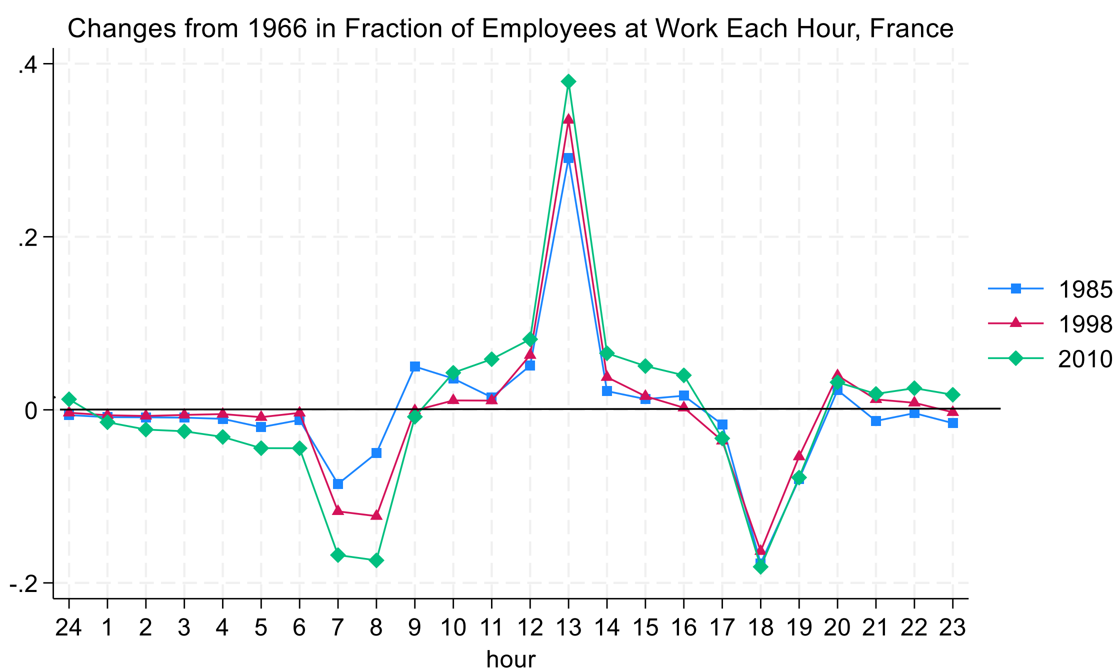


Figure 14. Change in the Fraction of Employees at Work at Each Hour, France, Compared to 1966.

Appendix Table A1: Decompositions: Implied 30-year Change in Percent of Employees on the Job at Each Hour, Unconditional and Conditional, 1973-2004 CPS, 14 Industry Classifications

Hour	(1) Mean	(2) Raw trend x 30	(3) All Xs constant (conditional trend x 30)	(4) Demographics constant	(5) Education constant	(6) Industry mix constant
24	0.105	-0.022	-0.016	-0.018	-0.020	-0.022
1	0.092	-0.020	-0.013	-0.015	-0.018	-0.019
2	0.085	-0.017	-0.011	-0.013	-0.015	-0.017
3	0.082	-0.015	-0.009	-0.011	-0.013	-0.014
4	0.083	-0.013	-0.006	-0.009	-0.011	-0.012
5	0.091	-0.002	0.007	0.002	0.001	0.007
6	0.137	0.037	0.052	0.040	0.042	0.043
7	0.336	0.052	0.097	0.054	0.068	0.077
8	0.683	0.015	0.029	0.008	0.015	0.036
9	0.828	0.011	-0.015	-0.011	0.001	0.017
10	0.859	0.009	-0.023	-0.015	-0.019	0.014
11	0.870	0.009	-0.025	-0.017	-0.003	0.012
12	0.875	0.004	-0.029	-0.022	-0.008	0.008
13	0.860	0.017	-0.018	-0.009	0.005	0.020
14	0.859	0.017	-0.015	-0.006	0.005	0.026
15	0.865	-0.002	-0.024	-0.016	-0.014	0.003
16	0.811	-0.032	-0.038	-0.032	-0.044	-0.026
17	0.627	-0.014	-0.028	-0.003	-0.031	-0.021
18	0.320	0.002	0.013	0.022	0.0001	-0.005
19	0.207	-0.014	0.004	0.004	-0.001	-0.020
20	0.172	-0.032	-0.014	-0.015	-0.026	-0.036
21	0.153	-0.035	-0.020	-0.021	-0.030	-0.038
22	0.132	-0.027	-0.016	-0.017	-0.023	-0.030
23	0.123	-0.026	-0.019	-0.020	-0.024	-0.028

All trend coefficients underlying Columns (2) (raw) and (3) (conditional) are statistically significant at conventional levels, except those in Column (2) at hours 5, 15, and 18.

Appendix Table A2: Decompositions: Implied 20-year Change in Percentage of Employees on the Job at Each Hour, Unconditional and Conditional, ATUS, 2003-23, 14 Industry Classifications

Hour	Mean	Raw trend x 20	All Xs constant (conditional trend x 20)	Demographics constant	Education constant	Industry mix constant
24	0.039	-0.009	-0.006	-0.009	-0.006	-0.009
1	0.043	-0.021	-0.017	-0.021	-0.017	-0.020
2	0.022	-0.013	-0.008	-0.013	-0.009	-0.012
3	0.018	-0.004	-0.002	-0.005	-0.002	-0.004
4	0.042	-0.001	0.005	-0.002	0.004	0.0004
5	0.076	0.010	0.021	0.007	0.021	0.013
6	0.180	0.017	0.039	0.010	0.040	0.024
7	0.415	-0.001	0.022	-0.011	0.025	0.007
8	0.702	0.003	0.007	-0.003	0.010	0.006
9	0.832	0.018	0.004	0.015	0.010	0.016
10	0.871	0.024	0.008	0.021	0.013	0.022
11	0.886	0.020	0.003	0.017	0.008	0.018
12	0.894	0.029	0.004	0.017	0.008	0.018
13	0.892	0.018	0.003	0.016	0.006	0.016
14	0.888	0.017	0.003	0.016	0.004	0.016
15	0.867	0.011	-0.006	0.011	-0.006	0.010
16	0.792	0.006	-0.018	0.010	-0.021	0.005`
17	0.634	0.001	-0.032	0.007	-0.038	0.000
18	0.382	-0.013	-0.040	-0.009	-0.044	-0.014
19	0.245	-0.022	-0.037	-0.019	-0.039	-0.022
20	0.185	-0.022	-0.030	-0.019	-0.033	-0.021
21	0.144	-0.021	-0.025	-0.018	-0.029	-0.020
22	0.107	-0.019	-0.021	-0.018	-0.023	-0.019
23	0.070	-0.019	-0.019	-0.019	-0.019	-0.019

All trend coefficients underlying Columns (2) (raw) and (3) (conditional) are statistically significant at conventional levels, except those in Column (2) at hours 7, 8, 16, and 17; and Column (3) at hours 3, 4 and 8-15.

Appendix Table A3: Decompositions: Implied 30-year Change in Percent of Employees on the Job at Each Hour, Unconditional and Conditional, 1973-2004 CPS, 38 Industry Classifications

Hour	(1) Mean	(2) Raw trend x 30	(3) All Xs constant (conditional trend x 30)	(4) Demographics constant	(5) Education constant	(6) Industry mix constant
24	0.105	-0.022	-0.012	-0.018	-0.021	-0.017
1	0.092	-0.019	-0.009	-0.016	-0.018	-0.014
2	0.085	-0.017	-0.008	-0.014	-0.016	-0.012
3	0.082	-0.015	-0.005	-0.011	-0.014	-0.010
4	0.083	-0.013	-0.003	-0.009	-0.012	-0.008
5	0.091	-0.002	0.0102	0.002	0.0004	0.004
6	0.137	0.036	0.055	0.039	0.042	0.047
7	0.336	0.051	0.101	0.054	0.066	0.083
8	0.683	0.015	0.026	0.009	0.014	0.032
9	0.828	0.011	-0.021	-0.009	0.001	0.009
10	0.859	0.009	-0.028	-0.015	-0.002	0.006
11	0.87	0.008	-0.030	-0.016	-0.003	0.005
12	0.875	0.003	-0.034	-0.021	-0.008	0.0005
13	0.86	0.016	-0.024	-0.008	0.005	0.012
14	0.859	0.017	-0.020	-0.004	0.005	0.013
15	0.865	-0.002	-0.029	-0.015	-0.013	-0.005
16	0.811	-0.032	-0.047	-0.032	-0.043	-0.035
17	0.627	-0.014	-0.037	-0.005	-0.029	-0.031
18	0.32	0.001	0.015	0.021	-0.001	-0.003
19	0.207	-0.014	0.008	0.004	-0.010	-0.014
20	0.172	-0.032	-0.009	-0.016	-0.027	-0.030
21	0.153	-0.035	-0.015	-0.022	-0.031	-0.032
22	0.132	-0.027	-0.011	-0.018	-0.024	-0.023
23	0.123	-0.026	-0.013	-0.021	-0.024	-0.021

All trend coefficients underlying Columns (2) (raw) and (3) (conditional) are statistically significant at conventional levels, except those in Column (2) at hours 5, 15, and 18.