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ABSTRACT

Adjusting Labor along the Intensive MarginS*

We expand the analysis of cyclical changes in labor demand by decomposing changes along the intensive margin into those in days/week and in hours/day. Using large cross sections of U.S. data, 1985-2018, we observe around ¼ of the adjustment in weekly hours occurring through changing days/week. There is no adjustment of days/week in manufacturing; but 1/3 of the adjustment outside manufacturing occurs through days/week. The desirability of bunched leisure implies that secular shifts away from manufacturing have contributed to increasing economic welfare.

JEL Classification: J23, E24, J21

Keywords: days, labor demand, work hours, recessions

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I. Introduction

When there is a shock to labor demand, employers may respond along the extensive margin—by changing the number of workers (employment), and/or along the intensive margin—by changing the amount of labor time required of workers (typically measured as hours per worker). In reality, however, decisions about the intensive margin consist of at least two distinct choices: 1) How many days per week will the representative worker be employed; and 2) How many hours will s/he be required to work on the typical day. These choices cannot necessarily be aggregated into the single choice of hours per week, since one can readily imagine that the costs of changing days or changing hours per worker differ across firms, over a business cycle, and vary secularly.

A hoary literature has examined how firms alter their labor input in response to shocks along the extensive and intensive margins, going back to studies by Nadiri and Rosen (1969), Sargent (1978), Shapiro (1986) and Rossana (1990). The conventional wisdom by the 1990s was that perhaps ¾ of the adjustment of labor inputs by the typical American employer was along the extensive margin (Cho and Cooley, 1994), which international evidence suggests may not have changed since then (Wesselbaum, 2016). The focus of the literature on the adjustment of labor inputs along different margins has switched to examining the structure of the costs of adjustment, often using plant- or firm-level data (Hamermesh, 1989; with Nakata and Takehiro, 2003; and Mathä et al., 2021, being a few more recent subsequent examples), and to consideration of adjustment in general equilibrium search models (e.g., Trapeznikova, 2017).

The restriction of research on labor adjustment to the single intensive margin, hours per time period (typically a week), is the result of the availability of data: The U.S. and many other countries provide monthly data on this measure, making it easy for researchers to examine its temporal variation (along with that of employment). Data that would allow examining more than one intensive margin are generally unavailable; but at a few times the U.S. produced nationally representative samples that included information on both workers' days per week and their weekly hours, allowing us to examine adjustment along these two intensive margins. We do so in what follows, first introducing the data, then examining aggregate adjustment, and then estimating differences in the relative importance of the intensive margins across industries and considering reasons for them. The result is the first set of facts decomposing labor adjustment into movements along separate intensive margins.[1]

Aside from understanding how labor demand responds to shocks, this additional decomposition is important for considering the welfare implications of macroeconomic changes. We are essentially dealing with scheduling—how employers allocate the time of a given number of employees during some time period.[2] A 20-percent reduction in time spent working in response to a negative demand shock could occur, as extreme examples, through a cut of 1.6 hours per day for each worker remaining employed or by a cut of one work day per week on a five-day workweek for each remaining worker. It seems likely that workers are not indifferent between these two equal reductions in work time. If so, changes in industrial structure will alter workers' welfare to the extent that they change the relative importance of adjustment costs along these two dimensions.

II. Data and Description

The total flow of labor inputs is conventionally written as:

(1a) $L = L(E, H)$,

where E is the number of workers and H their hours per time period (typically a week) (going back to Rosen, 1968). We can re-write (1a) as:

(1b) $L = L^*(E, D, h)$,

where D is days per week, and $h = H/D$ is hours per day. Writing production as a function of labor input $Y=F(L)$, and simplifying L^* as being generalized Cobb-Douglas, we can write:

(2) $\ln L_t = a_0 + a_1 \ln E_t + a_2 \ln H_t = a_0 + a_1 \ln E_t + a'_2 \ln D_t + a'_3 \ln h_t$,

where the a_i describe the labor aggregator and t denotes the time period.

[1]Bresnahan and Ramey (1994), who assembled micro data on automobile plants' days of operation (closings), is a previous example of considering adjustment along more than one intensive margin.

[2]Battisti et al. (2024) focus on days and hours worked **per year** among Italian manufacturing employees. While a novel approach, it does not get at the scheduling problem that is the central focus of this study.

In many years the Current Population Survey (CPS) has included a May Work Schedule Supplement to its monthly survey. In six of those years, 1973, 1985, 1991, 1997, 2001, and 2004, the Supplement asked respondents on how many days per week they usually work. Since the sample consists of CPS respondents, we have information on its members' demographic characteristics, their location (state), and the industry in which they work. The CPS has not obtained this information since 2004; but in its 24 monthly waves in 2017 and 2018 the American Time Use Survey (ATUS), which randomly samples recent CPS respondents, obtained similar information.

We use information from the ATUS with the five CPS Supplements, 1985 and onward, and for each observation link the data to the unemployment rate at that time in the individual's state of residence.[3] Ideally, we would like to use a measure of output in each location and at each time, but none is consistently available. We are implicitly assuming that the local unemployment rate is exogenous to an individual employer's decision about altering the demand for his/her labor. For each respondent to these surveys, we also take the industry of employment to create fourteen consistently defined industry aggregates.[4]

Table 1 presents descriptive statistics for each of the six samples. It and the subsequent tables include all observations for which data on the state unemployment rate was available and for which the ratio H/D = h, which was computed from the responses in the Supplement, was in the closed interval 1 to 24.[5] First note that Column (1) shows that the underlying samples are, except for the ATUS, quite large, reflecting the size of a typical monthly CPS sample of workers. With the ATUS only sampling about 1,000 people per month, the two-year sample of workers 2017-18 is necessarily much smaller. Despite that, the sample sizes should present sufficiently large numbers of observations for nearly all states and years. The

[3]We could also use local unemployment rates, but these are not available for many of the observations and, in any event, are necessarily based on much smaller samples.

[4]Because we could not aggregate industries listed in the 1973 May CPS Supplement in the same way as in the later Supplements, we cannot include 1973 in the analyses.

[5]This latter restriction excluded 0.32 percent of the total observations, with 2/3 of those excluded being observations from the 1985 and 1997 samples.

average (national) unemployment rate varied between 4 and 7 percent over the six years. State unemployment rates across these samples ranged between 1.9 and 13.5 percent, with a standard deviation of 1.57, so that a two standard-deviation change in the sample is roughly equivalent to what has been observed on average in post-World War II recessions in the U.S.[6]

Despite the substantial variation in unemployment across these years, there is remarkably little variation in hours per week averaged within each annual sample, a range of 3.9 percent of the average over the six samples. The range of days worked across the years is proportionally smaller than that of hours/day (only 1.3 percent) and much smaller than the range of state-year unemployment rates. Despite the limited variation over time in these annual averages, the within-sample standard errors show that there is substantial variation within each sample in each of these components of work time.

III. Aggregate Estimates

In its first three rows Columns (2) – (5) of Table 2 show estimates from regressions describing variations in ln(H), ln(D, and ln(h) respectively. In each column we list only the parameter estimate on the state-year unemployment rate, and in each regression we use CPS sampling weights (equalized on average across the years), with standard errors clustered on states. Column (2) includes only the state-year unemployment rate. These estimates suggest only a small response of weekly hours to changes in unemployment (less than a two-percent drop in the typical U.S. recession) and almost no cyclical responsiveness of days worked. Because the regressions exclude the available demographic information, however, the estimates are not credible: We know (Hamermesh and Biddle, 2024) that there are clear patterns relating days worked to demographic characteristics, and these may also be correlated with unemployment.

To account for this, the regressions estimates shown in Column (3) of Table 2 add vectors of the CPS respondents' demographic characteristics, including their education, potential work experience, race/ethnicity, gender, and marital status. The decline in weekly hours with higher unemployment becomes

[6]All within-year averages use the CPS or ATUS sampling weights. The averages across all years are adjusted so that on average each year's sample contributes the same amount to the average.

much larger, implying a roughly 4 percent (1.6-hour) drop during the typical U.S. recession. The responses of both days/week and hours/day to changing unemployment are both statistically significant, with a little over ¼ of the total response arising from changes in D, the remainder from changes in h.

There are substantial differences in days worked by industry (Hamermesh and Biddle, 2024), so including a vector of indicators for the 14 industries would appreciably alter the estimated responses to unemployment if there are large enough correlations of industry and state-year unemployment. As the estimates in Column (4) show, however, these correlations must be fairly small, as these estimates differ little from those in the previous column. Larger changes in the estimated parameters are produced when we add state fixed effects, as shown in Column (5) of the table. We do not include year fixed effects here, since with only six years of data adding them would vitiate most of the sample variation in unemployment.[7]

We view the estimates in the final column of Table 2 as the best descriptions of the breakdown in responses to unemployment along the intensive margins. They suggest that in a typical U.S. recession, with a 3 percentage-point increase in the unemployment rate, weekly hours decline by about 5 percent, about two hours per week, holding demographics and industry affiliation constant. About 30 percent of that decline results from a drop in days worked (equivalent to one less day of work by 10 percent of continuing employees), while 70 percent stems from cuts in daily hours (equivalent to about 0.3 hours per day by all continuing employees). Obviously, these are average responses describing the average worker, and just in the cross-sections, they mask substantial heterogeneity. They do, however, summarize what occurs along two separate dimensions when unemployment rises. As such, they provide a novel addition to our understanding of how labor markets, and the amount of labor demanded, vary with general economic fluctuations.

We can compare these movements along the intensive margins to changes along the extensive margin in the aggregate. Column (1) of Table 2 lists the estimated response of aggregate employment to the unemployment rate, based on aggregated annual data, 1989-2018 and including a time trend. Comparing

[7] If we add a vector of indicators for the six sample years the parameter estimates are -0.00307 (s.e.=0.00158), -0.00202 (s.e.0.00087), and -0.00105 (s.e.=0.00135) for ln(H), ln(D), and ln(h) respectively.

it to the estimates from a similarly specified equation describing ln(H), shown in the final row of Column (1) of Table 2 and also based on aggregate data, yields the standard finding that cyclical movements along the extensive margin are three to four times as large as those along the intensive margin. This replicates the conventional wisdom, but using more recent data.

This admittedly rough calculation yields a minor mystery—the aggregate estimate is far below the preferred estimate based on pooled cross-sections of micro data, d(lnH)/dURATE = -0.01796, shown in Column (5). Note, however, that the estimate of this response in Column (2), in which no control variables are included, is nearly identical to the aggregate estimate. Implicitly the differences between our preferred estimate and the aggregate measure arise because we have controlled for a wide array of demographic and other variables in producing the former.

The relative sizes of the adjustments along the intensive margin are not informative about the structures of adjustment costs along them; they cannot be, given our reliance on highly aggregated data, which are all that are available. They do, however, suggest that, if those costs are variable, the marginal cost is increasing more rapidly for many firms along the margin of days than of hours per day; and if they are fixed, the results suggest that lumpy costs of adjusting days are larger than those of altering hours per day.

We stress that these estimates are based solely on the American experience. In other countries macroeconomic downturns may be met by different combinations of responses of employment and hours per week. For examples, in both Germany in the Great Recession (Burda and Hunt, 2011) and in Australia from 1998-2016 (Bishop et al., 2016) a majority of the response to macroeconomic decline was through cuts in H rather than E. How much of the large cuts in H resulted from cuts in days rather than hours per day is a useful topic for research which awaits the relevant data from those and other countries.

IV. Disaggregating by Industry

Among the 14 industry groups into which we divided the six samples, four have sufficient observations to produce large enough samples for estimating parameters and to be linkable to extraneous variables describing their characteristics. These are manufacturing (17 percent of the entire sample);

education and health services (18 percent), combining two of the 14 industry groups; other services (18 percent); and retail and food services (15 percent), again combining two groups.[8] We re-estimate the basic equation from the final column in Table 2 over each of these four sub-samples separately.

Table 3 presents the results of this disaggregation describing ln(H), ln(D), and ln(h). Comparing the impacts of unemployment on ln(H) to those in the aggregate (Column (5) of Table 2) shows that there are substantial differences from the aggregate estimates along the usual intensive margin, with hours adjusting least in manufacturing and most in other services. The responsiveness of hours/day does not differ greatly across the four industry groups and differs fairly little from the aggregate responsiveness.

The interesting findings in Table 3 are the differences in the magnitudes of adjustment along the intensive margin of days/week. In manufacturing, and to a slightly lesser extent in education and health services, there is essentially no adjustment of days/week over the cycle. In retail and food services, however, the adjustment of days is over twice as large as in these industries; and in other services it is over ten times larger. Overall, as the final column of Table 3 shows, about 1/3 of the much larger responsiveness of weekly hours in non-manufacturing arises from cyclical changes in days worked. There is substantial heterogeneity, even across such broad aggregates as groups of industries, in the breakdown of adjustment in weekly hours between days/week and hours/day. Implicitly, workers' schedules in those industries can be varied along both dimensions more easily than in manufacturing.

While we cannot explicitly determine why there are such sharp differences in the responses of days/week across these four sets of industries, a number of comparisons are suggestive. As the first row of Table 4 demonstrates, there is less voluntary mobility in the industry groups in which days/week vary less over the business cycle. Statistics describing usual weekly earnings in these industries, the second row of Table 4, show a monotonically inverse relationship between earnings and the size of the cyclical variation in days/week. Perhaps most important, those two industry groups in which days/week are unresponsive to variations in unemployment are characterized by smaller within-industry differences in days worked. The

[8]We combine four of the 14 groups into two pairs in order to match our work to available statistics describing various characteristics of workers in these groups

coefficients of variation are smaller in these industries; and, as the final tableau in Table 4 shows, the work time of greater percentages of workers in these industries is concentrated at the industry mode of days worked. This is particularly true in manufacturing industries. Manufacturing in the U.S., the focus of so much of the literature on cyclical adjustment, behaves substantially differently from the aggregate economy along the intensive margin of days/week.

V. Conclusion and the Implications of Structural Change

We have decomposed the cyclical adjustment in the demand for labor beyond the conventional breakdown (into changes in employment and weekly hours) to consider how adjustments in weekly hours are divided between changes in days worked per week and those in hours worked per day. Using large repeated cross-sections of American household data, we find that variations in days worked account for around 30 percent of the response of weekly hours to changes in aggregate unemployment, with changes in hours per worker per day accounting for 70 percent. Given the historic and apparently still prevailing breakdown in aggregate labor adjustment of ¾ through changes in employment, ¼ through changes in weekly hours, our results suggest that over the past 40 years a bit less than 10 percent of the total response of labor demand to cyclical shocks has been through changes in days worked, with most of the changes in weekly hours arising from changing hours worked per day.

The U.S. industrial structure tilted toward services and retail trade and away from manufacturing over our sample period. Our slightly disaggregated results demonstrate that in manufacturing the entire adjustment along the intensive margin arises through changing hours per day, with no adjustment in days worked. In contrast, outside manufacturing about 1/3 of the adjustment along the intensive margin occurs through changing days worked per week. With only six cross sections of data, we cannot estimate how the parameter estimates of these responses changed; the differences across industries in the average responses, however, suggest that shifting industrial structure has led the U.S. economy toward greater overall reliance on adjustments in days per week.

The implied secular change in the contributions of changing days worked and changing hours worked per day implies simultaneous changes in workers' well-being. We have demonstrated (Hamermesh and Biddle, 2024) that workers prefer to concentrate their leisure across the workweek: Among workers with four-day full-time schedules, those enjoying three consecutive days of leisure are more educated and more experienced than those whose three days are discontinuous. Consecutive leisure is a superior good. That being the case, a shift away from manufacturing and, according to our results, thus to cyclical adjustments based more on changing days per week than on changing hours per day, will at the same overall change in hours per week over the cycle have enhanced workers' welfare.

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Table 1. Descriptive Statistics, Weekly Hours, Days, and Daily Hours, U.S. 1985-2018

Year (No. observations)	Hours/week	Days/week	Hours/day	Unemployment rate
1985	38.443	4.897	7.888	7.222
(25,494)	(10.317)	(0.858)	(1.931)	(1.614)
1991	38.841	4.888	7.972	6.793
(48,300)	(10.204)	(0.821)	(1.901)	(1.175)
1997	39.786	4.938	8.180	4.984
(45,111)	(10.942)	(0.948)	(2.363)	(1.029)
2001	40.018	4.904	8.196	4.412
(38,331)	(10.281)	(0.784)	(1.945)	(0.705)
2004	39.690	4.897	8.132	5.594
(45,475)	(10.371)	(0.798)	(1.925)	(0.872)
2017-18	39.292	4.876	8.053	4.103
(8,764)	(11.073)	(0.853)	(1.967)	(0.682)
All Years	39.345	4.900	8.070	5.518
(211,475)	(10.551)	(0.846)	(2.015)	(1.571)

*Weighted by CPS or ATUS sampling weights, adjusted across years so that the average weights in each year are identical. Standard deviations in parentheses below the means.

Table 2. Main Estimates of the Impact of Unemployment, All Workers/Industries, Variations Along Intensive Margins (N=211,475)*

	(1)	(2)	(3)	(4)	(5)
	Aggregate Data			**Individual Data**	
				Controls:	
		None	Individual**	Add industry fixed-effects***	Add state fixed-effects
Dep. Var.:					
ln(H)		-0.00577 (0.00128)	-0.01346 (0.00151)	-0.01413 (0.00152)	-0.01796 (0.00183)
R^2		0.001	0.098	0.120	0.124
ln(D)		-0.00012 (0.00054)	-0.00349 (0.00055)	-0.00380 (0.00056)	-0.00540 (0.00072)
R^2		<0.0001	0.045	0.059	0.061
ln(h)		-0.00564 (0.00100)	-0.00997 (0.00116)	-0.01033 (0.00118)	-0.01256 (0.00141)
R^2		0.001	0.058	0.078	0.081
ln(E)****	-0.01216 (0.00204)				
R^2	0.962				
ln(H)****	-0.00484 (0.00041)				
R^2	0.992				

*Standard errors in parentheses, clustered on states.
**Vectors of indicators of educational attainment, potential work experience, race/ethnicity, gender, and marital status.
***Fourteen, mostly one-digit industries.
****Annual time series, 1989-2018, including time trend. Ln(H) equation also includes an indicator for years 1994 and later.

Table 3. Estimates of Effect of Unemployment on Intensive Margins, by Industry[*]

	Industry				
	Manufacturing	**Education and Health Services**	**Other Services**	**Retail and Food Services**	**All Non-manufacturing**
N =	34,936	39,010	37,015	32,579	176,539
ln(H)	-0.00972 (0.00132)	-0.01345 (0.00210)	-0.03315 (0.00348)	-0.01272 (0.00402)	-0.02044 (0.00208)
R^2	0.054	0.057	0.106	0.210	0.106
Ln(D)	-0.00062 (0.00065)	-0.00097 (0.00136)	-0.01307 (0.00167)	-0.00213 (0.00158)	-0.00663 (0.00088)
R^2	0.014	0.033	0.060	0.112	0.051
ln(h)	-0.00910 (0.00118)	-0.01248 (0.00187)	-0.02008 (0.00281)	-0.01059 (0.00348)	-0.01381 (0.00157)
R^2	0.039	0.039	0.064	0.112	0.063

[*]Standard errors in parentheses, clustered on states. All estimates include individual controls and state fixed effects

Table 4. Miscellaneous Characteristics of Major Industries

	Industry			
	Manufacturing	**Education and Health Services**	**Other Services**	**Retail and Food Services**
Annual average monthly quit rate, 2019*	1.6	1.9	2.3	3.3
Average usual weekly earnings, 1985-2018**	$752	$646	$637	$427
Coefficient of variation of weekly earnings**	0.720	0.755	0.926	0.918
Cross-section coefficient of variation**				
ln(H)	0.193	0.291	0.288	0.346
ln(D)	0.127	0.190	0.178	0.218
ln(h)	0.166	0.265	0.243	0.282
Percent of workers at mode:				
H	67.8	52.0	50.0	39.5
D	84.2	77.1	73.0	59.0
h	63.5	50.9	46.8	35.1

*https://www.bls.gov/news.release/jolts.t22.htm. The quit rate listed under retail and food services is for retail only.
**Calculated from the CPS data underlying the estimates in Tables 1-3. Unweighted average of annual statistics, 6 samples, 1985-2018.