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HOW LONG WAS THE WORKDAY IN 1880?

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ABSTRACT

We know remarkably little about the length of the working day before the 1880s. In this paper, we summarize what is known about the trend in the length of the workday in American manufacturing industry from 1830 to 1890. We than develop estimates of the daily hours of work and form the basis for our on-going research into the performance and operation of the industrial labor market in America in the late nineteenth century.

We conclude on the basis of our firm-level sample data that the average workday in American manufacturing industry in 1880 was almost exactly ten hours, placing the attainment of the ten-hour day almost a decade earlier than hitherto supposed. Despite the decline in hours to 1880, however, daily hours of work were still long enough that they would have required the use of artificial light in most factories during the winter. Our statistical analysis also reveals and documents small but statistically variations in hours between firms and industries and between regions and by location.

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HOW LONG WAS THE WORKDAY IN 1880?*

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Remarkably little is known about the length of the working day in manufacturing before the 1880s despite a number of contemporary investigations and continued scholarly interest in this question.[1] This paper, however, provides new evidence on the length of the workday in manufacturing industry in 1880 based upon unpublished data collected by the 1880 Census of Manufactures. These statistics represent the earliest detailed evidence on hours of work covering virtually every manufacturing industry in most states in each region of the country and in urban as well as rural areas. They are crucial to our research in progress on the performance and operation of the industrial labor market in the late nineteenth century. Detailed analysis and interpretation of these statistics is, however, deferred to subsequent papers.

Our estimates show that the average workday across all manufacturing firms in 1880 was about ten hours a day. This is shorter than traditionally assumed and pushes the attainment of the ten-hour day back to 1880.[2] There were, however, marked and statistically significant variations about this average by location, region, state, and industry.

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[1]See for example, U.S. Department of the Interior. Census Office. *Report on the Statistics of Wages in the Manufacturing Industries with Supplementary Reports on the Average Retail Prices of the Necessaries of Life and on Trade Societies and Strikes and Lockouts*, by Joseph D. Weeks, 1880 Census, vol. 20, (Washington, DC: GPO, 1883) hereafter referred to as the *Weeks' Report*; *Senate Report 1394, 52 Cong., 2d. sess*, (1893), "Wholesale Prices, Wages, and Transportation," hereafter referred to as the *Aldrich Report*; Massachusetts. Bureau of Statistics of Labor, *Tenth Annual Report*, (Boston: Rand, Avery & Co., 1879), and U.S. Department of Labor, *Bulletin 18*, (Washington, DC: GPO, 1898). For more recent studies of hours, see, for example, Clarence D. Long, *Wages and Earnings in the United States 1860-1890*, (Princeton: NBER, 1960) and Stanley Lebergott, *Manpower in Economic Growth*, (New York: McGraw-Hill, 1964). Although they are primarily concerned with changes in the twentieth century, see also Martha Shiells, "Hours of Work and Shiftwork in the Early Industrial Labor Markets of Great Britain, the United States, and Japan," unpublished Ph.D dissertation, University of Michigan, 1987 and Robert Whaples, "The Great Decline in the Length of the Workweek,". unpublished paper, University of Wisconsin--Milwaukee, October 1988.

[2]See, for example, John R. Commons, et al., *History of Labour in the United States*, 3 volumes (New York: Macmillan, 1918), III, p. 99

NINETEENTH CENTURY TRENDS IN AVERAGE HOURS OF WORK.

Estimates of hours of work for the early nineteenth century are mostly for specific firms, areas or industries and cannot be generalized for the nation or industry as a whole. For example, in the Lowell mills in the 1830s:

> "[F]rom the first of September to the first of May, work commenced in the morning as soon as the hands can see to advantage, and stopped regularly during these eight months at half past seven o'clock in the evening. . . . During the four summer months . . . work is commenced at five o'clock in the morning, and stopped at seven in the evening."[3]

Other early estimates of the length of the work day such as from sunrise to sunset or for the "whole day" are too general to be of much use.[4]

(a) The *McLane Report*

More comprehensive--but less detailed--quantitative evidence on hours of work early in the nineteenth century is to be found in the responses to the survey of manufactures commissioned by the Secretary of the Treasury, Louis McLane, in 1832.[5] Firms were asked to report "How many hours in the day do the operatives work?"[6] or "How many hours a day employed?"[7] Many complied. For example, J. Treadwell of Salem, Mass. reported that "the average per day is about ten hours the entire year" for manufactures generally.[8] William Jackson of Newton, Mass. was more specific stating that in the soap and candle industry employees worked "twelve hours, exclusive of meals."[9] John Tyler, however, was much more general, reporting that in Suffolk County (i.e. Boston), Mass. "the common practice is for operatives to work from sunrise to sunset, and labor beyond these hours is considered and

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[3]James Montgomery, *A Practical Detail of the Cotton Manufacture of the United States,* (Glasgow: John Niven, 1840), p. 173.

[4]See, for example, John R. Commons, et al., *History of Labour, op. cit.,* I, p. 158 and Daniel T. Rodgers, *The Work Ethic in Industrial America, 1850-1920,* (Chicago: University of Chicago Press, 1974), p. 18.

[5]U.S. Congress. House of Representatives, "Documents Relative to the Manufactures in the United States," *22d Cong. 1s. sess., House Executive Document No. 308,* 1833. Hereafter referred to as the *McLane Report.*

[6]*Ibid.,* Vol. 1, p. 67.

[7]*Ibid.,* Vol. 2, p. 7.

[8]*Ibid.,* Vol. 1, p. 86.

[9]*Ibid.,* Vol. 1, p. 88.

paid for as extra work; nevertheless, there are many exceptions to this rule."[10] The average of such estimates by industry based upon Kenneth Sokoloff's sample data from the *McLane Report* is shown in Table 1.[11] On average, employees worked about 11 hours and 20 minutes a day in 1832, or 68 hours per week for a standard 6-day work-week. This estimate is consistent with that from other studies as we show below but the averages for specific industries often differ substantially between sources.

TABLE 1
Average Hours of Work in 1832 by Industry

Industry (ordered by daily hours)	Hours of Work per day (Hours:Minutes)
Millinery	9:53
Paper	10:05
Leather Tanning	10:46
Carriages and Wagons	11:02
Machinery	11:06
Metal Products	11:10
Iron	11:23
Boots and Shoes	11:30
Flour Mills	11:43
Cotton Textiles	11:50
Woolen Textiles	11:55
All industries	11:20

Source: Data provided to the authors by Kenneth Sokoloff from his sample drawn from the *McLane Report*, "Documents Relative to the Manufactures in the United States," *22d Cong. Is. Sess., House Executive Document No. 308.*

(b) The *Weeks* and *Aldrich Reports*

Much of what has been known about hours, however, comes not from the *McLane Report* but from two retrospective federal surveys made towards the end of the nineteenth century. The first was the special report on the statistics of wages prepared by Joseph D. Weeks in conjunction with the Tenth Census in 1880.[12] The second was prepared for

[10] *Ibid.*, Vol. 1, p. 471.

[11] We are grateful to Kenneth Sokoloff for providing us with these statistics.

[12] *Weeks' Report, op. cit..*

Senator Nelson W. Aldrich of Rhode Island, the Chairman of the Senate Committee on Finances, by Carroll D. Wright, then Commissioner of Labor.[13]

Both of these sources, however, have been thought to be seriously flawed with the result that the evidence they present has been treated with considerable skepticism.[14] This has been particularly true of the *Weeks Report*. The reasons are not hard to find. Weeks reported that he made no effort to canvas all firms or to use the responses already received in connection with the 1880 Census of Manufactures but instead selected what he thought were "typical" establishments of "standing."[15] Consequently the data appear subject to selection bias. Moreover, even among the pre-selected group of firms, response rates were often low. For example, out of 89 schedules sent to selected boot and shoe manufacturers, Weeks received replies from just 21 firms and of these, only 13 contained sufficient information to warrant publication.[16] As a result, regional estimates of hours seem to be based upon potentially unrepresentative, self-selected, small samples of firms from a limited number of industries. For example, only eighteen southern firms reported hours of work for 1850 to Weeks and only 121 southern businesses reported their hours for 1880--about as many as from New York state.[17]

The *Aldrich Report*, on the other hand, is silent about how the data were collected and aggregated, about sample sizes and sample weighting, and so on while describing Weeks' investigation as being of "restricted scope."[18] At the same time, we know that collection of the data was supervised by Carroll D. Wright, a leading figure in the annals of American

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[13]*Aldrich Report, op. cit.*

[14]See, for example, Long, *Wages and Earnings, op. cit.,* pp. 7-9; Lebergott, *Manpower, op. cit.,* pp. 271-74; and Claudia Goldin and Robert Margo, "Wages, Prices, and Labor Markets Before the Civil War," NBER Working Paper No. 3198, December 1989. However, Coehlo and Shepherd have made extensive use of the Weeks data in their studies of regional price and real wage differences. See Philip Coehlo and James Shepherd, "Differences in Regional Prices: The United States, 1851-1880," *Journal of Economic History*, 34, 3 (September 1974): 551-91 and Philip Coehlo and James Shepherd, "Regional Differences in Real Wages: The United States, 1851-1880," *Explorations in Economic History*, 13 3(July 1976): 203-30.

[15]*Weeks' Report, op. cit.*, p. ix. Unfortunately we do not know whether the "typical" firm was the average, median or modal firm. Nor do we know whether firms of reputation and longevity behaved differently from the "typical" firm of 1880?

[16]*Ibid.*, p. 13.

[17]*Ibid.*, pp. xxx-xxxi. Note, however, no state or regional data whatsoever are reported by the *Aldrich Report.*

[18]*Aldrich Report, op. cit.*, p. 14.

statistical history, "from actual payrolls."[19] As a result, the *Aldrich Report* data have generally received the benefit of the doubt and have been the survey of choice.

However, as we will show, it is the Weeks and not the Aldrich data on hours that compare most favorably with our manuscript census estimates. Consequently, we do not think that the traditional skepticism of the Weeks data is justified--at least for 1880--while our results lead us to question the accuracy of the Aldrich data for that year.

Despite the imperfections of the Weeks and Aldrich data we have used them to construct estimates of the average daily hours of work from 1830 to 1880. These are shown in Table 2. In general, the *Weeks Report* shows shorter daily hours for most industries than the *Aldrich Report*. The differences are sometimes very large. For example, workers in the woolen textile industry in 1850 worked 11 hours 30 minutes a day according to Weeks, but 14 hours a day according to Aldrich. Both series, however, show that workers in the textile and paper industries (which were heavily concentrated in New England) worked the longest hours--twelve hours or more a day in 1830 and well over ten hours a day as late as 1880.[20]

Interpolating from the Weeks data, we estimate that by the time McLane collected his data (1832) the average workday had probably shrunk to about 11 hours 27 minutes long. This compares favorably with the 11 hours 20 minutes estimated by Sokoloff from his *McLane Report* sample (see Table 1). Unfortunately, estimates for most of the individual industries where comparisons between Weeks and McLane are possible are not so similar. For example, Weeks estimated that workers in the paper industry averaged 12 hours in 1830 and 11 hours 20 minutes in 1840 compared with 10 hours 5 minutes in Sokoloff's sample.[21] In general, Weeks reported longer hours than McLane, except for carriage and

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[19]*Ibid.*, p. 374.

[20]No regional data are reported by Aldrich and small, potentially unrepresentative, samples in the Weeks data especially for the South make such estimates a dubious proposition there too.

[21]According to private correspondence with Kenneth Sokoloff (Sokoloff to Atack, February 19, 1990), these differences apparently arise from the sample selection criteria and point out the dangers of making population estimates based upon small samples. For example, the returns for Connecticut firms in the *McLane Report* (*McLane Report*, I, pp. 977-1050) are not as detailed as those for many other states and were therefore not sampled by Sokoloff. The Connecticut River valley, however, was one of the centers of paper-making in America at that time and the *McLane Report* lists 11 paper mills in Connecticut, all

TABLE 2
Trends in the Hours of Labor During the Nineteenth Century
(Hours:Minutes per day)

Industry/Authority	1830	1840	1850	1860	1870	1880	1890
Agricultural Implements							
Weeks	9:30	9:30	9:40	9:40	9:45	9:44	--
Aldrich	--	n.a.	n.a.	10:00	10:00	10:00	10:00
Boots and Shoes							
Weeks	n.a.	n.a.	10:30	9:48	9:52	9:49	--
Brewing							
Aldrich	--	n.a.	n.a.	12:00	12:00	12:00	12:00
Carriages and Wagons							
Weeks	9:30	10:12	9:55	9:58	9:47	9:45	--
Aldrich	--	10:00	10:00	10:00	10:00	10:00	10:00
Cotton Textiles							
Weeks	12:30	12:06	11:49	10:55	10:43	10:43	--
Aldrich	--	14:00	13:30	12:12	11:00	10:18	10:00
Flour Milling							
Weeks	n.a.	n.a.	11:43	11:16	10:55	10:58	--
Furniture							
Weeks	10:00	10:00	10:00	10:00	9:52	9:50	--
Leather Tanning							
Weeks	12:00	11:00	10:30	10:00	9:57	9:58	--
Aldrich	--	n.a.	n.a.	11:00	10:00	10:00	10:00
Lumber Milling							
Weeks	n.a.	10:40	11:12	10:31	10:09	10:01	--
Aldrich	--	12:00	11:00	10:48	10:48	10:48	10:00
Machinery							
Weeks	10:40	11:00	10:14	10:08	10:01	10:00	--
Aldrich	--	10:00	10:18	10:06	10:06	10:06	10:06
Meat Packing							
Weeks	n.a.	n.a.	n.a.	n.a.	10:00	10:00	--
Paper							
Weeks	12:00	11:20	11:22	10:49	10:49	10:52	--
Aldrich	--	n.a.	n.a.	12:00	12:00	12:00	12:00
Printing							
Aldrich	--	n.a.	10:00	10:00	10:00	10:00	10:00
Tobacco							
Weeks	9:00	9:15	9:30	9:25	9:27	9:30	--
Woolen Textiles							
Weeks	12:40	12:00	11:30	11:00	10:38	10:25	--
Aldrich	--	n.a.	14:00	12:42	11:30	11:24	10:00
All Industries:							
Weeks[a]	11:31	11:11	10:55	10:20	10:11	10:07	--
Aldrich	--	11:24	11:30	11:00	10:30	10:18	10:00

[a]Weighted by relative employment; n.a. No observation; -- No data
Sources: Weeks: US Department of the Interior. Census Office, *Report on the Statistics of Wages in the Manufacturing Industries with Supplementary Reports . . .*, by Joseph D. Weeks, 1880 Census, Volume 20, (Washington DC: GPO, 1883), pp. xxxii-iii. Aldrich: *Senate Report 1394, 52 Cong., 2d. sess*, (1893), "Wholesale Prices, Wages, and Transportation," Table 44, pp. 178-9.

reporting working 12 hour-days, that is to say about the same as reported by Weeks. See *McLane Report*, I, pp. 992-3. Instead the estimate reported in Table 1 is based upon the six paper mills in Sokoloff's sample which reported complete information. These firms were located in peripheral areas of paper-making such as western Pennsylvania and Vermont and cannot be considered representative of the industry as a whole. There is no evidence, however, that these small sample problems for individual industries and the sample selection criteria result in significant bias in Sokoloff's 1832 *McLane Report* sample as a whole.

wagons-making and machinery. According to John R. Commons, both of these groups were in the vanguard of agitation in the 1830s for the adoption of a ten-hour day but what role this may have played in their relatively short working day in 1832 is not known.[22]

(c) The Trend in Hours of Work, 1830-1890

Hours declined over time in virtually every industry. The average for all industries declined by an hour and twenty-four minutes a day, a reduction of 12 percent or by eight hours twenty-four minutes a week--assuming a six-day work-week as seems to have been customary throughout this period--between 1830 and 1880 and between 1840 and 1890. This decline, however, was not evenly distributed across the decades and across industries. The data in Table 2 show a fairly rapid decline in hours during the first half of the nineteenth century, especially during the 1850s when hours declined from 10 hours 55 minutes a day in 1850 to 10 hours 20 minutes in 1860 based upon Weeks' estimates and from eleven and a half hours to 11 hours according to the *Aldrich Report* (Figure 1). The *Aldrich Report* also shows a 30-minute decline in the length of the average workday during the 1860s, but the decline shown in the *Weeks Report* was much more modest--9 minutes. Reductions in the length of the workday thereafter were more gradual. By 1880, though, Weeks determined that "the most common number of hours constituting a day's labor . . . is 10"--as we also conclude.[23]

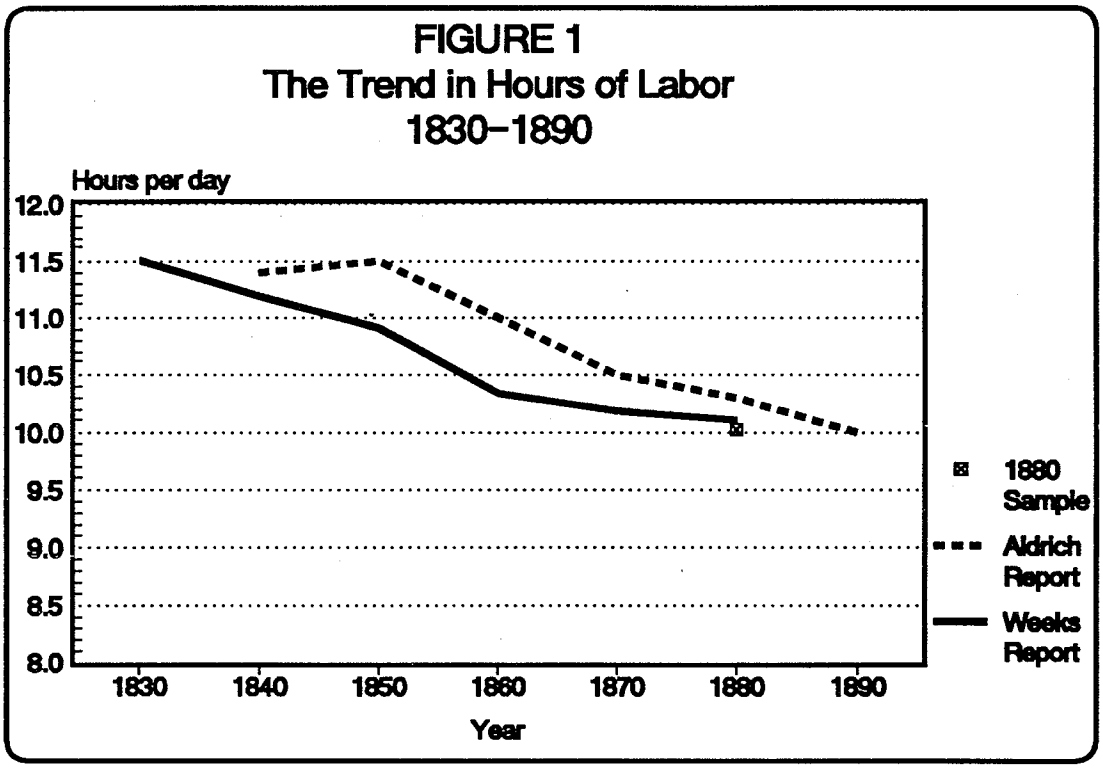
Hours for most workers probably declined over the course of the nineteenth century. Workers in the tobacco industry, however, may have seen their hours increase after 1830 but even so according to Weeks they still had shorter hours than other workers in 1880--9 hours 30 minutes a day. At the opposite extreme, Weeks estimated that workers in the flour milling industry had the longest workday averaging 10 hours 58 minutes a day in 1880--a spread of 1 hour and 28 minutes between average hours in these two industries.[24] Aldrich reports a somewhat wider spread of hours in 1880--2 hours--between brewing or paper and agricultural implements, carriages and wagons, leather tanning, or printing. Despite these

[22]See Commons, et al., *History of Labour, op. cit.*, I, pp. 384-93.

[23]*Weeks Report, op. cit.*, xxviii.

[24]Our estimates based upon the 1880 Census data are similar. Flour mills had about the longest workday averaging 10 hours 42 minutes; tobacco had one of the shortest workdays, 9 hours 53 minutes. See Table 6 below.

differences, however, both the Weeks and Aldrich series show that textiles workers experienced substantial reductions in the length of their working day from 12 hours or longer a day before 1840 to between 10 and 10.5 hours by 1880 or 1890, much of this allegedly as a result of legislation.[25]



After 1870 much more data on hours of work are available, for example in the annual reports of the various state Bureaus of Labor Statistics such as Massachusetts (1870 and 1873) and Ohio (1878).[26] However, not until 1886 are national data available in the annual

[25]See, for example, Ohio. Bureau of Labor Statistics, *Second Annual Report . . . 1878*, (Columbus: Nevins & Myers, 1879), p. 266. We will examine this proposition at length in our forthcoming working paper, "Whom Did Protective Legislation Protect?.

[26]Massachusetts Senate. Massachusetts Bureau of Statistics of Labor, *First Report of the Bureau of Statistics of Labor, Senate 120* (Boston: Wright and Potter, 1870), especially pp. 373-386 and Massachusetts House. Massachusetts Bureau of Statistics of Labor, *Fourth Report of the Bureau of Statistics of Labor, House 173* (Boston: Wright and Potter, 1873), especially pp. 243-6. See also Ohio, *Second Annual Report, op. cit., pp. 257-286.* For a summary of the various studies prior to 1892, see U.S. Department of Labor, *Third Special Report of the Commissioner of Labor: Analysis and Index of All Reports Issued by Bureaus of Labor Statistics,* (Washington DC: GPO, 1893) especially pp. 297-300.

reports of the U.S. Commissioner of Labor.[27] Our data, described below, thus provide the earliest national statistics on hours of work in American manaufacturing industry.

THE 1880 CENSUS OF MANUFACTURES AND HOURS OF WORK

(a) Problems with the existing data on hours

While the trends in--if not the absolute levels of--the daily hours of work in manufacturing industry during the nineteenth century reported by both Aldrich and Weeks are broadly similar, we have developed a new body of data because of the serious questions that have been raised about both of these sources. Carroll Wright, for example, described the Weeks data as "averages . . . made up in counting rooms of the manufacturing concern."[28] At the same time, though, he also conceded that the Aldrich data which he collected "refer to certain picked establishments, where, in view of the complete organization at an early date, it is possible that shorter hours made an earlier appearance."[29] This, however, seems unlikely since those data show longer workdays than the other sources in virtually every industry at each point in time. Our new data, on the other hand, provide a much more complete picture across industries, locations and regions than can be gleaned from existing sources. Their most serious disadvantage is that they are for just for one year, 1880. These new statistics are computed from samples of individual establishment level data collected as a part of the regular 1880 census of manufactures. The results of our inquiry, however, are broadly consistent with Weeks' findings.

It is unclear why Weeks chose to collect his own data on hours rather than use the census data except that tabulation and summarization of the actual census data took much longer than expected and eventually exhausted the available funds.[30] As a result, some census data never were aggregated and reported, among them the data on hours. One consequence of this, however, is to provide us with an independent check upon Weeks'

[27]See, for example, U.S. Department of Labor, *The First Annual Report of the Commissioner of Labor*, March 1886, pp. 143-226 and U.S. Department of Labor, *Third Special Report, op. cit.*, especially pp. 297-300. Also U.S. Department of Labor, *Index of All Reports Issued by Bureau of Labor Statistics Prior to March 1, 1902*, (Washington DC: GPO, 1902).

[28]Carroll D. Wright, "Cheaper Living and the Rise of Wages, *Forum*, 16, October 1893, p. 221.

[29]*Aldrich Report, op. cit.*, pp. 179-80.

[30]See Margo J. Anderson, *The American Census: A Social History* (New Haven: Yale University Press, 1988), p. 100.

methods and sources. This fails to justify the traditional skepticism with which Weeks' data have been treated. We are also provided us with a hitherto unused data source that has the potential to cast light upon the nature and operation of the industrial labor market in the late nineteenth century.

(b) 1880 manuscript census data on hours.

The data underlying this paper come from a national random sample of 8,173 of the nation's manufacturing firms in 1880 drawn from the original census manuscripts[31] for all states for which the records are extant.[32] The census covered the business activities of all manufacturing firms producing at least $500 gross output annually for the period June 1, 1879 through May 31, 1880. These firms answered a common core of 29 questions, 14 of which dealt with various labor-related issues such as labor force composition, wages, hours and plant utilization.[33] For the most part, however, the results of these queries were never tabulated and published as part of the census record.[34]

This study is based upon the replies to the questions about "the number of hours in the ordinary day of labor" between May and November and November and May.[35] Virtually all firms answered these questions and their replies appear to be internally consistent--for example, firms which reported zero hours for one or other six month period also reported that they were idle for at least half the year. The sample firms cover virtually every

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31These data have been deposited with the Inter-University Consortium for Political and Social Research (ICPSR) at the University of Michigan under the name "Atack-Bateman Samples from the 1880 Census of Manufacturing." In addition to the national sample used here, there are individual random samples for thirty-seven states and territories which are also available from them.

32Searches of the Rhode Island Historical Society, State Archives, and the Rhode Island Records Center have unfortunately failed to turn up the manuscripts of the 1880 census of manufactures for Rhode Island. This is the only important manufacturing state for which we could not locate the records. Also missing are data for Arizona, Colorado, Dakota, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming.

A "true" national sample would contain only one or two firms from each of the less industrialized and recently-settled states and territories for which records have not been located. For the purposes of this study, we have treated Washington D.C. as if it were a state since in 1880 it was home to almost 1,000 firms--many more than Delaware and Florida.

33See Carroll D. Wright, *History and Growth of the United States Census*, (Washington, DC: GPO, 1900), pp. 315-61 for a list of the questions and special schedules.

34The exception was the publication of some hours data in the special report on the Iron and Steel industry put together by James M. Swank. See U.S. Department of the Interior. Census Office, *Report on the Manufactures of the United States* (Washington D.C.: GPO, 1883), "Statistics of Iron and Steel Production," p. 745.

35Wright, *History and Growth, op. cit.*, p. 315.

important industry.[36] Tens of thousands of workers were employed by these firms and the data provide detailed information on hours variations across firms, and between industries, states, and regions.[37]

The industrial distribution of these sample firms across the regions is shown in Table 3. About a third of the firms were drawn from the Midwest, almost 45 percent from the Northeast and less than 20 percent from the South. Regionally, sample sizes should be adequate for reasonable statistical inferences. So too are the samples for most industries. The sample sizes for non-ferrous metals (SIC 36) and instruments (SIC 38) are, however, too small to support statistical inferences about the population and these industries are dropped from the industry statistics reported below. Similarly, some individual cells for a particular industry in a region become quite small. For example, although the entire sample has over twelve hundred firms in the lumber industry, only 31 of these were located in the western states (California, Oregon and Washington). We have arbitrarily selected 15 observations as a reasonable minimum sample size from which to draw inferences. Assuming that errors are randomly distributed, this produces a 95 percent confidence interval about the mean sample estimates of ± 2.131 standard deviations.

(c) What did "hours" measure?

While the instructions to the enumerators give no guidance on precisely what information was desired in response to the question about "the number of hours in the

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[36]A few industries, however, are poorly represented in the sample, most notably iron and steel and textile firms, because the statistics for the major firms in these industries were collected by special enumerators and the manuscripts have not been found. For example, James Swank, Secretary of the American Iron and Steel Institute, collected the data for the iron and steel industry. Since the large firms were few in number (though important employers) their selection in the random sampling scheme would have been unlikely anyway. Therefore the firm statistics are probably not biased by their absense. We cannot, however, be so sure for those results weighted by employment. Nevertheless, the samples do contain data for some firms in these industries; some of which were large having been mistakenly collected (though crossed out) by the regular census enumerator.

The individual firm data collected by these special agents were not available in the nineteenth century either. According to the Illinois Commissioner of Labor the special agents did not report these data to the census office by individual establishments. See Illinois. Bureau of Labor Statistics, *Third Biennial Report*, (Springfield, Illinois: H. W. Rokker, 1884), p. 5.

[37]The firms in the national sample employed over 86,000 men, women and children–an average of 11.2 employees per firm–and ranged from firms with only one employee to a firm with 2,510 employees.

TABLE 3
The Industrial and Regional Distribution of Firms in the Atack-Bateman National Sample of Firms from the 1880 Census of Manufacturing
(number of firms)

Industry	2-digit SIC	Region: South	Midwest	Northeast	West	Nation
Ag. Services	7	55	4	0	1	60
Construction	17	57	248	376	23	704
Food	20	397	475	597	34	1,503
Tobacco	21	43	85	123	6	257
Textiles	22	5	16	28	0	49
Clothing	23	18	111	194	11	334
Lumber	24	284	480	468	31	1,263
Furniture	25	27	85	107	7	226
Paper	26	4	15	57	2	78
Printing	27	17	44	77	8	146
Chemicals	28	45	40	94	5	184
Leather	31	177	413	480	29	1,099
Glass/Brick	32	35	108	67	2	212
Primary Metals	33	37	134	137	13	321
Fabricated Metals	34	6	30	43	2	81
Machinery	35	68	153	217	15	453
Non-Ferrous Metals	36	0	0	3	0	3
Transport. Equipment	37	3	6	34	3	46
Instruments	38	0	2	6	0	8
Misc: Metals	39	25	53	156	12	246
Coke/Gas/Oil	49	2	10	16	0	28
Blacksmithing	76	159	316	364	33	872
All Industries		1,464	2,828	3,644	237	8,173

Source: Calculated from the Atack-Bateman National Sample of Firms from the 1880 Census of Manufactures.

ordinary day of labor," we can be reasonably certain that firms did not report the actual hours at work on a particular day or over a period since virtually all reported an integer number of hours.[38] Instead, we interpret the question as asking for the normally scheduled hours of work. Over a period of months, however, we assume that the actual hours of work were approximately equal to those scheduled. This assumption may be wrong but, if so, the available evidence suggests that the bias will lead us to over-estimate rather than under-

[38]Census Office. Department of the Interior. Tenth Census, 1880, *Instructions to Enumerators*, (Washington, DC: GPO, 1880).

estimate the length of the working day. It thus strengthens our claim that the 10-hour day was achieved somewhat earlier than hitherto supposed.[39]

As already noted, the 1880 Census of Manufactures covered activities between June 1, 1879 through May 31, 1880. According to the National Bureau of Economic Research this period is one of rapid recovery from the severe depression of 1873-1879 (business cycle peak to trough).[40] The cycle, which began with a peak in October 1873, reached its trough in March 1879--the longest contraction, 65 months, recorded among the NBER reference cycles.[41] Thereafter recovery was rapid and the term "boom" in connection with business conditions entered the economic vocabulary for the first time.[42] By September 1879 the nation's steel mills reportedly had orders to keep them at capacity into 1880.[43] Business failures which had totaled $38.8 million in the first quarter of 1879 (seasonally adjusted) and $197.8 million for the year II/1878-I/1879 fell to only $11.5 million in the first quarter of 1880 and totaled only $66.9 million for the period covered by the 1880 census year (III/1879-II/1880).[44] The stock market surged. Standard and Poor's index (1935-39=100) rose from 33.3 in June 1879 to 39.9 in May 1880, having been as high as 44.1 in March.[45] Some monetary indicators expanded even more.[46]

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[39]See Claudia Goldin, "Maximum Hours Legislation and Female Employment: A Reassessment," *Journal of Political Economy*, 96, 1(Feb. 1988), pp. 189-205, especially Table 2, p. 197. The data on actual and scheduled hours in the late 1910s and early 1920s suggests that while our assumption that scheduled and actual hours were equal over a period of months is wrong with respect to the period after World War I the bias is such that we are more likely to *overstate* hours of work. For the states surveyed (which all had higher than average scheduled hours of work), the ratio of actual to scheduled hours ranged from 81.5% in Delaware to to 93.9% in Rhode Island. See U.S. Department of Labor. Women's Bureau, "Women in [State] Industries: A Study of Hours and Working Conditions," *Bulletins Nos. 10, 17, 19, 21, 22, 24, 26, 29, 32, 34, 35, 37, 44, 48, 51, 55, 56, and 58*, (Washington D.C.: GPO, 1919-1927).

[40]According to calculations by Eckler, the depression of 1873-79 ranked second in terms of severity as measured by the percentage decline in six series (Imports, Clearings, Pig Iron Production, Cotton Consumption, Railroad Revenues and Coal Production). See A. Ross Eckler, "A Measure of the Severity of Depressions, 1873-1932," *Review of Economics and Statistics*, 15, 2(May 1933), pp. 75-81, especially p. 79.

[41]See, for example, Wesley C. Mitchell and Arthur F. Burns, "Statistical Indicators of Statistical Revivals," *National Bureau of Economic Research Bulletin 69*, (May 28, 1938), especially Table 1, p. 2. See also NBER Studies in Business Cycles Volume 10, *Business Cycle Indicators*, Geoffrey H. Moore (ed.), (Princeton, NJ: Princeton University Press for the NBER, 1961), 2 volumes, especially Table 5.1, I, p. 121.

[42]Rendigs Fels, *American Business Cycles 1865-1897*, (Chapel Hill: UNC Press, 1959), p. 121 quoting from the *Bankers' Magazine*, 40(November 1885), p. 339 which declared that "two years covered the whole of the "boom" commencing in the summer of 1879, and ending in the summer of 1881."

[43]Fels, *Business Cycles, op. cit.*, p. 122 quoting the *Commercial and Financial Chronicle*, 29(September 6, 1879), 236.

[44]Moore, *Business Cycle Indicators, op. cit.*, II, p. 99.

[45]*Ibid.*, p. 107.

[46]See, for example, Milton Friedman and Anna J. Schwartz, *A Monetary History of the United States, 1867-1960*, (Princeton, NJ: Princeton University Press for the NBER, 1963), p. 96-99.

It is likely that this expansion had some impact upon employment and hours. According to Moore, however, changes in hours lead changes in employment by an average of four months.[47] Since recovery began in March 1879, it seems reasonable to assume that hours had already made much of their adjustment before the census year began. Hours would thus tend to be "high" in comparison with hours earlier in the decade, possibly even close to scheduled hours of work during this recovery phase of the business cycle when the Census was taken.

We also assume that breaks and mealtimes were not included in the reported hours of work. Certainly, the custom in America was to exclude these from the calculation of hours of work, as the following statements plainly show:

> "from the first of November to the first of March, the hands take breakfast before sunrise, that they may be ready to begin work as soon as they can see; but from the first of April till the first of October, 30 minutes are allowed for breakfast at seven o'clock, and during the months of March and October at half-past seven.
> During the four summer months, or from the first of May to the first of September, work is commenced at five o'clock in the morning, and stopped at seven in the evening.
> The dinner hour is at half-past twelve o'clock throughout the year; the time allowed is 45 minutes during the four summer months, and 30 minutes during the other eight."[48]

> "Work, 60 hours per week, commences at 6.40 in the morning, and closes at 6 P. M., except Saturdays, when it closes at 4 P. M."[49]

> *"Testimony of Miss ————.*
> American; has worked 20 years, now 66 hours per week; . . . starts for mill at 6.20 A. M.; works 5½ hours; has 45 minutes for dinner; continues till 6.30 P. M., except on Saturdays, when work stops at 5 P. M."[50]

> *"Testimony of ————.*
> A Superintendent of a cotton mill; . . . The hours for running are from 6½ A. M., to 6½ P. M., with one hour for dinner;"[51]

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[47]Moore, *Business Cycle Indicators, op. cit.*, I, p. 63 and Chapter 15, pp. 485-504, especially pp. 490 and 503-4. See also Gerhard Bry, "The Average Workweek as an Economic Indicator," *NBER Occasional Paper 69*, (1959).

[48]Montgomery, *A Practical Detail of the Cotton Manufacture, op. cit.*, p. 173. Montgomery, after this detailed description of the workday throughout the year, states that from May through August the workday averaged 12 hours and 45 minutes. This is consistent with the description of a workday commencing at 5 a.m. and ending at 7 p.m. with an hour and 15 minutes allowed for breakfast and dinner.

[49]Massachusetts. House Doc. 173, *Fourth Annual Report of the Bureau of Statistics of Labor*, (Boston: Wright & Potter, 1873), p. 288.

[50]Massachusetts. Senate Doc. 120, *Report of the Bureau of Statistics of Labor*, (Boston: Wright & Potter, 1870), p. 120.

[51]*Ibid.*, p. 121.

Lastly, we interpret hours as time spent at the job rather than hours actively engaged in work, even though we will occassionally talk about "hours of work." The significance of this distinction may be judged from a study by the Iron and Steel Commission in 1911 which found that while the working day at the blast furnace of a large steel mill was 12 hours, the actual number of hours when workers were active was much less and varied from job to job. First helpers, for example, were active 9 hours 56 minutes a day (83 percent of the time), 57.4 percent of which was classified as "heavy work" and 32.1 percent of the time was spent at "medium work."[52] Hoist men, on the other hand, were active only 7 hours 28 minutes a day (62 percent of the time), most of it at "light work."[53]

(d) Whose hours were measured?

Other important assumptions about the nature and operation of the labor market are also implicit in our treatment of hours. For example, we assume that most work activities in an establishment were inter-dependent so that all workers began and ended their workday at the same time. The evidence on this, however, is somewhat mixed. For example, Weeks reported that:

> "Much of the work about brick-yards is piece work, a certain number of bricks constituting a day's work. This gives rise to a great variation in the hours of labor, not only at different works in different parts of the country, but among employes at the same works. The employes, not piece-workers, work on an average 10 hours a day. The burners, whose work requires constant attention, are generally divided into two gangs, each working a shift of 12 hours."[54]

Similarly, in "a few" cotton textile mills "there are some classes whose time of working is different from that of the majority of classes at the works."[55] However, since Weeks makes special mention of those establishments where groups of workers kept differing hours of work, it would seem that they were the exception rather than the rule.

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[52]See "Report of Conditions of Employment in the Iron and Steel Industry," *62 Cong. Sess. I,* Senate Documents Volume 20, (Washington DC: GPO, 1913) US Serial Set 6098, p. 344. We are grateful to Stanley Engerman for bring this to our attention.

[53]*Ibid.*

[54]*Weeks' Report, op. cit.*, p. 27.

[55]*Ibid.*, p. 328.

In most firms, workers probably started and finished the working day together. To guarantee this, firms signalled the start of the workday with bells or whistles. Indeed, the very architecture of the mill, dominated by the bell tower, speaks to the importance of keeping time. According to Daniel Rodgers in his study of the work ethic in nineteenth century America:

> "where clocks and watches remained rare, factory bells served the essential, utilitarian function of ringing the labor force out of bed, into work, and home again at the day's end. But in the more ornate bell towers there were clearly marks of faith as well as necessity. In their great clock faces and clanging bells, the towers broadcast the mechanization of work and time, the narrowing and tightening of the injunction to diligence that was at the heart of the industrial transformation of work."[56]

Certainly, management had a keen interest in labor discipline and fixed work hours were one means of monitoring performance to limit shirking.

Tardiness was frequently punished by fines that might amount to as much as a half-day's pay.[57] Habitual lateness was punished by discharge. One interpretation of these employer sanctions, consistent with our hypothesis, is that work attendance and punctuality were important to the employer. Moreover, the large penalties relative to the value of an *individual* worker's lost production suggests that something much more than just the individual's contribution was at stake.

Entry and egress were also controlled. The factory gates could be closed and locked to keep out the tardy and regulate the movement of the workers.[58] Firms also established rules for the workplace and although not all enforced the rules,[59] many did. In some firms, elaborate and draconian workplace rules were strictly enforced to maintain labor discipline

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[56]Rodgers, *Work Ethic*, *op. cit.*, p. 154.

[57]Illinois. Bureau of Labor Statistics, *Fourth Biennial Report*, (Springfield, Illinois: H. W. Rokker, 1886), pp. 501-26, especially p. 506.

[58]Montgomery quotes the Senate testimony of R. D. Layton that the five hundred workers at the carriage works of James Cunningham and Sons in Rochester, New York, were locked up from starting time to quitting time so that no pieceworker could finish a stint and leave. See David Montgomery, *The Fall of the House of Labor*, (Cambridge University Press, 1987), p. 152.

[59]For example in response to an inquiry about about "Special Industrial Occupations" in Milford, the Massachusetts Bureau of Statistics of Labor correspondent reported that in the boot and shoe industry there "discipline is not so strict in any sense; most of the factories have printed rules, but are very lax in their enforcement." See Massachusetts Bureau of Statistics of Labor, *Fourth Report*, *op. cit.*, p. 274.

and to ensure and monitor performance. For example, an Illinois Corset factory employing 787 workers had the following rules:

> "1. Hours of work will be from 7 A.M. to 12 M., and from 1 to 6 P.M.
> 2. Employes who are five minutes, or over, late will be fined. Those coming after 8 A.M. and 2 P.M. will not be admitted at all;
> . . .
> 4. . . . any one bringing eatables of any description (candies included) into the work-room will be fined; in the case of repetition will be discharged.
> . . .
> 6. Talking, singing or visiting each other during working hours is strictly forbidden. [Fined at discretion of forewoman.]
> . . .
> 9. Only on presentation of an excuse ticket at the door will employes be permitted to leave the room during working hours
> . . .
> 12. Two weeks wages will be retained from each employe . . . which will be payable to the employe . . . provided he or she has complied with rule 13.
> 13. Employes intending to quit our employ must give a written notice of two weeks to the office. Employes leaving our employ before the expiration of six months, or without giving such notice, will forfeit the amount of their first two weeks wages."[60]

Such rules and the severe penalties for infractions were the cause of many labor complaints and led to a number of strikes.[61]

Furthermore, when hours for one group of workers--women--were limited by law, employers opted to reduce hours for all workers rather than have staggered starting or finishing times.[62] The nature of some occupations, however, required attendence before the start of the regular workday, for example, engine room personel--steam engineers, stokers and firemen--but we do not believe that their working hours determined the length of the reported work day.

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[60]Illinois. Bureau of Labor Statistics, *Fourth Biennial Report, op. cit.*, p. 503-4.

[61]See, for example, the summaries of strikes and their causes in U.S. Department of Labor, *The Third Annual Report of the Commissioner of Labor. 1887, Strikes and Lockouts*, (Washington, DC: GPO, 1888), especially pp. 1018-1022. Complaints about "obnoxious" work rules figured in at least 200 of the 22,304 strikes between 1881 and 1886 whose grievances were tabulated--many more than caused by increased hours. Moreover, an additional 360 strikes listed a "change in the hour of beginning work" as their cause.

[62]See, for example, Ohio. Bureau of Labor Statistics, *Second Annual Report of the Bureau of Labor Statistics . . . for the Year 1878*, (Columbus: Nevins & Myers, 1879), p. 266. Also *Weeks' Report, op. cit.*, p. 394. Indeed, for a few years after the passage of a state ten-hour law in 1874 limiting the hours of work only for women, textile mills in Massachusetts tried to maintain their 11 hour day by sending half the female workforce outside for 30 minutes each morning and afternoon while the remaining female operatives doubled-up on the number of machines they tended. The two groups would then switch.

In the end, the practice was outlawed and firms adopted a 10 hour day for all their workers. See our forthcoming working paper, "Whom Did Protective Legislation Protect?"

(e) How do we measure hours?

In the estimates of central tendency--means, medians and modes--which follow, two variants are offered. One set are unweighted and may be thought of as the average (median or mode) for firms. We think of these as the scheduled hours of operation for businesses. In the other, hours are weighted by the number of employees and are intended to measure the average (median or modal) hours on the job for employees. We think of these as scheduled hours of work.

As we have noted, the census reported hours separately for the winter six months (November to May) and the summer six months (May to November). We use these data as reported by census for our estimates of seasonality in different industries and regions. However, where we have needed a single estimate of the number of hours that a firm operated or an employee was scheduled to work during the year we averaged winter and summer hours, except for the 32 firms which reported zero hours for each six month period and those for which data were missing were dropped.[63] If a firm reported no hours for just one of the six-month periods, we used the reported work hours for the non-zero six-month period as the average number of hours of work per day.[64]

Since we do not believe that workers were either willing or able to work excessively long hours, we have arbitrarily limited the daily hours of work *per worker* to no more 14 hours per day in any six-month period. Consequently, if a firm reported that the number of hours in an ordinary day of labor exceeded 14 in any six-month period we have assumed that it employed two shifts, each working one-half of the reported number of hours.[65] The number of such firms was small--just over one percent of all firms that reported summer

[63]In addition, there were 136 establishments in which summer hours were missing (as distinct from zero), 135 with missing winter hours and 141 firms with both summer and winter hours missing. These firms were excluded from the calculations.

[64]Forty-nine firms (0.6% of the sample) reported zero hours for one of the six month periods. Of these, 31 reported not operating in winter and were typically firms in flour milling, lumber, and brickmaking. Twelve of the 18 firms that reported not working in summer were in the agricultural services industry.

[65]That is to say, firms reporting 15 hours of work were recorded for these calculations as operating 7.5 hours per worker, but 15 hours per firm.

hours and well under one percent of firms reporting winter hours--and the impact upon the weighted average hours of work is small--only about 3 minutes a day.[66]

SEASONALITY

(a) Differences in hours between summer and winter.

By distinguishing between hours during the summer months and those during winter, the census data provide some crude evidence on the intensity of work over the course of the year which we use to investigate seasonality and to infer the use of artificial light in the workplace. Variations in hours lasting less than six months, however, remain hidden within the data. Moreover, the two six-month periods used by the Census do not necessarily coincide with the seasonal demands for a particular industry or locale.

Historically, however, the regularity of hours and certainty of employment increased with the rise of the factory because of the increased costs of idled fixed capital equipment.[67] Moreover, worker discipline and supervision tended to be greater in larger establishments to increase the intensity of use of expensive capital equipment. In such plants, workers no longer worked alongside the owner taking their rhythm and cues from their employer but instead were driven by professional supervisors whose own jobs depended upon their ability to exact performance from the workforce. This certainly seems to have been the case in the boot and shoe industry since, according to Weeks, "before shoemaking was systematized, hours of labor were very irregular, the workmen who decided their own hours working some days only a few hours and then working far into the night for a few days to make up lost time."[68]

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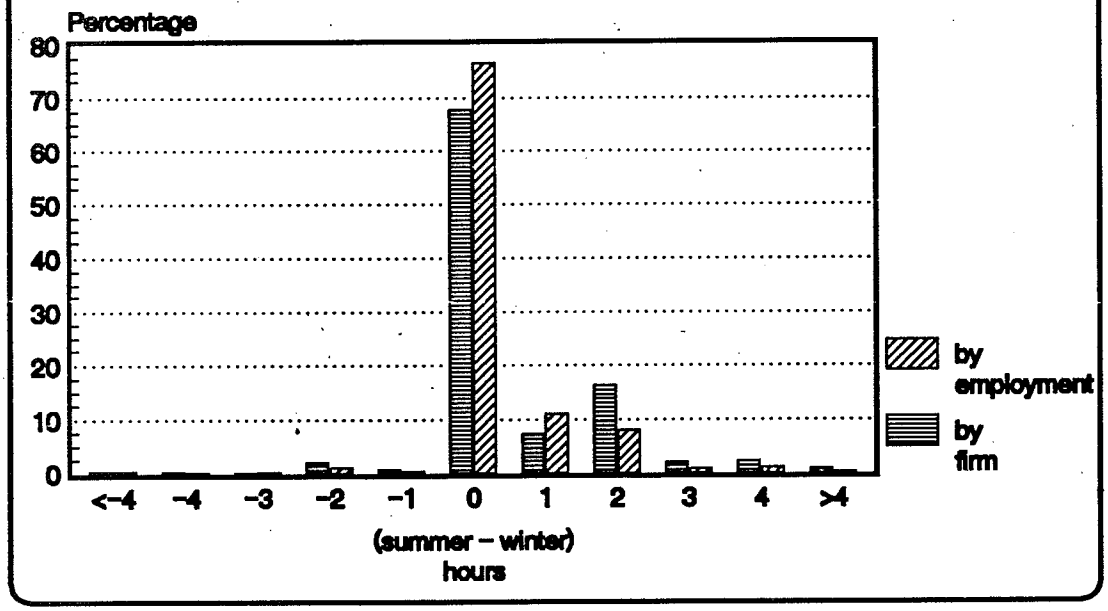
[66]Eighty-two of 8053 firms that reported summer hours (including those which reported that they did not work during summer) listed daily hours of 15 or more. In winter only 61 firms reported working that long.

[67]See, for example, G. N. von Tunzelmann, *Steam Power and British Industrialization*, (Oxford: The Clarendon Press, 1978); John S. Lyons, "Technological Dualism, Rivalry and Complementarity: Handicrafts in the Transition to 'Modern Industry,'" Miami University (Ohio) xerox, 1988. Michael Huberman, "How Did Labor Markets Work in Lancashire? More Evidence on Prices and Quantities in Cotton Spinning, 1822-52," *Explorations in Economic History*, (forthcoming, October 1990). See also the efficiency wage models, especially J. I. Bulow and L. H. Summers, "A Theory of Dual Labor Markets with Application to Industrial Policy, Discrimination, and Keynesian Unemployment," *Journal of Labor Economics*, 4, (1986), pp. 376-414..

[68]*Weeks Report, op. cit.*, p. 16.

The pattern of seasonality revealed by the census data (see Figure 2) proved to be quite different from the typical pattern in agriculture. Whereas farm workers generally enjoyed shorter winter hours of work with the suspension of field activities excepting the daily chores of feeding livestock, milking cows and so on that maintained the overall rythmn of farm life, industrial workers seem to have received little respite from long hours of work as the hours of daylight shortened with the onset of winter.

FIGURE 2
Distribution of Differences between Summer and Winter Hours of Work in 1880



The majority of establishments (more than 68 percent) reported operating for the same number of hours in winter as in summer and 76 percent of industrial workers saw no difference in their scheduled hours of work between summer and winter. The disparity between these two statistics emphasizes that larger firms were more likely to have adopted fixed and regular work hours. A few firms, about 4 percent of the total, worked longer in winter than summer. Among these were establishments in seasonal industries such as meat-packing and ice houses where the cold was a boon rather than a hindrance, but about

30 percent of establishments working longer hours in winter than summer were in food processing (mostly flour milling) and about a quarter were in the leather industry. Firms which operated much longer hours in winter than summer were were mostly in flour milling and agricultural services consistent with the seasonal nature of the supply of inputs for these industries.

Agricultural services, in particular, proved to be much more seasonal than any other. This industry was represented in the sample primarily by southern cotton-ginning and cotton-pressing and hemp-preparation businesses, although there were a few more geographically dispersed grain-threshing concerns. Firms in these industries generally worked substantially longer in winter than summer--an average of 1 hour 34 minutes a day per firm and 1 hour 35 minutes per employee (see Table 4). Indeed, a quarter of all firms that were idle half the year were in the agricultural services industry and of the eighteen firms in the national sample that reported being idle during the summer, two-thirds were agricultural service firms.

As Figure 2 shows, however, it was relatively more commonplace for firms to operate longer hours in summer than winter although they only stretched the summer workday by one or two hours, if at all. This difference is about what one would expect from firms taking advantage of increased daylight.

Across all industries and firms, scheduled hours of work for firms in winter averaged 32 minutes a day less than during summer (Table 4, column 3 minus column 4).[69, 70] For employees, the difference was less pronounced--only 18 minutes less work per day in winter (Table 4, column 6 minus column 7)--consistent with the hypothesis that larger employers

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[69]Measured by the difference, not the absolute difference, between summer and winter hours reported in the Table.

[70]These averages include 49 firms that listed zero winter or summer hours. Excluding firms reporting zero hours in summer raises average summer hours across all firms to 10 hours 21 minutes a day and for employees to 10 hours 9 minutes; excluding firms with zero winter hours raises the winter average to 9 hours 50 minutes a day for both firms and employees.

In subsequent sections of this paper, we estimate what we term "the average number of hours in an ordinary day's work," that is we average summer and winter hours except where one or other is zero in which case we use the non-zero estimate as our measure of the length of the average work day. See the discussion on how we measure hours above.

TABLE 4
Seasonality in 1880: Average Daily Hours of Work in Summer and Winter and the Average *Absolute* Difference between Summer and Winter Hours
(Hours:Minutes)

		Weighting: per Firm:[1]			per Employee:[2]		
Industry	2-digit SIC code	Summer Hours (Hrs:Mins)	Winter Hours (Hrs:Mins)	Mean *Absolute* Difference (Hrs:Mins)	Summer Hours (Hrs:Mins)	Winter Hours (Hrs:Mins)	Mean *Absolute* Difference (Hrs:Mins)
Ag. Services	7	7:47	9:19	2:24	8:02	9:31	2:47
Construction	17	10:02	9:17	0:46	10:01	9:22	0:40
Food	20	10:40	10:11	0:53	10:16	9:58	0:41
Tobacco	21	9:59	9:47	0:17	10:10	9:46	0:26
Textiles	22	10:10	9:41	0:39	10:16	10:07	0:12
Clothing	23	10:00	9:51	0:11	10:01	9:58	0:04
Lumber	24	10:23	9:26	1:02	10:31	9:43	0:52
Furniture	25	10:07	9:40	0:31	9:59	9:35	0:37
Paper	26	10:20	10:08	0:19	10:28	10:40	0:25
Printing	27	9:48	9:43	0:05	9:54	9:52	0:02
Chemicals	28	10:25	10:00	0:37	10:27	10:04	0:26
Leather	31	10:19	10:05	0:29	10:04	9:54	0:14
Glass/Brick	32	10:07	9:21	0:52	10:02	9:25	0:46
Primary Metals	33	10:04	9:44	0:26	10:06	9:41	0:27
Fabricated Metals	34	9:57	9:35	0:25	10:00	9:47	0:14
Machinery	35	10:04	9:30	0:37	10:03	9:29	0:35
Transport. Equipment	37	9:56	9:19	0:37	9:59	9:54	0:05
Misc: Metals	39	9:50	9:44	0:20	9:39	9:58	0:38
Coke/Gas/Oil	49	10:52	10:34	0:17	10:09	10:09	0:01
Blacksmithing	76	10:28	9:37	0:54	10:24	9:37	0:50
All Industries		10:17	9:45	0:43	10:07	9:49	0:26

Notes:
[1]Calculated strictly on the basis of each firm's reported hours of work between May and November and November and May.
[2]Reported hours of work greater than 14 hours per day treated as shift work by two shifts. Each firm observation is weighted by the sum of its male, female and child workers.

Each column of this table includes firms that list zero winter or summer hours (though not both).

Source: Atack-Bateman 1880 national manufacturing sample.

were more likely to maintain regular hours of work year 'round. In two industries (agricultural services and paper-making), however, workers were likely to find that the workday lengthened as the hours of daylight shortened and larger firms lengthened the day by more than small firms. More typically, however, the workday lengthened in the summer and shrank in the winter. For example, in the construction industry, lumber milling, brickmaking and blacksmithing, firms worked much longer--45 minutes a day or more--in summer than winter and the average employee in these industries could expect at least a half hour a day more work in summer. In some other industries though, such as clothing and printing, longer summer hours across all firms in the industry were a matter of just a few more minutes a day.

However, many of the firms working much longer summer than winter hours were in the same industries as those where other firms were working much longer winter hours. Indeed, at least one firm in each industry reported longer hours in one season than the other. This leads us to infer that there were no industry-specific technological impediments that constrained firms to operate in just one season. Moreover, it means that the simple difference between average summer and winter hours understates the seasonal variation in hours. As an alternative, we have also calculated the mean *absolute* difference between summer and winter hours in Table 4 (columns 5 and 8). The absolute difference in seasonal hours in agricultural services is very large. The average worker in this industry could expect to see a fluctuation of more than 2 hours 45 minutes in the length of their workday between winter and summer. Hours for the average agricultural services firm varied almost as much--2 hours 30 minutes (Figure 3). These differences were double those in any other industry. At the opposite extreme, hours in printing varied hardly at all.

Closer examination of the data reveals substantial regional differences in summer and winter hours and seasonal variations. Summer to winter differences and the mean absolute variation were much greater in the South than elsewhere despite the less pronounced seasonal variation in climate and hours of daylight in that region (Table 5). We also note that southern workers had the longest average working day in summer, 10 hours 20 minutes, while southern firms had the shortest average scheduled hours of work during the

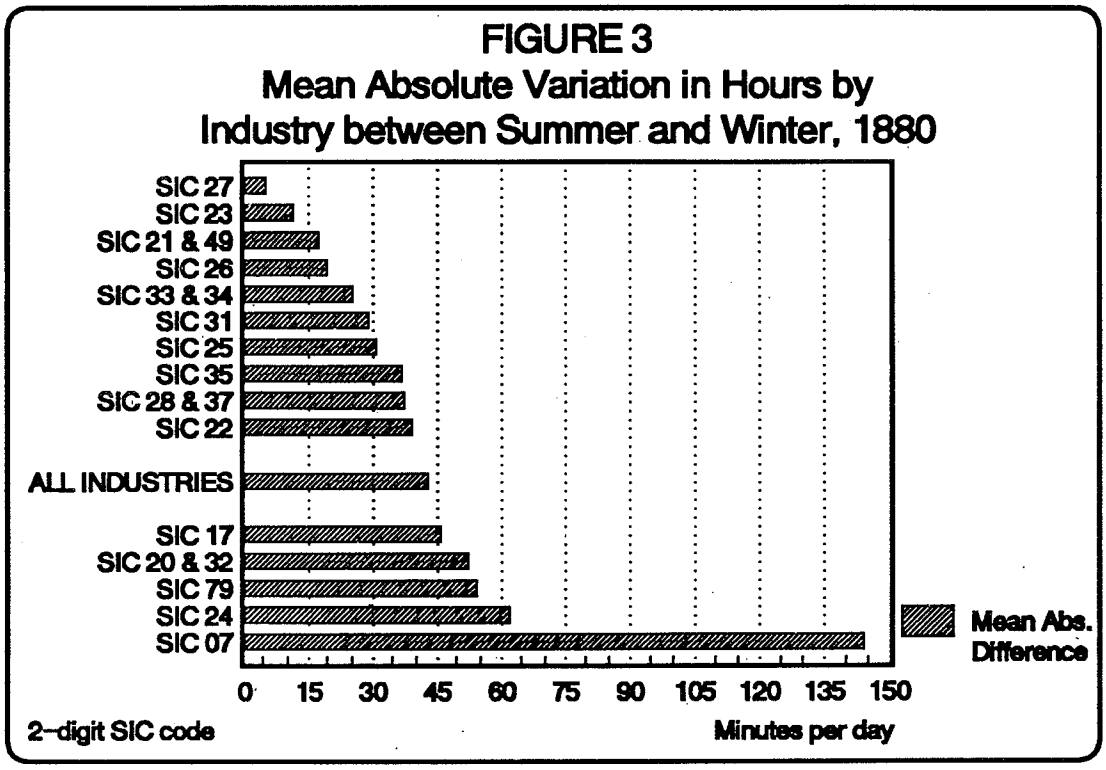


TABLE 5
Regional Differences in the Hours of Work During Summer and Winter in 1880
(Hours:Minutes)

Weighting/ Region	Summer	Winter	(Summer *minus* Winter)	Absolute Difference
By Employment:				
South	10:20	9:36	0:44	0:52
Midwest	10:10	9:44	0:25	0:29
Northeast	10:03	9:54	0:09	0:19
West	10:12	9:52	0:20	0:28
By Firms:				
South	10:12	9:32	0:39	1:02
Midwest	10:16	9:42	0:34	0:42
Northeast	10:20	9:53	0:26	0:36
West	10:15	9:45	0:30	0:31

Source: Atack-Bateman 1880 national manufacturing sample.

summer. The explanation for this seemingly paradoxical result is that the relatively few large southern employers worked long summer hours. The converse was true in the Northeast. There, small firms generally worked long hours and the larger firms worked shorter hours.

(b) Winter hours and the use of artificial light.

We noted earlier that the lengthening of the scheduled working day in summer was consistent with the increased hours of daylight. However, the scheduled winter hours of work shown in Tables 4 and 5 must have exceeded the hours of available daylight for many firms, especially in the more northerly latitudes. According to the *Old Farmers' Almanac*, in mid-December there were about ten and a quarter hours of daylight in the Deep South, about 9 hours 45 minutes in the Midwest and Upper South and less than 9 hours between sun-up and sundown in the Upper Midwest and northern New England.[71] The long winter hours of work, averaging about nine and three-quarter hours, must therefore have required the use of artificial lighting--certainly in the more northerly states. The use of artificial lighting by the Massachusetts textile mills, first with oil and candles and then by coal gas and enhanced by white-washed walls, is well known, but our data suggest that the practice was much more widespread, particularly in the larger establishments which worked longer hours. In the South and in parts of the Midwest, however, average scheduled winter hours seem short enough that the use of artificial light would not have been necessary.

Based upon the number of hours of daylight and the length of the scheduled winter hours of work, we have made some very crude estimates of the use of artificial light in mid-December to meet the scheduled work hours in America's manufacturing establishments. These are shown in Table 6. We believe that these estimates err on the conservative side since we have based our estimates of the need for artificial light solely upon the number of hours between sun up and sundown without regard to difficulties of transmitting outdoor light into buildings. However, this procedure raises the question of why the use of artificial light was not even more extensive earlier in the century when hours of work were even longer. The answer, we believe but do not document here, lies in the decline in the

[71] *The Old Farmers' Almanac, 1989*, (Dublin, NH: Yankee Publishing Inc., 1989), pp. 74 and 80-84.

seasonality of employment.[72] At earlier dates, we think it much more likely that firms cut back hours sharply or shut-down altogether during the shortest days of the year but that this was much less likely towards the end of the century as production was regularized and work routinized.

TABLE 6
Estimated Probability of the Use of Artificial Light by Industry to Meet Scheduled Winter Hours of Work in 1880

Sorted by probability of use of artificial light.

Industry	2-Digit SIC	Estimated Probability of Use of Artificial Light[1]
Agricultural Services	7	.52
Transportation Equipment	37	.54
Construction	17	.56
Lumber	24	.62
Machinery	35	.67
Glass/Brick	32	.68
Blacksmithing	76	.69
Furniture	25	.75
Printing	27	.77
Chemicals	28	.78
Food	20	.78
Misc. Metals	39	.78
Primary Metals	33	.78
Tobacco	21	.79
Fabricated Metals	34	.79
Paper	26	.79
Leather	31	.82
Textiles	22	.82
Clothing	23	.84
Coke/Gas/Oil	49	.96
All		.72

[1]The fraction of firms for which scheduled winter hours exceeded the available hours of daylight in mid-December at each latitude.

Source: The Atack-Bateman 1880 national manufacturing sample

One possible bias in these estimates arises from the variation in hours of daylight from north to south. This makes for considerable variation in the available hours of daylight in some north-south oriented states such as Illinios. Consequently, we have based our estimate of the hours of daylight in each state on the state's center of manufacturing. Thus,

[72]Professors Stanley Engerman and Claudia Goldin are currently investigating this whole issue of employment seasonality but have not yet published their results.

for example, we used 9 hours and 9 minutes as our estimate of the number of daylight hours on December 15 in Illinois, this being the hours of daylight in Chicago while Cairo in southern Illinois had 9 hours and 37 minutes of daylight on the same date.

Overall we estimate that 72 percent of the nation's manufacturing establishments were using artificial light to meet their production schedules in the winter of 1879-80, assuming that these schedules were being maintained in December 1879. The probability of using artificial light was lowest in the agricultural services industry where hours were among shortest anyway and which was concentrated in the southern states where hours of daylight in winter were longest. Even so, perhaps half of all firms in this industry would have had to use artificial light to meet their winter scheduled production hours if they were located close to the manufacturing centers in those states. However, if these firms were concentrated in the southern portions of the states then virtually none would have needed to use artificial light. None of the statistics for the other industries were so sensitive to assumptions about firm location within the states. Thus we conclude that most firms would have needed to use artificial light in the depths of winter to maintain production schedules and in textiles, clothing, and coke, gas and oil production, the probability of using artificial light during winter was over 80 percent. These industries were more common in the northern states where there were fewer hours of daylight in winter and we know that textiles in particular relied heavily upon the use of artificial lighting.

Relatively short winter scheduled hours of work in the South, however, did not mean that southern firms avoided having to use artificial light (Figure 4 and Table 7). Indeed, although the average hours of work during the winter months in the South were only 9 hours 32 minutes and at least this many hours of daylight were available as far north as Richmond, Virginia we estimate that 55 percent of southern firms had established hours during winter that, if actually worked, would have required the use of artificial light. On the one hand, in Alabama and Mississippi fewer than ten percent of establishments would have needed lights in winter while in others as diverse as Georgia and Virginia, more than 60 percent of firms should have needed to use artificial light. In the Northeast and Midwest, more than three-quarters of all establishments may have had to use artificial light during the shortest days of the year and in some of the northern-most states such as Vermont,

Wisconsin and Washington, more than 80 percent would have needed supplementary lighting.

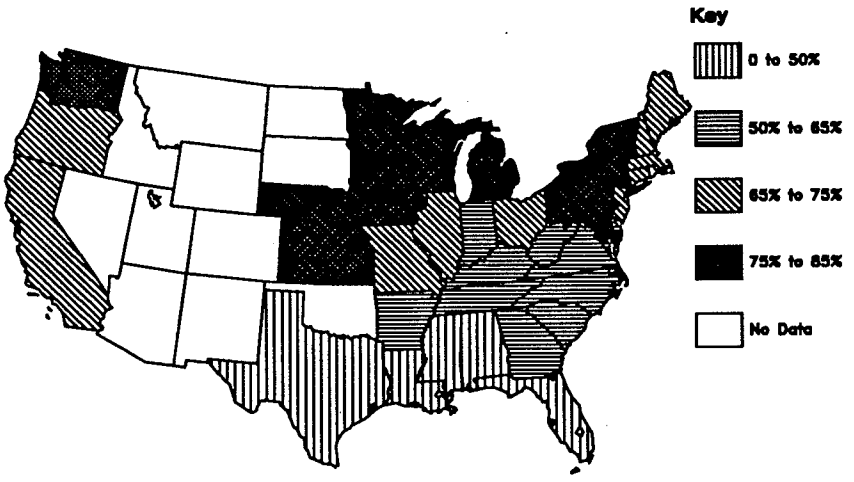
TABLE 7
Regional Reliance upon Artificial Light to Meet Scheduled Winter Hours of Work in Manufacturing in 1880

Region	Estimated Probability of Use of Artificial Light[1]
South	.55
Midwest	.75
Northeast	.77
West	.73
U.S.	.72

[1]See Table 6.

Source: The Atack-Bateman 1880 national manufacturing sample

FIGURE 4
Percent of Firms Using Artifical Light in 1880



Source: Atack–Bateman State Samples from the 1880 Census of Manufactures

A simple logit equation expressing the probability that a firm would have to use artificial light as a function of size (measured by value of output in thousands of dollars), capital intensity (measured by the capital-labor ratio), latitude and dummies to capture industry-specific and region-specific norms and urban-rural location reveals that latitude dominates the decision (Table 8). The results also suggest that larger, more capital-intensive urban firms were much more likely to use artificial light in winter. The coefficients of the regional dummies show that independent regional changes relative to the Northeast (the omitted regional dummy) were unimportant. The industry dummies reveal, however, that some industries, most notably the building trades, were much less likely to use artificial light relative to food processing establishments, the omitted industry dummy variable.

The equation in Table 8 can also be used to investigate what the estimated quantitative impact upon the probability of using artifical light was of changes in latitude, location, industry, firm size and capital intensity. The probability that a firm used artificial light in winter given the firm's characteristics such as industry, location, capital intensity and size represented by the vector X_i^* is given by:

$$p(\text{artifical light}) = 1/[1 + e^{(-\beta_0 - \beta_i X_i^*)}]$$

The possible combinations are infinite. We have therefore chosen to present just a few estimates for firms with specific characteristics and in particular locations. These are shown in Table 9 which shows how this probability changes for firms with specific different characteristics. Continuous variables are set to their mean values unless otherwise noted and the dummy variables are set to either zero or one as given. Thus, for example, for a northeastern flour mill located in rural southern Pennsylvania we estimate the probability that the firm used artifical light in winter to be 0.776, but if the firm was located in Philadelphia (or some other urban area in southern Pennsylvania), the probability rises to 0.828. If the firm instead were located around latitude 44° (in Vermont, say), then the probabilities would be 0.874 and 0.906 respectively. Further, for a food processing firm in Philadelphia producing say $1,000,000 output per year the probability that this firm used artifical light in December 1879 is estimated to be 0.94. At the opposite extreme, the

probability that a rural southern Pennsylvania wagon and carriage maker used artifical light was only 0.422.

TABLE 8
Explaining the Probable Use of Artificial Light by America's Manufacturing Firms in 1880

Logit equation

Variable	ß	t-value	Mean	Variable	ß	t-value	Mean
Constant	-5.78709	-9.719					
Output	.00119	2.241	21.28	Capital-labor	.00006	2.315	940.03
City	.33099	5.273	.48	latitude	.17378	12.141	40.43
South	-.06612	-.605	.18	Midwest	.09491	1.474	.35
West	.06837	.409	.03	SIC 07	.10441	.359	.01
SIC 17	-1.40745	-12.249	.09	SIC 21	-.23592	-1.317	.03
SIC 22	-.11495	-.297	.01	SIC 23	.01255	.070	.04
SIC 24	-.84621	-8.831	.16	SIC 25	-.47949	-2.665	.03
SIC 26	-.36487	-1.242	.01	SIC 27	-.42847	-1.918	.02
SIC 28	-.18129	-.888	.02	SIC 31	.07616	.678	.13
SIC 32	-.62726	-3.662	.03	SIC 33	-.25252	-1.572	.04
SIC 34	-.46882	-1.635	.01	SIC 35	-.89131	-6.961	.06
SIC 37	-1.55657	-4.941	.01	SIC 38	-1.35148	-1.824	.00
SIC 39	-.49276	-2.744	.03	SIC 49	1.31598	1.280	.10
SIC 76	-.59402	-5.402	.10				

Log likelihood = -4185.4069

Matrix of Actual and Predicted Outcomes

Actual	Predicted	
	No Light	Light
No Light	416	1751
Light	261	5315

Percentage predicted correctly = (416+5315)/7743 = 74%

Percentage not using artifical light predicted correctly: 19%

Percentage using artifical light predicted correctly: 95%

TABLE 9
The Impact of Firm, Locational and Industry Characteristics on the Proabability of the Use of Artifical Light During the Winter of 1879.

Firm, locational and industry characteristics	Probability of use of artifical light	
	Rural firms	Urban firms
Base firm	.776	.828
Latitude 44°	.874	.906
Output $100,000	.792	.841
Output $1,000,000	.918	.940
Capital-labor ratio doubled	.786	
Capital-labor ratio + 2σ	.809	
Midwest	.792	.842
Midwest, latitude 44°	.884	.914
West	.788	.838
West, latitude 44°	.882	.912
SIC 17	.459	.542
SIC 24	.598	.675
SIC 25	.682	.749
SIC 27	.693	.759
SIC 32	.649	.721
SIC 35	.587	.665
SIC 37	.422	.505
SIC 76	.657	.727

Computed from the equation: $p(\text{artifical light}) = 1/[1 + e^{(-\beta_0 - \beta_i X_i^*)}]$ using the coefficients for β_0 and β_i from Table 8 and values for X_i as shown below and in Table text:

Mean characteristics (X_i):

Output $21,000
K/L $940/employee

Base firm (X_i):

latitude 40°
Industry SIC 20
Northeast region

(c) Analysis of the variance of hours.

Rather than present a formal model of hours determination, we ran an analysis of variance (ANOVA) to determine whether or not it was useful to categorize the data by industry, urban/rural location, region, latitude and use of water power to explain the variation in scheduled summer and winter hours of work and the difference, both simple and absolute, between summer and winter hours (Table 10). Although we were not able to

TABLE 10
Analysis of Variance of Scheduled Summer and Winter Hours of Work

Summer Hours ANOVA

Number of obs = 8023 R-square = 0.0918
Root MSE = 1.38336 Adj R-square = 0.0769

Source	Partial SS	df	MS	F	Prob > F
Model	1526.21943	129	11.83116	6.18	0.0000
SIC	169.29192	20	8.46460	4.42	0.0000
Latitude	119.66204	15	7.97747	4.17	0.0000
Water	15.24799	1	15.24799	7.97	0.0049
City	.76152	1	.76152	0.40	0.5357
Region	2.86992	3	.95664	0.50	0.6865
SIC*City	225.91452	19	11.89024	6.21	0.0000
City*Water	1.01220	1	1.01220	0.53	0.4739
Latitude*Water	47.52346	14	3.39453	1.77	0.0365
Region*SIC	106.83720	55	1.94250	1.02	0.4439
Residual	15104.8158	7893	1.91370		
Total	16631.0353	8022	2.07318		

Winter Hours ANOVA

Number of obs = 8018 R-square = 0.0869
Root MSE = 1.53928 Adj R-square = 0.0719

Source	Partial SS	df	MS	F	Prob > F
Model	1778.31406	129	13.78538	5.82	0.0000
SIC	245.43786	20	12.27189	5.18	0.0000
Latitude	135.18823	15	9.01255	3.80	0.0000
Water	3.60472	1	3.60472	1.52	0.2148
City	3.14442	1	3.14442	1.33	0.2479
Region	4.61584	3	1.53861	0.65	0.5872
SIC*City	190.48012	19	10.02527	4.23	0.0000
City*Water	9.94663	1	9.94663	4.20	0.0382
Latitude*Water	81.19255	14	5.79947	2.45	0.0019
Region*SIC	157.44272	55	2.86259	1.21	0.1395
Residual	18689.6949	7888	2.36938		
Total	20468.009	8017	2.55308		

Table 10 is continued on page 33

TABLE 10 (continued)
Analysis of Variance of the Simple and Absolute Differences Between Scheduled Summer and Winter Hours of Work

(Summer - Winter) Hours ANOVA

Number of obs = 8017 R-square = 0.0915
Root MSE = 1.36648 Adj R-square = 0.0766

Source	Partial SS	df	MS	F	Prob > F
Model	1482.41534	129	11.49159	6.15	0.0000
SIC	104.76050	20	5.23802	2.81	0.0000
Latitude	79.78866	15	5.31924	2.85	0.0002
Water	4.16061	1	4.16061	2.23	0.1312
City	6.97630	1	6.97630	3.74	0.0504
Region	1.04884	3	.34961	0.19	0.9032
SIC*City	29.57323	19	1.55649	0.83	0.6686
City*Water	17.01522	1	17.01522	9.11	0.0027
Latitude*Water	54.56499	14	3.89750	2.09	0.0098
Region*SIC	89.39337	55	1.62533	0.87	0.7408
Residual	14727.1498	7887	1.86727		
Total	16209.5652	8016	2.02215		

Absolute (Summer - Winter) Hours ANOVA

Number of obs = 8017 R-square = 0.1039
Root MSE = 1.27944 Adj R-square = 0.0893

Source	Partial SS	df	MS	F	Prob > F
Model	1497.07527	129	11.60523	7.09	0.0000
SIC	61.82191	20	3.09110	1.89	0.0096
Latitude	94.79438	15	6.31963	3.86	0.0000
Water	1.15548	1	1.15548	0.71	0.4056
City	32.00977	1	32.00977	19.55	0.0000
Region	2.95554	3	.985181	0.60	0.6179
SIC*City	45.23176	19	2.38062	1.45	0.0909
City*Water	6.37694	1	6.37694	3.90	0.0457
Latitude*Water	23.93145	14	1.70939	1.04	0.4048
Region*SIC	141.12318	55	2.56588	1.57	0.0047
Residual	12910.814	77887	1.63697		
Total	14407.8892	8016	1.79739		

estimate fully saturated ANOVA models of the independent factors and all possible combinations of the interaction of these factors, we estimated models which incorporated the independent factors and a number of two-way interactions which we thought might be important.[73]

Industry, represented by the 2-digit SIC codes, was intended to capture some of the influences of technology and general market conditions upon hours.[74] Latitude, approximated by the latitude (rounded to the nearest degree) of a state's principal manufacturing center, was intended to capture length-of-daylight and climatic effects. Waterpower, represented by a dummy variable for whether or not a firm used water as its motive power, was thought to capture climatic limitations that might affect operation during winter and the water flow requirements and storage demands created by running long hours. "City" was a dummy variable for whether or not the firm was located in an incorporated community with at least 2,500 inhabitants. Our thought was that it might capture some of the labor market constraints in the form of worker preferences and employment opportunities. Region was intended as a proxy for culture.

Four different two-way interactions were also introduced into the ANOVA. The interaction between city and industry was intended to take account of the alleged differences in industry mix between urban and rural areas, given the differences in hours between industries shown in Table 4 and our expectations about the effects of urbanization upon hours.[75] An interaction term between waterpower and urbanization was included to reflect our expectation that reliance upon waterpower would limit long hours especially in winter and the limited opportunities to build a large urban-industrial complex around waterpower because of the fixed capacity of the site, the expense of building a network of

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[73]Unfortunately, we could not run one potentially important intereaction, that between industry and latitude (as a proxy for climate, resource endowments, etc.), because of computer software and computer memory restrictions. There were 22 2-digit SIC codes identified in the data and 16 different latitudes. Instead, we substituted the interaction between industry and region. This proved to be statistically insignificant.

[74]Two industries, SIC 36 (Non-ferrous metals) and SIC 38 (Instruments) were pooled as "miscellaneous manufacturing" because of their small sample sizes. See Table 3.

[75]See David R. Meyer, "Midwestern Industrialization and the American Manufacturing Belt in the Nineteenth Century," *Journal of Economic History*, 49 4(December 1989), pp. 921-938 and David R. Meyer, "Forging the American Manufacturing Belt: Regional Urban-Industrial Dynamics in the Nineteenth Century," unpublished typescript (Brown University, 1989).

canals and competing demands for urban uses of the water.[76] We expected the interaction between latitude and waterpower to pick up the dependency of waterpower upon climate. Lastly, we modeled the general impact of culture and location upon industry mix by interacting the regional dummy variables with 2-digit SIC groupings.

Regardless of whether or not one accepts our implicit assumption that the variables actually capture only these factors, the ANOVA results suggest that these divisions and classifications are potentially useful. The results reveal that these independent variables and their interactions jointly "explain" a statistically significant proportion of the variation in the dependent variable. In each ANOVA, latitude and industry are important independent factors influencing hours; and waterpower was important only in the summer. Urban location which proved not to be useful a particularly useful categorization in explaining summer and winter hours was marginally important in explaining the difference between summer and winter hours and very important as a factor influencing the absolute difference in hours between summer and winter. Rural areas were more likely than urban to have different summer and winter hours and the absolute size of the difference was strongly associated with location. The results also show that there were statistically significant interactions between latitude and waterpower with hours (although these were not important for explaining the absolute difference between summer and winter hours), urban location and waterpower with hours (except in summer), and the type of industry and urban location with hours (except in explaining the difference between summer and winter hours). As we have noted, there is considerable evidence, both qualitative and quantitative, in support of each of these relationships. The posited interaction between region and industry, however, proved to be statistically insignificant except as a factor in the absolute difference between summer and winter hours. In particular, firms in each industry in the South were much more likely to have substantial summer to winter hours variations than firms in those same industries located elsewhere.

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[76]See Louis C. Hunter, *A History of Industrial Power in the United States, 1780-1930. Volume 1: Waterpower in the Century of the Steam Engine*, (Charlottesville, VA.: University Press of Virginia, 1979).

THE DISTRIBUTION OF HOURS OF WORK IN 1880

As discussed above, we averaged summer and winter hours to determine average hours during the 1880 census year except where zero hours were reported for one of the six month periods. In such cases we used the reported hours for the other six month period as our estimate of average hours during the year. For employees, we also assumed that hours in excess of 14 hour per day represented shift work by two shifts. As a result, some of the difference between the hours of operation for firms and the weighted hours of work per employee is accounted for by the truncation of the workday for employees. The effect of this, however, was very small and most of the difference reflects differences in hours between firms of different sizes. The usual situation, according to a survey conducted by Carroll D. Wright, was for smaller firms to work longer hours than the large firms to compensate for older machinery and other productive inefficiencies.[77] Indeed, Wright argued that this economic necessity made small firms the major source of political opposition to the passage of laws limiting the length of the working day.[78] Our data, however, often shows the opposite result. In 1880, it was the larger, not the smaller, firms in many industries that operated longer hours. But, in most cases, the differences were small.[79]

Our estimate of the overall distribution of hours weighted by employment during the 1880 census year is shown in Figure 5. The distribution of scheduled hours of work by firm was not that much different except that less than one percent of all firms in the national sample had scheduled hours of work that exceeded fourteen per day. These estimates of the daily hours of work, however, take no account of part-time work or layoffs.

More than 57% of the firms, employing almost 66% of the total labor force, reported that workers averaged exactly ten hours in an ordinary day's labor. Fully two-thirds of the workforce had scheduled hours of work of between ten but less than eleven hours per day.

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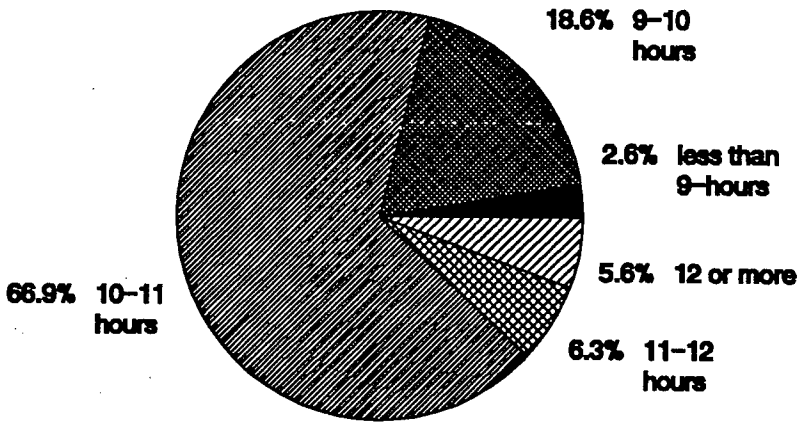
[77]Massachusetts. Bureau of Statistics of Labor, *Twelfth Annual Report*, (Boston: Rand and Avery, 1881), "Uniform Hours of Labor," pp. 323-475, especially pp. 382-98 and p. 467.

[78]*Ibid.*, p. 467.

[79]See Table 13 below.

This fraction is somewhat higher than that reported by Weeks as working ten hours.[80] Moreover, whereas the *Weeks Report* classified over 14% of establishments as working 12 to 13 hours, our data show fewer than 6% of all employees worked that long. At the same time, more than twenty percent of firms had cut scheduled hours to less than the standard of ten hours per day averaged over the year. However, the eight-hour day--the labor union goal of the 1880s--was still a long way away for most workers as less than four percent of firms had adopted a workday that short by 1880 and they employed less than two percent of the labor force.[81] The distribution of hours was thus slightly skewed in favor of longer, rather than shorter, hours.

FIGURE 5
The Distribution of Hours in an Ordinary Day of Labor, 1879/80.



(Weighted by employment)

[80]Weeks recorded 59.6% of employees as working a ten-hour day. See *Weeks Report, op. cit.*, p. xxix.

[81]For a history of the 8-hour movement in America, see John R. Commons, et al., *History of Labour in the United States*, Vol. 2 (New York: Macmillan, 1926), especially Chapter 4. Federal workers, however, achieved the 8-hour day by Executive Order of President Grant on May 19, 1869. See Marion Cotter Cahill, *Shorter Hours*, (New York: Columbia University Press, 1932): 69-71, also Matthew A. Kelly, "Early Federal Regulation of Hours of Labor in the United States," *Industrial and Labor Relations Review*, 3, 3(April 1950): 362-74.

Estimates of modal hours for plants and workers by industry were singularly uninteresting. In every case the mode was the same--ten hours a day. Estimates of hours for the median plant and the median worker were almost as uninteresting. Ten hours was the norm everywhere for the median plant in each industry and region and for the median worker in the Midwest and Northeast. The only deviations occured in three southern industries and two western ones: the median worker in southern tobacco plants and machine shops and western construction trades had a 9.5 hour day while in southern furniture and western lumber milling the median worker could expect an 11 hour day. This high degree of uniformity only serves to emphasize our claim that the ten-hour day was the norm in American manufacturing by 1880.

(a) How Pervasive Was Shift Work?

Weeks argued that many of those who worked twelve hours were shift workers.[82] If so, then our results suggest a much smaller percentage of plants were operated on a shift basis. Whereas the hours distribution reported by Weeks is bimodal at ten and twelve hours,[83] ours is unimodal with a fractionally smaller percentage of plants operating 12 than 11 hours a day (7.45% versus 7.52%) and fractionally fewer workers working twelve than eleven hours (see Figure 5).

This does not, of course, permit us to reject the hypothesis that the distribution of hours we report is the aggregation of two quite separate and different distributions, one for non-shift work, the other for shift work. Nor does the 1880 census help resolve this problem since no notation was made on the schedules themselves regarding shift work. However, a small number of plants obviously operated "double turn" since they reported 24 hours as an ordinary day of labor.[84]

Since the Census gives no direct evidence on shift work, we have tried to approach the problem indirectly by looking at the distribution of hours in those industries such as

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[82]*Weeks Report, op. cit.*, p. xxviii

[83]*Ibid.*, p. xxix.

[84]This is indicative of the ambiguity in the question of the "number of hours in the ordinary day of labor." Were firms to report hours that they operated or hours that a laborer worked? Certainly those reporting 24 hours adopted the former convention.

brewing, chemicals and primary metals that might be characterized by continuous production processes. If workers in these industries worked shifts, our expectation was that we would observe a greater proportion of *plants* operating 8 or 12 hours as an ordinary day of labor compared with other industries. This proved to be the case. During the summer months, 18% of firms in these industries reported working 12 hours a day compared with only 7.5% among all industries, while almost 7% worked an 8 hour day in contrast to about 3% across all industries. During the winter months, 13.5% worked 12 hours and 13.5% also worked 8. Nevertheless, ten hours was still the most commonly scheduled work period--one not amenable to continuous production with shift workers--and, although we cannot rule out the possibility of plain ten-hour shifts, we think such shifts were unlikely and infrequent.

(b) Industry Differences in the Scheduled Hours Of Work

With more than half of the firms and two-thirds of the employees working a scheduled ten-hour day, there would seem little point investigating regional and industry differences in hours of work in 1880. Certainly we found that in every industry in each region and across the entire sample the median and modal number of scheduled hours for firms was ten hours per day.

However, while a scheduled workday of ten-hours can be considered standard by 1880, there remained statistically significant differences in the average scheduled hours per firm across regions and industries because of deviations from the norm (Table 11). The extremes may be represented by the food industry (SIC 20) on the one hand where firms outside of the South operated for about eleven hours a day and the agricultural services (SIC 7), construction (SIC 17), printing (SIC 27) and transportation equipment industry (SIC 37) on the other which operated only about nine and three quarter hours or less per day. As a result we estimate that the mean scheduled hours of work nationwide in 1879/80 was 10 hours 5 minutes per day. This is only two minutes per day less than that estimated

Table 11
The Average Daily Scheduled Hours of Operation by Region and Industry in 1880
(Hours:Minutes)
Standard deviations are shown in parentheses

Industry	2-digit SIC	Region: Midwest	Northeast	South	West	U.S.
Agricultural Services	7	--	--	9:43 (1:25)	--	9:45 (1:22)
Construction	17	9:37 * (0:35)	9:42 * (0:50)	9:44 * (0.44)	9:40 * (0:40)	9:40 * (0:37)
Food	20	10:55 * (1:39)	11:01 * (1:55)	10:00 (1:35)	11:03 * (1:38)	10:42 * (1:48)
Tobacco	21	9:47 * (0:43)	10:00 (1:00)	9:51 (0:49)	--	9:53 (0:52)
Textiles	22	10:09 (0:39)	9:53 (0:30)	--	--	10:01 (0:39)
Clothing	23	9:59 (0:40)	10:06 (1:02)	10:09 (0:45)	--	10:03 (0:54)
Lumber	24	9:58 (0:48)	9:59 (0:49)	9:46 * (1:03)	10:17 (0:58)	9:57 * (0:53)
Furniture	25	9:53 (0:40)	9:49 * (0:36)	10:12 (1:05)	--	9:53 * (0:43)
Paper	26	10:20 (1:00)	10:15 (1:00)	--	--	10:14 * (1:01)
Printing	27	9:55 (0:28)	9:42 * (0:35)	9:42 (0:46)	--	9:45 * (0.36)
Chemicals	28	10:24 * (1:04)	10:25 * (0:51)	9:53 (1:06)	--	10:16 * (1:32)
Leather	31	10:12 * (0:52)	10:11 * (0:58)	10:16 * (1:20)	10:00 (0:51)	10:12 * (1:01)
Glass/Brick	32	9:48 * (0:43)	9:57 (0:54)	9:44 * (0:43)	--	9:51 * (0:46)
Primary Metals	33	9:54 (0:37)	9:54 (0:43)	9:56 (0:34)	--	9:54 * (0:40)
Fabricated Metals	34	9:45 (1:00)	9:52 * (0:18)	--	--	9:49 * (0:39)
Machinery	35	9:43 * (0:49)	9:49 * (0:31)	9:49 * (0:33)	9:43 * (0:25)	9:47 * (0:35)
Transportation Equipment	37	--	9:40 * (0:30)	--	--	9:37 * (0:33)
Miscellaneous Metals	39	9:39 * (0:51)	9:55 (0:48)	9:54 (0:17)	--	9:52 * (0:46)
Coke/Gas/Oil	49	--	10:37 * (0:48)	--	--	10:42 * (0:54)
Blacksmithing	76	9:59 (0:52)	10:09 * (0:46)	9:58 (0:57)	9:40 * (0:40)	10:03 (0:49)
All Industries		10:05 * (1:03)	10:09 * (1:10)	9:56 (0:13)	10:00 (0:58)	10:05 * (1:07)

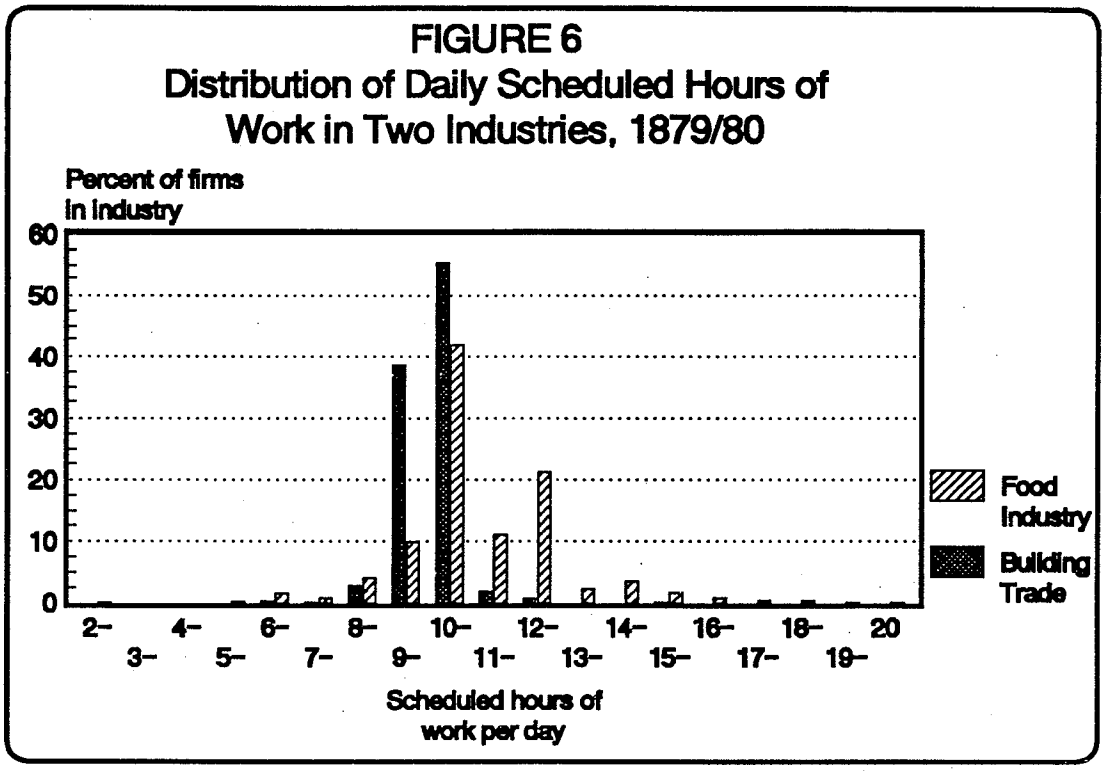
-- Insufficient observations (minimum of 15)
* Significantly different from 10 hours per day with 95% confidence.
Source: Atack-Bateman 1880 national sample.

by Weeks but considerably shorter than reported by Aldrich.[85] However, close as this estimate is to a flat ten hours per day, it is statistically significantly different from ten hours per day with a confidence greater than 99.99%. So too were the regional estimates for the Midwest and Northeast. Moreover, although the range of hours from the region with the longest average scheduled hours, the Northeast, to that with the shortest, the South, is small--13 minutes a day--it does mean that firms in the Northeast and Midwest operated perhaps an hour longer each week than the average firm in the South.

Those industries where the regional or national estimates of average scheduled hours of operation was statistically significantly different (with 95% confidence) from ten hours per day are marked with an asterisk. A majority of industries in the Northeast and nationwide are so marked but the statistics on the median and modal values make it clear that these deviations from the ten-hour norm result from a number of firms in each industry working either especially long or especially short hours. For example, in the building trades (SIC 17) more than half of the firms (54.42%) worked exactly 10 hours a day with a range from six to fifteen hours and an inter-quartile range between 9 and 10 hours while in the food industry (SIC 20) although over 40% of firms worked exactly 10 hours, the range was from 2 hours per day to 20 hours per day with an inter-quartile range of 10 to 12 hours (Figure 6). Thus, in the one industry there was considerable uniformity in scheduled hours of work across firms while in the other, firms were much more heterogeneous in terms of their hours of operation.

Some industries were regional. Most agricultural service firms, for example, were found in the South and this industry had among the shortest average scheduled work hours whereas paper-making where hours tended to be long was more concentrated in the Northeast. At the same time, although average scheduled hours of operation across all firms was shortest in the South, southern firms in some industries such as the building trades, clothing, furniture and leather had longer hours on average than those elsewhere. Similarly, northeastern textile mills and cabinet-makers had shorter average hours than

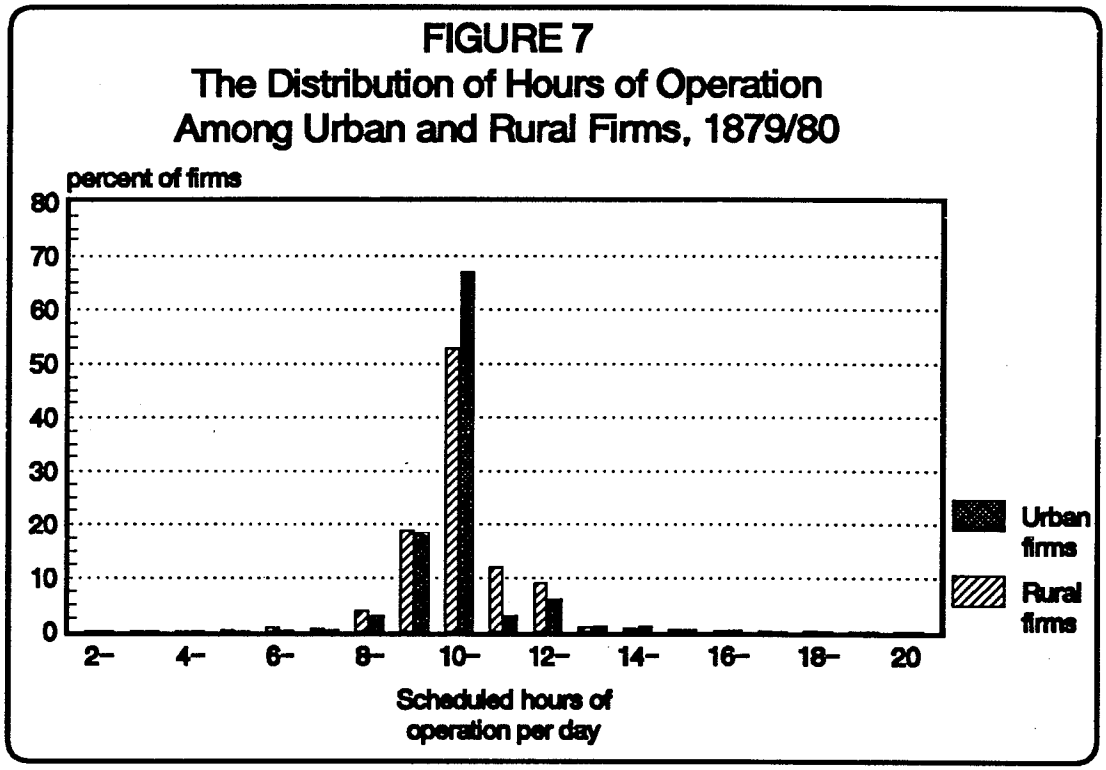
[85]See Table 2 above.



firms in these same industries in other regions. Clearly, then industry mix and region mattered in hours determination.

Another factor that seems to bear upon the distribution of scheduled hours of work is whether the establishment was in a rural or urban area, where urban is defined as any incorporated town or city with a population of 2,500 or more. Rural firms were much morelikely to work longer hours primarily because a much larger fraction of rural firms operated eleven and twelve hours a day (Figure 7). Some of this reflects differences in the industry mix and differences in the organization of firms as between artisan shops, sweatshops, manufactories, mills, and factories, but it may also have been influenced by labor opposition to long hours which found more forceful expression in concentrated impersonal urban environments. Moreover, since the journey to work was almost certainly much longer in rural than urban areas, rural workers must have spent much longer away

from home each day in work-related activities than city residents.[86] The hours of urban firms, however, were not always less than those of the rural. For example, rural food processors operated for an average of 10 hours 29 minutes a day whereas their urban counterparts averaged 11 hours 5 minutes a day. This difference is both large and statistically highly significant. In most industries, though, rural firms worked a few minutes longer each day than firms in towns and cities, especially in the paper industry where rural mills operated 52 minutes a day longer those in cities.[87]



[86]Hershberg et al., for example, found that while the journey to work in Philadelphia almost doubled between 1850 and 1880, workers still typically lived within a mile of work and most blue-collar workers lived even closer. See Theodore Hershberg, Harold E. Cox, Dale Light, Jr., and Richard R. Greenfield, "The "Journey-to-Work": An Empirical investigation of Work, Residence and Transportation, Philadelphia, 1850 and 1880," in Theodore Hershberg (ed.), *Philadelphia*, (Oxford University Press, 1981): 128-73.

[87]Paper mills were more or less evenly divided between urban and rural locations in 1880.

We are not yet in a position to model the market determination of hours since we have no information on labor supply.[88] Instead we posit that hours were determined by custom--of the region, industry and urban/rural location--rather than by factors such as capital intensity and labor preferences. All of the independent variables are binary and the dependent variable is the number of hours that each firm worked in excess of the national average of 10 hours five minutes per day. Consequently there is no constant term in the equation and the coefficients directly measure the shortfall or excess hours for firms with each characteristic compared with the national average. The results are shown in Table 12. This model is, in essense, a repeat of Table 11 that performs significance tests of the difference between the cell values and the global average. For example, we see that the coefficient for southern agricultural service firms is -0.3587, that is to say these firms operated 22 minutes less per day than the average firm nationwide which is precisely the difference shown in Table 11. The only difference between the two variants is that the estimate in Table 12 also tells us that this difference was statistically significantly different from the national average whereas in Table 11 we could not reject the hypothesis that these firms worked a ten-hour day. The one additional item of interest that we can glean from this table is that urban location was not a statistically significant explanatory variable after controlling for region and industry.

HOW MANY HOURS A DAY DID PEOPLE WORK IN 1880?

Just as most firms operated on a ten-hour per day work schedule, so too most employees also seem to have worked a ten-hour day. The modal hours or work for employees was ten-hour per day in every industry and region and the median employee was typically scheduled to work ten hours a day. However, hours for the median worker in a number of southern and western industries departed from this standard workday. For example, in southern tobacco firms and western construction trade firms the median employee worked 9 hour 30 minutes a day while in southern furniture-making and western

[88]We are currently linking the ICPSR 1880 Census data to our manufacturing sample. When completed this will provide aggregate county-level evidence on labor force characteristics such as age, sex, literacy and ethnic mix from which to estimate labor supply.

TABLE 12
How Different Were Scheduled Hours of Operation in 1879/80 from the National Average by Industry and Region? (Decimal hours)

Variable	Coefficient	Standard Error	Variable	Coefficient	Standard Error
Urban	-.013507	.0274255			
South:			Northeast:		
SIC 7	-.358721 *	.1486474			
SIC 17	-.3450881 *	.1428624	SIC 17	-.3735033 *	.0603045
SIC 20	-.0902349	.0543717	SIC 20	.9396558 *	.0478636
SIC 21	-.2173485	.165251	SIC 21	-.0747529	.1010665
SIC 22	.3183542	.4796528	SIC 22	-.1898554	.2074951
SIC 23	.0700213	.2612534	SIC 23	.0240195	.0820603
SIC 24	-.3141034 *	.0636382	SIC 24	-.0915997	.0500536
SIC 25	.1204571	.2067104	SIC 25	-.2547215 *	.1059055
SIC 26	-.8296198	.5363471	SIC 26	.1826495	.143212
SIC 27	-.3719497	.261099	SIC 27	-.3777979 *	.12834
SIC 28	-.1939575	.1604038	SIC 28	.3513031 *	.1124825
SIC 31	.1812811 *	.081338	SIC 31	.1036623 *	.0515836
SIC 32	-.3430337	.1813544	SIC 32	-.1266638	.1319235
SIC 33	-.1492864	.176973	SIC 33	-.1763005	.0937291
SIC 34	-.1595763	.4384619	SIC 34	-.2072911	.1648134
SIC 35	-.2519155	.1307518	SIC 35	-.2586731 *	.0753481
SIC 37	-1.582997 *	.7580753	SIC 37	-.4033478 *	.184933
SIC 39	-.1778638	.2157352	SIC 39	-.1478101	.0897756
SIC 76	-.1185631	.0851756	SIC 76	.0790735	.0571375
Other industries	.923757	.7584473	Other industries	.2405153	.2153919
Midwest:			West:		
SIC 7	-.2079965	.5361279	SIC 7	-.076243	1.072256
SIC 17	-.4637736 *	.0704981	SIC 17	-.4058535	.224425
SIC 20	.8327259 *	.0528289	SIC 20	.9696101 *	.2029117
SIC 21	-.2846679 *	.1183768	SIC 21	-.7429097	.4384619
SIC 22	.0757861	.2686388			
SIC 23	-.0925808	.1045306	SIC 23	-.3540208	.3583527
SIC 24	-.1100075 *	.0492841	SIC 24	.2018797	.1925381
SIC 25	-.1883227	.1172079	SIC 25	-.3658164	.4056153
SIC 26	.2516875	.2772534	SIC 26	.673757	.7584473
SIC 27	-.1468806	.1631463	SIC 27	-.576243	.3799667
SIC 28	.3210556	.1708973	SIC 28	-.176243	.4801544
SIC 31	.1136388 *	.0540078	SIC 31	-.0804348	.1999444
SIC 32	-.2751875 *	.1035263	SIC 32	-.0829965	.7580753
SIC 33	-.1859621 *	.0941071	SIC 33	-.1968226	.2977716
SIC 34	-.312728	.1968285	SIC 34	-.576243	.7584473
SIC 35	-.3606419 *	.087779	SIC 35	-.347412	.277368
SIC 37	-.3284942	.4381998	SIC 37	-.576243	.619472
SIC 39	-.418669 *	.1488328	SIC 39	-.1229254	.3241518
SIC 76	-.0975347	.0606686			
Other industries	.5881725	.3102752	Other industries	-.4058853 *	.186641

OLS Regression model: (Scheduled Hours - 10.08975) = β_1Urban dummy + β_i(Regional dummy*Industry dummy) + ϵ
F (78, 7928) = 13.03 R^2 = 0.1137
* Significantly different from zero at better than the 95 percent level.

lumber-milling the median employee was scheduled for an 11 hour workday. Still, these were the exceptions to the ten-hour norm and the average across all industries and regions was exactly 10 hours, confirming once again our assertion that the ten-hour day was achieved perhaps a decade earlier than previously thought.

The data in Table 13 represent our best estimates of the average hours in an ordinary day's labor over the course of the year from June 1879 through May 1880 broken down by industry and region. These are calculated using the estimates of hours underlying Table 11, but with each firm's hours weighted by their employment rather than counting equally in the determination of the average. Nationwide, workers averaged especially long hours (10 hours 15 minutes or longer per day) in the food, paper-making and chemical industries while in the building trades workers averaged only 9 hours 45 minutes. In western lumber milling, hours were even longer, averaging over 11 hours a day.

Where these estimates exceed those in Table 11, firms with larger workforces operated longer hours than those with small labor forces. They are marked with an asterisk in Table 13. Where the estimates in Table 13 were for shorter hours than in Table 11, those firms with large numbers of employees generally operated shorter hours than those employing relatively few workers. Carroll Wright's claim that the smaller firms tended to rely more heavily upon longer hours proved to be true for the Northeast and Midwest as a whole, but not in the South and West.

CONCLUSIONS

Our goal in this paper was simply to use our newly developed firm-level sample data from the 1880 Census of Manufactures to generate the first industry and regional level estimates of the length of the working day in 1880, rather than present new and radical reinterpretations of late nineteenth century labor history. Nevertheless our estimates have led us to one new and important conclusion namely that the ten-hour day had been achieved by perhaps two-thirds of all industrial workers by 1880--a decade earlier than the traditional dating and in advance of the widespread and persistent labor agitation of the

Table 13
The Average Scheduled Hours of Work per Day by Region and Industry in 1880 (Hours:Minutes)
Standard deviations are shown in parentheses

Industry	2-digit SIC	Region: Midwest	Northeast	South	West	U.S.
Agricultural Services	7	--	--	9:57 * (1:02)	--	9:57 * (1:00)
Construction	17	9:39 * (0:36)	9:42 (0:37)	9:44 (0:34)	9:34 (0:30)	9:41 * (0:36)
Food	20	10:21 (1:01)	10:16 (1:13)	10:09 * (1:15)	10:39 (1:17)	10:17 (1:09)
Tobacco	21	9:52 * (0:36)	10:05 * (0:37)	10:00 * (0:44)	--	9:58 * (0:42)
Textiles	22	10:06 (0:23)	9:58 * (0:16)	--	--	10:12 * (0:28)
Clothing	23	9:51 (0:26)	10:01 (0:42)	10:09 (0:38)	--	9:59 (0:40)
Lumber	24	10:07 * (0:45)	9:57 (0:43)	9:57 * (1:02)	11:09 * (0:58)	10:07 * (0:53)
Furniture	25	9:50 (0:33)	9:52 * (0:34)	10:18 * (1:01)	--	9:47 (0:42)
Paper	26	10:10 (0:55)	10:42 * (0:55)	--	--	10:33 * (0:55)
Printing	27	9:58 * (0:10)	9:51 * (0:23)	9:58 * (0:28)	--	9:53 * (0:22)
Chemicals	28	10:10 (0:37)	10:10 (0:53)	10:37 * (1:18)	--	10:20 * (1:04)
Leather	31	10:00 (0:35)	9:57 (0:26)	10:00 (1:00)	10:00 (0:25)	9:58 (0:31)
Glass/Brick	32	9:45 (0:37)	9:58 * (0:49)	9:36 (0:48)	--	9:48 (0:43)
Primary Metals	33	9:55 * (0:25)	9:52 (0:36)	9:57 * (0:20)	--	9:53 (0:31)
Fabricated Metals	34	9:53 * (1:00)	9:53 * (0:13)	--	--	9:54 * (0:22)
Machinery	35	9:43 (0:26)	9:51 * (0:22)	9:40 (0:22)	9:42 (0:25)	9:46 (0:24)
Transportation Equipment	37	--	9:55 * (0:15)	--	--	9:55 * (0:16)
Miscellaneous Metals	39	9:43 * (0:36)	9:58 * (0:46)	9:52 (0:18)	--	9:57 * (0:43)
Coke/Gas/Oil	49	--	10:03 (0:15)	--	--	10:08 (0:29)
Blacksmithing	76	9:54 (0:42)	10:06 (0:45)	10:00 * (0:57)	9:40 (0:39)	10:00 (0:46)
All Industries		9:58 (0:42)	9:59 (0:40)	10:01 * (0:56)	10:01 * (1:06)	10:00 (0:44)

-- Insufficient observations (minimum of 15)
* The larger firms in this industry and region, measured by employment, had longer hours.
Source: Atack-Bateman 1880 national sample.

1880s. Other interesting, but less important findings also emerge from our estimates of hours. First, the hours estimate for 1880 as reported in oft-maligned *Weeks Report* is consistent with our independent estimates while that in the much more widely-used *Aldrich Report* is not, suggesting a need to reappraise the respective merits of these two sources. Second, seasonality in terms of hours of work, especially shorter winter hours, was much less pronounced than we had supposed. Instead, most firms maintained their hours year 'round which must have forced between two-thirds and three-quarters of all firms to use artificial light during the depths of winter. The data also suggest that as of 1880 shift work had not yet become common. Lastly, the data reveal small, but statistically significant, differences in hours between industries, regions (especially between the South and elsewhere) and urban versus rural location which preliminary research suggests were amplified many-fold by differential rates of seasonality.

In subsequent papers we will investigate the determination of these hours; how long the working year was and the estimating how widespread seasonal unemployment might have been; what role, if any, was played by early protective legislation to limit the length of the working day; whether what today we would still consider long hours of work at ten hours per day had an adverse effect upon labor productivity; the nature of the relationship between hours and wages; and the implications of these findings for late nineteenth century labor history.