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Part-Year Operation in 19th Century American Manufacturing: Evidence from the 1870 and 1880 Censuses

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Introduction

The growth of manufacturing was central to the economic development of nineteenth century America. In the early stages of industrialization, the commitment to produce was frequently seasonal or part-time, and establishments might shut down operations for weeks or months at a time. But, as transportation improved and markets widened in their geographic scope and, as technological and organizational change created economic incentives for more continuous operation, it is generally believed that a growing share of establishments operated on a full-time equivalent basis throughout the year. In turn, a greater likelihood of full-year operation may have enhanced the rate of investment and/or the pace of technological change in manufacturing, providing an engine for endogenous growth.[1]

The conventional wisdom that part-year operation in American manufacturing declined in significance over the course of the nineteenth century rests, however, on limited quantitative evidence especially for periods prior to the very end of the century.[2] This paper uses random samples from the surviving manuscripts of the 1870 and 1880 censuses of manufacturing to document the extent of part-year operation during the early post-bellum period.[3] Our major finding is that, in both 1870 and 1880, the typical establishment (regardless of whether weighted by its capital stock or by employment) was "full-year" -- that is, operated on a full-time equivalent basis for twelve months, with no (reported) periods of "short-time" or periods at less than full-time equivalent operation. However, full-year operation was far from universal. Substantial numbers of establishments -- for example, nearly 40 percent in 1880 -- were "part-year"; that is, they relied on short-time at some point during the year, or else had not operated for the full twelve months.

Econometric analyses reveal that the likelihood of part-year operation varied across industries, location, and establishment characteristics. In particular, large, capital-intensive establishments were less likely to be part-year. We also show that workers at part-year establishments, on average, received higher monthly wages than workers at full-year establishments, a differential that is consistent with the hypothesis that workers at part-year establishments required some compensation for the loss and inconvenience of annual downtime.

ESTABLISHMENT-LEVEL EVIDENCE: THE 1870 AND 1880 CENSUSES OF MANUFACTURING

The United States government began collecting a "census" of manufactures as early as 1810.[4] Like such surveys today, those conducted in the nineteenth century were intended to be a complete enumeration of all establishments in existence--a goal not remotely achieved until 1850. To be counted, however, a plant did not necessarily have to be in operation at the time the censuses were taken. Moreover, establishments may have been new entrants -- that is, commenced production during the census year. By definition, such establishments could not have operated for the entire census year even if their modus operandi was full-time production. More fundamentally, establishments could also be part-year if they ceased operations for some portion of the census year.[5]

If we imagine the smallest possible period of production to be an hour, then the maximum annual number of hours an establishment could have been operating was 8,760 hours = 24 hours per day, 365 days per year. From this maximum, establishments had several ways to adjust their operating time downward. On a daily or weekly basis, they might reduce the number of hours per day or days per week. This might happen routinely or occasionally, but the plant otherwise remained in operation every week throughout the year. In addition (or possibly as an alternative), they might shut down for a longer period--a few weeks, a month, or more.

As a general rule the earlier censuses of manufacturing did not identify part-year establishments.[6] The first regular attempt to do so systematically was at the Ninth Census in 1870, when a single question was asked about the number of "full-time equivalent" months of operation.[7] A more satisfactory state of affairs prevailed in 1880, when two questions on average daily hours were asked, along with four questions about the number of months of operation -- in particular, the number of months of "full-time" operation, the number of months on three-fourths time, the number of months on two-thirds time, and the number of months on half-time. The census apparently presumed (as do we) that anything less than half-time constituted a full month of downtime. These data, especially those for 1870, are not ideal but are the best information currently available on a national basis for the period.[8] The 1870 and 1880 samples are described in detail elsewhere. For our purposes here, what is important is the samples were designed to be nationally representative of the universe of surviving manuscript returns from the two federal censuses of manufacturing.[9]

We have taken the 1870 data at face value and used them to compute the average number of full-time equivalent months (FTE), percentage of "full-year" establishments (that is, twelve months of full-time equivalent operation) and the average number of full-time equivalent months among establishments that were part-year. For 1880, we estimate similar statistics from the more detailed breakdown provided by the census, together with estimates of total months of operation, hours per day, days per month, and annual hours. Days per month and annual hours are estimated separately for full and part-year establishments.[10]

Neither census specified directly how many days of operation constituted a full-time equivalent month. It is widely believed, however, that the typical full-time work week in manufacturing, ca. 1870-80, consisted of six days, Sunday being a day of rest. Based on this evidence, we assume that a full-time equivalent work year consisted of 309 days, or 25.75 days per full-time equivalent month.[11] Let m_j be the number of months of type j (j = full-time, three-quarters, two-thirds, and half-time). Our estimate of the average number of days per month is $D = \Sigma d_j \times s_j$ where d_j is the average number of days in a month of type j, and s_j is the share of total months, M ($= \Sigma m_j$).[12] Our estimate of average annual hours of operations is H x D x M, where H is average daily hours.[13]

Neither census routinely identified new entrants.[14] Thus, for example, if we observe variation in the incidence of part-year operation across industries or regions (as we do) we do not know how much of the variation can be attributed to differences in entry rates or to differences in shut-down behavior among established enterprises.[15] For this reason, as well as the fact that workers at established firms could have sought employment elsewhere during periods of downtime -- especially where downtime were anticipated or customary -- our estimates are not the same as average annual months (or hours) of full-time work among manufacturing workers, nor are they the same as the average number of months the capital invested had been in use at some economic activity (see below).[16]

Panel A of Table 1 shows various statistics pertaining to part and full-year operation. Establishments have been weighted by either the reported value of the capital invested, or by the number of employees. The capital-weighted estimates provide a window into part-year operation from the point of view of the owner(s). Ignoring new entrants, these show how long (invested) plant and equipment might have been idle on average. The employment-weighted estimates provide the alternative perspective of workers: How much time during the year employment would have been available, on average, at the establishment.

The principal conclusion from Panel A is that, regardless of weighting, a substantial majority of establishments were full-year in both 1870 and 1880. For the median (or typical) manufacturing establishment, full-year operation was already the norm as early as 1870. Because the proportion of full-year establishments was substantial, the deviation of the mean number of full-time equivalent (FTE) months from its theoretical maximum (twelve) was relatively small -- less than a month and a half in both years. Moreover, because we cannot differentiate between established firms and new entrants -- all of which, by definition, were part-year -- these conclusions hold even more strongly for the (unknown) subset of establishments that had been in existence the entire year.

In both years, the extent of full-year operation was somewhat greater when the data were weighted by capital invested than by employment and the difference between the two types of estimates were slightly greater in 1870, possibly a reflection of business cycle conditions (see below). Although the data suggest that full-year operation was more prevalent in 1870, mean FTE months of operation among part-year establishments was actually greater in 1880 than in 1870; that is, when establishments were not operating, they were down for shorter times in 1880 than in 1870.

Despite the ubiquity of full-year operation, part-year operation was far from unusual. In 1880, between 38 and 40 percent of establishments (depending on the method of weighting) reported operating for fewer than twelve months on a full-time equivalent basis. On average, these establishments operated nine and a quarter to slightly more than nine and a half months per year. About half of the part-year establishments went on short-time during the year, the result being

that average FTE months among part-year establishments was less than average total months by 0.75-0.9 of an FTE month, or approximately 20 days of full-time equivalent work.

The estimates of annual hours reveal other departures from the maximum time available for production during a year. Weighted by employment, the typical establishment operated for approximately 2,738 hours per year -- about 115 hours more per year when the data are weighted by capital invested, or about eleven extra days of work at the average (capital-weighted) length of the working day. Not surprisingly, average annual hours were far higher at full-year than a part-year establishments -- almost a third, or 919 hours greater, when the establishments are employment weighted, somewhat less (848 hours) when establishments are capital-weighted.

We have computed a decomposition of the proximate sources of the deviation of annual hours from the maximum available.[17] The results, shown in Panel B of Table 1, reveal that most of the deviation -- between 72 and 73 percent -- occurred because the typical establishment did not (and, perhaps, could not) operate "round-the-clock". Indeed, the majority of establishments in the sample operated exactly ten hours per day, well below the maximum available.[18] Thus, from the owner's (or worker's) point of view, most annual downtime occurred on a day to day basis during the regular work-week. Another 17 percent or so can be explained by a combination of short-time, Sundays and holidays off -- that is, the average number of days of operation per month was less than the maximum number of available days per month. The remaining, and smallest, portion of the deviation of annual hours from its maximum -- 10-11 percent -- is directly attributable to part-year operation.[19]

One shortcoming of the estimates in Table 1 is that they pertain to just two particular years, a decade apart. As such, they may be distorted by biases in the census or influenced by business cycle conditions. We have already noted that the two censuses asked different questions. We can do nothing about this. We also noted that the samples were representative of the surviving manuscripts. Not all of them have survived. Some forms were damaged, others were lost or misplaced in transit to Washington. Others went missing when the documents were subsequently transferred to state and other archives where many currently are lodged. Most such losses were random and are unlikely to affect our substantive findings. There is, however, one possible exception to the random nature of these omissions. In 1880, certain industries were designated to be enumerated by "special agents" who were allegedly more familiar with industry conditions than regular census employees. Despite an assiduous search, the forms collected by these special agents have never been located.[20] As it happens, the line between the duties of the regular enumerator and those of the special agents was sometimes blurred such that the occasional establishment in a special agent industry was actually canvassed by regular enumerators. These were at risk of inclusion in the 1880 sample. When the sampling scheme picked these, they were, of course, included in the sample. In general, however, establishments in the "special agent" industries are under-represented in 1880.

We have explored the ramifications of the under-enumeration of special agent industries in two ways. Because the identity of these industries is known, it is possible to produce a version of Table 1 excluding all establishments in these industries in both 1870 and 1880 (see Appendix Table 1). Doing so produces some minor differences in levels but our substantive conclusions regarding the extent of full-year operation, use of short time, and so on, are essentially unchanged.[21] Alternatively, it is possible to estimate the mean number of FTE months and the percent of plants operating at twelve FTE months in 1880 correcting for the under-enumeration.[22] When this is done (see also Appendix Table 1) the differences between 1870 and 1880 are narrowed; in particular, the mean number of FTE months is greater in 1880, consistent with the hypothesis of a business cycle upturn.

With regard to business cycle conditions, the 1880 census was collected during an upturn in the economy. This had begun in March of 1979 -- two months before the start of the census year -- and lasting until March of 1882. By contrast, the economy had reached the cycle peak during the first month of the 1870 census year (June 1869), declining to a trough in December 1870, seven months after the census year ended.[23] In the absence of additional information, we might expect a greater share of full-year operation when business cycle conditions were good (1880) than when they were less rosy (1870) but this is opposite to what we found (see Table 1).[24] However, as noted earlier, comparisons across the two years are problematic because different questions were asked. In addition, we might expect that the incidence of new entrants -- who, by definition, could not have been full-year -- to have been greater during an upturn -- that is, in 1880, thus reducing the share of firms that were full-time. In this regard, it seems doubly noteworthy that, among part-year establishments, average FTE months were higher in 1880 than in 1870, for it is plausible that favorable business cycle conditions might increase the length of average working years of part-year establishments, such establishments being more vulnerable to an economic downturn.

Both a vice and a virtue of these census data is that there are almost no alternative sources against which to compare them. Based on the 1875 state census, the Massachusetts Bureau of Labor Statistics reported that employees at manufacturing establishments in the state worked an average of 267 days.[25] The Massachusetts establishments in our samples (weighted by employment and assuming a full-time work year of 309 days) operated for an average of 261 days in 1870 and 268 days in 1880, close to the state's estimate for 1875. The Ohio Bureau of Labor Statistics reported industry-level data on

the number of annual weeks of operation of manufacturing establishments in Ohio in 1877.[26] According to these data, the average for the state (weighting by industry employment) was 44.4 weeks. Using the data on Ohio establishments in our samples (weighting by employment and assuming 4.3 weeks of operation per full-time equivalent month), our estimates are, respectively, 46.2 weeks in 1870, and 44.2 weeks in 1880, again close to the state's own estimate. Thus, while additional data would be useful, our estimates are not out of line with what scattered other data are to be found on this topic.

Previous work on downtime in the late nineteenth or early twentieth centuries has been based on samples of workers or households. A fair summary of this work is that, compared with the late 20th century, the likelihood that a worker would experience unemployment at some point during a year was relatively high but the duration of unemployment was relatively brief.[27] Our results suggest that, for a substantial fraction of manufacturing workers -- at least 60 percent in 1880 -- downtime would have occurred only if the worker quit, was fired, or was selectively laid-off during a seasonal (or business cycle) downturn. However, for the (still sizeable) remainder, downtime became a possibility because the establishment simply ceased operations whether temporarily or permanently or was not in operation when the year began. The odds of being out of work for these reasons were decreasing in establishment size and capital intensity and thus, plausibly, over time. That is, our data are consistent with the view that, over the second half of the nineteenth century, selective lay-offs probably replaced "plant shut-downs" as the primary cause of unemployment on the labor demand side.

MULTIVARIATE ANALYSIS

While full-year operation was evidently the norm in post-bellum manufacturing, part-year operation was far from uncommon. We explore some of the correlates of part-year operation using multivariate analysis. Because our primary goal in this paper is descriptive, we focus on establishment-level information reported in the samples -- industry, location, and establishment-level characteristics such as size and capital intensity.

For both years we report regressions in which the logarithm of full-time equivalent months is the dependent variable. Because so many establishments operated full-year, we use Tobit analysis to estimate these regressions. For 1880, we also report regressions with the log of annual hours as the dependent variable. Although the distribution of log annual hours has "spikes"--some values are more prevalent than others--the range of values is sufficiently broad that, in our judgement, OLS can be used reliably here. The independent variables are the size of the establishment (as measured by total employment), capital intensity, the use of steam power, the gender and age composition of the work force, urban and regional status, and industry. As in Table 1, we weight establishments by either total employment or by capital invested.

In general, the effects of the independent variables are the same in sign in the regressions of annual hours and of full-time equivalent month. There is one exception: the use of steam power (this is discussed below). Moreover, the substantive findings are similar regardless of how the data are weighted. Consequently, in the interests of brevity we report just the employment-weighted regressions, and focus the discussion primarily on the results for full-time equivalent months.

Based partly on the results in Table 1, we expected to find that size (measured by employment) and capital intensity were positively correlated with full-year operation. These expectations are borne out in both years. We discovered that dummy variables for moderately large (100-499 employees) and very large (500 or more employees) plants captured the essential variation in the data as well (or better) than any continuous specification. With the information at our disposal it is difficult to distinguish between various explanations of the size-cum-capital intensity effect, but it is not difficult to list them.[28] Large, capital-intensive establishments may have had easier access to transportation networks, or to working capital. More fundamentally, these establishments presumably had higher fixed costs than smaller establishments (in the short run) but lower average variable costs at higher levels of production.[29] Such differences in access to markets and capital, and in cost structures enabled these establishments to better weather short-run declines in output demand.[30] The effects of size and capital intensity were somewhat greater in 1870 than 1880, consistent with the view that smaller establishments were less able to weather business cycle downturns than larger, more capital intensive establishments.

The use of steam, measured in horsepower, was negatively related to full-time operation in both years. Interestingly, however, steam power and annual hours were positively correlated in 1880, although the coefficient is not statistically significant. The two correlations (FTE months and annual hours) differ in sign because steam power was associated with a longer working day in 1880 (not shown). Steam-powered machinery required periodic maintenance. This was much easier (and less costly) to accomplish when the plant was shut down than when it was in operation. In light of these periodic shutdowns, and given that start-up costs of shut-down machinery may have been positive, it made good economic sense to operate steam-powered equipment for more hours per day.

The age and gender composition of the work force, as measured by the percentage of women and children among all employees, was negatively associated with full-year operation. A negative association between full-year operation and the use of child labor is not surprising: an unknown number of the children employed by establishments in the samples

presumably were attending school at some point during the census year. Many of the women employed in manufacturing were young, and may have preferred to take their annual downtime in a continuous form (that is, a month or longer) than on an on-going basis

Although it is possible to include industry dummies in the regressions at the 3-digit SIC level given the number of degrees of freedom (or to estimate individual regressions at the industry level) the results are too unwieldy to report in detail. After some experimentation, we decided that the essential features of the industry variation (but see below) were captured by dummy variables for three two-digit SIC codes -- SIC 7 (agricultural processing), SIC 24 (lumber products) and SIC 32 (stone, brick, and clay products). Establishments in each of these industries, particularly those in agricultural processing, were much more likely to be seasonal enterprises, and thus less likely to be full-year than establishments in other industries. This finding is clear in both years. As with some of the other variables in the regressions, the seasonal effects appear to be larger in 1870 than in 1880, consistent with the better state of the economy in the latter year than in the former.

The location of the establishment was also correlated with the likelihood of full-year operation. Urban establishments -- those located in incorporated cities and towns with a population of 2,500 or larger -- were more likely to be full-year than rural establishments. This may be because urban establishments faced a more regular pattern of output demand during the year, or were less likely to experience shut-downs due to irregular availability of raw materials (for example, because of transportation interruptions due to weather) or other inputs (for example, labor).

Regional differences in full-time operation are also apparent. In both years, establishments in the Northeast (the left-out regional dummy) were more likely to be full-year than in other regions (particularly the South and the Midwest). To some extent, however, the regional differences shown in Table 2 are an artifact of the (coarse) level of detail of the industry dummies. If three-digit SIC industry dummies are used instead, the Northeast-South differences essentially vanish, and those between the Northeast and the Midwest, and the Northeast and the West are smaller than those reported (but still statistically significant), suggesting that the remaining regional differences might diminish further (or disappear) with an even finer industrial classification.

It is always dangerous to infer time-series movements from cross-sectional relationships, because the latter may not be stable over time. However, subject to this caveat, the results in Table 2 are consistent with the hypothesis that part-year operation in nineteenth century manufacturing was declining in importance over time, because employment (and capital invested) became increasingly concentrated in larger, more capital intensive establishments, in urban areas, and in non-seasonal industries.[31]

WAGES AND PART-YEAR OPERATION

A majority of establishments operated year-round on a full-time basis in both 1870 and 1880. However, for part-year establishments, the average amount of annual downtime was considerable. If it were costless for workers at part-year establishments to find employment elsewhere when their establishment was not in operation, part-year operation would have had no implications for the marginal cost of labor faced by such establishments. However, were it not costless, and if more months of employment were desirable at the margin, then workers at part-year establishments would have demanded -- and, in a competitive labor market, received -- a wage premium for working at part-year establishments. Previous work exploring the existence of such "compensating differentials" in the 19th century has focused on samples of workers, not individual establishments, and so it is of some interest to see if the manufacturing samples are consistent with this hypothesis.[32]

Table 3 reports coefficients of a dummy variable for full-year operation from semi-log regressions of average annual and monthly (full-time equivalent) earnings, for both 1870 (Panel A) and 1880 (Panel B).[33] Average annual earnings is the annual wage bill divided by the number of employees. To maintain comparability between the two years, average monthly earnings is average annual earnings divided by full-time equivalent months of operation. Results are reported for regressions with and without independent variables other than the full-year dummy. When other independent variables are added these are the same as in Table 2. Since it the workers' perception of downtime that is important here, observations are weighted by total employment.

The average annual earnings of workers at full-year establishments were greater than at part-year establishments.[34] This is not surprising, because full-year establishments were in operation for more months of the year than part-year establishments. However, the annual earning gap between full and part-year establishments was smaller in percentage terms than the corresponding gap in full-time equivalent months of operation. Thus, as evidenced by the regressions of average monthly earnings, there was a monthly wage premium associated with employment at part-year establishments. This premium is consistent with the hypothesis of a compensating differential for unemployment. The result holds whether or not other independent variables are included in the regression. However, the inclusion of controls in the regression suggest greater similarity in the size of the wage premium in 1870 and 1880 than in the regressions without controls.[35]

One important objection to the results in Panels A and B of Table 3 is that differences in average skill level of workers between part-year and full-year establishments might be responsible for the apparent compensating differential. Although the regression holds constant the percentage of workers who were women and children, this may be far from an adequate control for skill. However, a sub-sample of establishments in 1880 also reported information on the average daily wages of "common" (unskilled) labor and of "mechanics" (skilled labor) at the establishment level. It is therefore worthwhile to see if the substantive findings of Panels A and B can be replicated using these data. As shown in Panel C of Table 3, when no other controls are included, full-year establishments paid lower average daily wages to common labor but higher daily wages to mechanics. However, when establishment-level controls are added, full-year establishments paid lower daily wages to both types of labor, consistent with the hypothesis of compensating differentials for part-year operation. The point estimate suggests that the differential was greater at the margin for mechanics, although the difference is not statistically significant.

Previous work on the growth of real wages in the nineteenth century has focused primarily on daily or monthly rates of pay.[36] It is believed that such data understate the true long-run growth in annual real wages because the length of the work year increased but the size of the bias is not known. Our results suggest that, at least so far as manufacturing was concerned, the size of the bias (measured on an annual basis) must have been less than the annual growth rate in the length of the work year, because monthly wages were higher at part-year establishments than full-year establishments.[37]

CONCLUDING REMARKS

This paper has used recently collected archival data to explore an important feature of nineteenth century American manufacturing, that of part-year operation. Our principle finding is that, in both 1870 and 1880, a majority of establishments operated on a full-time basis for the entire census year. Nonetheless, part-year operation was hardly unusual. Indeed, in 1880, approximately 40 percent of manufacturing workers, according to our estimates, were employed in establishments that had not operated for a month or longer during the census year. Conditional on its occurrence, the mean number of months of non-operation was non-trivial -- around four months, for example, in 1870. The likelihood of part-year operation depended on establishment characteristics; for example, it was less likely for large, capital-intensive establishments, and more likely for establishments in certain seasonal industries. Finally, part-year operation had important implications for labor costs; our data are consistent with the hypothesis that such establishments had to pay a monthly wage premium to attract (and keep) labor.

TABLE 1 PART-YEAR OPERATION: MANUFACTURING IN 1870 AND 1880

Panel A: Estimates of Annual Total Months of Operation, Annual Full-time Equivalent Months, Daily Hours, Days Per Month, and Annual Hours: 1870 and 1880

Sample Means	1870	1870	1880	1880
Weighted by:	Employment	Capital	Employment	Capital
Total months			10.90	11.09
FTE months	10.76	10.98	10.58	10.75
% at 12 total months			73.1%	76.1%
% at 12 FTE months (full-year)	70.6%	74.0%	59.8%	62.1%
Total months, part year			9.26	9.58
FTE months, part year	7.78	8.06	8.49	8.69
% using short-time, part year			50.0%	51.1%
Average amount of short-time in FTE months			0.77	0.89
Hours per day			10.05	10.34
Hours per day, full year			10.06	10.27
Hours per day, part year			10.03	10.45
Days per month			24.99	24.95
Days per month, part year			23.85	23.65
Annual hours			2,738.4	2,853.4
Annual hours, full year			3,108.0	3,174.6
Annual hours, part year			2,189.0	2,326.3
N (establishments)	4,775	4,775	7,606	7,606

Panel B: Decomposition of Log (Annual Hours): 1880
Sample Means %[of Log(Annual Hours) Explained By]

Weighted by:	Employment	Capital	Employment	Capital
Log (annual hours/8,760)	-1.215	-1.161		
Log (daily hours/24)	-0.875	-0.849	72.0%	73.1%
Log (days per month/30.417)	-0.201	-0.202	16.5%	17.4%
Log (months per year/12)	-0.139	-0.110	11.4%	9.5%

Notes to Panel A: FTE: full-time equivalent. Observations with missing male employment; zero total employment; missing, zero, or FTE months in excess of 12 are excluded, missing daily hours (1880 only) or missing value of capital invested are excluded. Full-year: 12 FTE months. Part-year: less than 12 FTE months. Short-time: Total months – FTE months. See text for method of estimating annual hours.

Notes to Panel B: Sample size is 7,606 establishments. See text for calculation of hours per day, days per month, and months of operation. Percent explained: absolute value of rows 2, 3, or 4 divided by absolute value of row 1 x 100 (eg. 72.0 = 0.874/1.214).

Source: 1870 and 1880 national samples of manufacturing establishments; see Atack and Bateman, "U.S. Historical Statistics."

TABLE 2 REGRESSIONS OF FULL-TIME EQUIVALENT MONTHS, ANNUAL HOURS, AND DAILY HOURS OF OPERATION

	Ln (FTE Months)	Ln (FTE months)	Ln (Annual Hours)
Constant	2.064 (27.281)	1.959 (37.321)	7.520 (293.666)
100 < = workers < 499 (dummy variable)	0.127 (3.699)	0.109 (5.190)	0.064 (6.323)
> = 500 workers (dummy variable)	1.595 (11.971)	0.801 (19.090)	0.180 (12.072)
Log (K/L)	0.130 (11.918)	0.102 (13.219)	0.051 (13.631)
Steam horsepower x 10^{-2}	-0.147 (13.625)	-0.074 (10.703)	0.005 (1.547)
(women + children)/ workers	-0.041 (0.768)	-0.175 (5.411)	-0.043 (2.870)
Urban	0.128 (4.375)	0.293 (15.145)	0.098 (10.288)
Midwest	-0.193 (6.423)	-0.159 (8.090)	-0.064 (6.743)
South Atlantic	-0.272 (3.458)	-0.231 (7.721)	-0.087 (5.903)
South Central	-0.111 (1.552)	-0.221 (5.731)	-0.152 (7.764)
West	-0.219 (2.052)	-0.091 (1.850)	-0.036 (1.459)
SIC 7 (agricultural services)	-1.381 (8.546)	-0.999 (7.559)	-0.876 (11.764)
SIC 24 (lumber products)	-0.490 (11.771)	-0.295 (10.972)	-0.172 (12.348)
SIC 32 (stone, brick, and clay products)	-0.825 (13.512)	-0.376 (9.654)	-0.237 (11.396)
Method	Tobit	Tobit	OLS
N	4,775	7,606	7,606
R^2	0.204	0.139	0.170

Notes: Observations weighted by employment. Log (K/L): log of capital invested divided by employment. Capital invested is in nominal terms. Urban = 1 if establishment located in a town or city of population 2,500 or larger.

TABLE 3 EFFECT OF FULL-YEAR OPERATION ON AVERAGE EARNINGS OR WAGES, 1870 AND 1880
Panel A: 1870, Average Annual or Monthly Earnings

	Log Average Annual Earnings	Log Average Annual Earnings	Log Average FTE Monthly Earnings	Log Average FTE Monthly Earnings
Full-year establishments	0.161 (4.144)	0.271 (8.775)	-0.347 (9.226)	-0.192 (6.572)
Controls?	No	Table 2	No	Table 2
R^2	0.004	0.526	0.021	0.538
N	3,888	3,888	3,888	3,888

Panel B: 1880, Average Annual or Monthly Earnings

	Log Average Annual Earnings	Log Average Annual Earnings	Log Average FTE Monthly Earnings	Log Average FTE Monthly Earnings
Full-year establishments	0.380 (21.926)	0.258 (16.415)	-0.050 (3.205)	-0.118 (8.273)
Controls?	No	Table 2	No	Table 2
R^2	0.061	0.345	0.001	0.280
N	7,338	7,338	7,338	7,338

Panel C: 1880, Average Daily Wages, Unskilled or Skilled

	Unskilled	Unskilled	Skilled	Skilled
Full-year establishments	-0.022 (2.168)	-0.066 (7.177)	0.031 (3.400)	-0.035 (4.096)
Controls?	No	Table 2	No	Table 2
R^2	0.0007	0.275	0.002	0.239
N	5,504	5,504	6,681	6,681

Notes to Panel A : Figures in row 1 are coefficients of dummy variable for full-year establishments in a regression of log average annual or monthly earnings. Full-year establishments are those with twelve full-time equivalent months of operation. Average annual earnings = Annual wage bill/employees. Average monthly FTE earnings: Average annual earnings/full-time equivalent months of operation. Absolute value of t-statistics in parentheses. N: number of establishments in regression. Controls: regression includes independent variables listed in Table 2. Observations weighted by employment.

APPENDIX TABLE 1
ESTIMATES ON ANNUAL TOTAL MONTHS OF OPERATION, ANNUAL FTE MONTHS, DAILY HOURS, DAYS PER MONTH, AND ANNUAL HOURS: 1870 AND 1880, EXCLUDING ESTABLISHMENTS IN "SPECIAL AGENT"

INDUSTRIES

Sample Means	1870	1870	1880	1880
Weighted by:	Employment	Capital	Employment	Capital
Total months			10.92	11.06
FTE months	10.57	10.60	10.61 [10.79]	10.72 [10.96]
% at 12 total months			73.4%	75.2%
% at 12 FTE months (full-year)	69.5%	68.6%	60.0% [60.7%]	60.8% [63.9%]
Total months, part year			9.31	9.60
FTE months, part year	7.32	7.55	8.54	8.71
% using short-time part year			50.9%	51.2%
Average amount of short-time in FTE months			0.77	0.89
Hours per day			10.05	10.31
Hours per day, full year			10.05	10.20
Hours per day, part year			10.04	10.47
Days per month			24.98	24.93
Days per month, part year			23.84	23.66
Annual hours			2,745.3	2,833.4
Annual hours, full year			3,106.4	3,152.7
Annual hours, part year			2,204.4	2,337.9
N (establishments)	4,516	4,516	7,476	7,476

Notes: Establishments in "special agent" industries are excluded, see text. Otherwise, exclusion restrictions are the same as in Table 1. Figures in [ ] correct for under-enumeration of establishments in special agent industries; see ftn. 19.

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NOTES

1. See Sokoloff (1986) and Engerman and Goldin (1994) for the general argument that part-year operation declined over time; and Sokoloff, "Inventive Activity" for related evidence that market expansion promoted greater technical progress.
2. Sokoloff (1986, especially the notes to Table 13.1, pp. 686-7) for example, notes scattered references to part-time operation in both the 1820 Census and the 1832 McLane Report but absent complete and reliable reporting on part-year operation chose to truncate the samples (including those for 1850 and 1860 for which no information on part-time operation whatsoever was given)--eliminating low-output firms in the left-tails of the labor-productivity distribution--for his best measures of antebellum labor productivity growth. Part-year operation, however, was not *per se* the focus of his analysis. For evidence on the extent of seasonality in manufacturing at the end of the nineteenth century, see Engerman and Goldin, (1994).
3. These samples are described in some detail in Atack and Bateman, (1999).
4. For a discussion of the evolution of these censuses see Wright (1900) and especially Fishbein (1973).
5. That is, because the population of establishments at risk of being surveyed included only those firms in existence at the time of the enumeration, the nineteenth century censuses necessarily exclude establishments that operated during the census year--the year prior to the survey--but which shut down *permanently* prior to the taking of the census (i.e. exited the industry).
6. Information on part-year status was reported for some establishments in 1820 and 1832; see Sokoloff (1986, footnote 4, p. 725). The instructions for the Eighth Census in 1860 asked enumerators to report months of operation if establishments were idled for "long"; see U.S. Census Office (1860). However, "long" was neither defined, nor was space made available on the form to answer any such question; and, as a consequence, very few establishments provided the information.
7. See Wright (1900).
8. However, in the case of the 1880 estimates, any upward bias in the estimate of full-time equivalent months is offset, in whole or part, by the fact that establishments that operated for less than half-time were considered idle for the entire month.
9 For a detailed discussion of the data, see Atack and Bateman (1999). We use the "national samples" as discussed by Atack and Bateman, as these are designed to be self-weighting. All data and necessary documentation analyzed in this paper can be downloaded from http://www.vanderbilt.edu/Econ/faculty/Atack/atackj.htm.
10. In 1880, total months of operation is the sum of months on full-time, months on three-quarter's time, months on two-thirds time, and months on half time. Full time equivalent months is Months on full-time + 0.75*(Months on three-quarters time) + 0.667*(Months on two-thirds time) + 0.5*(Months on half-time).

11. With 52 weeks per year, at six days per week, the work year would be 312 days. See, for example, Massachusetts, Bureau of Labor Statistics (1873), which uses 308 days as the length of a full-time equivalent work year, while Massachusetts, Bureau of Labor Statistics (1876), uses a work year of 310 days. Presumably the difference (2-4 days) is an allowance for holidays. Our estimate of 309 days is the average of the two Massachusetts figures.
12. In 1870, all months are of type j = full-time. As stated in the text, the number of days in a full-time month is 25.75. We reduce days in the other types of months by the relevant fraction (for example, 12.875 in a month on half-time).
13. The 1880 census reported daily hours between November and May ("winter" hours) and from May to November ("summer" hours). Our estimate of average daily hours is the average of winter and summer hours, replacing winter with summer hours if data on summer hours are missing, and vice versa; see Atack and Bateman (1992).
14. On occasion, marginal notes can be found in the manuscripts identifying new entrants, but not with a sufficient frequency to identify establishment-level correlates. Many others not identified by the individual enumerators also certainly were also new entrants.
15. Based on the numbers enumerated by the manufacturing censuses, the average annual rate of increase between 1850 and 1880 in the number of manufacturing establishments was 2.4 percent [= 100 x ln (number of establishments in 1880/number of establishments in 1850)/30; computed from U.S. Bureau of the Census (1975, Series P-1, p. 666). Even if the entry rate of new establishments were, say, five times as large as the average net rate (2.4 percent, according to the above calculation) the overwhelming majority (nearly 88 percent) of establishments in 1870 and 1880 could not have been new entrants. Thus it is highly likely that most of what we are documenting pertains to the shut-down behavior of established enterprises, not new entrants.
16. To take an extreme example, if 100 percent of manufacturing workers were employed at establishments that operated through the entire year, the only time routinely available for alternative employment (or, for that matter, leisure) would have been those daily hours that workers were not working (for example, in the evening) or Sundays, or holidays.
17. The decomposition is based on the fact that ln (Annual Hours/8,760) = ln (H/24) + ln (D/30.417) + ln (M/12), where 8,760 = total number of hours per year, 24 = number of hours per day, 30.417 = average number of days per month, 12 = months per year. Panel B of Table 1 reports the sample means (weighted by employment or capital invested) of these variables. The percentage explained is simply the ratio of the sample mean of any of the components--for example, ln (H/24)--to the total--ln (Annual Hours/8,760). See Panel B of Table 1 for details.
18. Atack and Bateman (1992).
19. Most of the deviation in terms of days per month was due to Sundays (and holidays). If these days are removed from the calculation (not shown in Panel B of Table 1, but available from the authors on request) the proportion of annual downtime accounted for by short-time (at least to the degree measured by the census) was very small -- 3 to 4 percent, depending on the method of weighting.
20. Delle Donne (1973).
21. A list of relevant three-digit Standard Industrial Classification (SIC) codes pertaining to the special agent industries is available on request from the authors.
22. The specific details are available from Robert A. Margo on request. In brief, we assume that (a) the estimates of mean FTE months and percent at twelve FTE months for non-special agent industries in 1880 are unbiased (b) the true 1880 ratios (capital or employment weighted) of mean FTE months in special agent to non-special agent industries is that same as in 1870 (c) the economy-wide shares of employment or capital in special-agent industries in 1880 are given by a linear trend based on the shares in 1850, 1860, and 1870 (d) employment and capital shares in 1850 and 1860 are computed from samples analogous to those analyzed in this paper; see Atack and Bateman (1999).
23. These statements are based on the dating of business cycle movements by the National Bureau of Economic Research; see http://www.nber.org/cycles.html.
24. However, it is also worth noting that when establishments in "special agent" industries are excluded, mean full-time equivalent months was slightly higher in 1880 than in 1870, consistent with the view that business conditions were more favorable in 1880 than in 1870.
25. Massachusetts, Bureau of Labor Statistics (1879). These data pertain to workers, not establishments, and for this reason alone might differ from ours in terms of the length of the work year. Because the data are worker averages, we weight the establishment data by employment.
26. Ohio, Bureau of Labor Statistics (1879).
27. See, for example, Keyssar (1986) or Margo (1990).
28. The causality may run in reverse (from that implied by the regression specification) between part-year operation and capital-intensity. Entrepreneurs may have been more likely to invest if an establishment was likely to be full-year, since their capital would obviously not be idle.
29. That is, size (and capital intensity) conferred a productivity advantage at sufficiently high levels of output; see Sokoloff (1988, 705- 7 and 712).
30. In addition, if a large (in employment terms) establishment shut down operations unexpectedly, the costs of re-assembling a work-force may have been considerable, creating an incentive to maintain production at a lower level of output (for example, through selective layoffs) rather than shutting down completely.
31. See Chandler (1977, especially chs. 8 and 9) Atack, Bateman, and Margo (2000), and Engerman and Goldin (1994).
32. See Fishback and Kantor (1992) and Margo (2000, ch. 3) for evidence that the *per diem* wage of workers hired on a monthly basis was lower than the daily wage of workers hired on a daily basis.
33. The semi-log specification is widely used in such studies; see, for example, Margo (2000, ch. 3).
34. As noted earlier in the paper, the various antebellum censuses of manufacturing generally did not distinguish part-year from full-year establishments. In addition, the 1850 and 1860 manufacturing censuses reported the average

monthly wage bill, but not the annual wage bill. Previous research on profit rates in manufacturing in 1850 and 1860 have been forced to assume that all establishments were full-year in order to compute annual labor costs (= average monthly wage bill x 12); see Bateman, et al. (1975), Bateman and Weiss (1981), and Atack and Bateman (2000). However, our findings that not all establishments were full-year (Table 1) and average annual wages were lower at part-year establishments (Table 3) suggest that this assumption produces estimates of annual labor costs that are too high and, consequently, estimates of profit rates that are too low.

35. Because we cannot distinguish new entrants from established enterprises, the wage premium in part-year establishments may also incorporate a risk premium associated with employment at new entrants.

36. See, for example, Margo (2000, chs. 3, 5).

37. That is, a shift from part to full-year operation generated a less than proportionate increase in the average annual wage, because monthly wages were higher at part than at full-year establishments.