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Skill Intensity in Late Nineteenth Century Manufacturing: Evidence from the 1880 Census of Manufactures

Jeremy Atack

Fred Bateman

Robert A. Margo

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Atack and Margo are affiliated with the Department of Economics, Vanderbilt University, and the NBER. Bateman is affiliated with the Department of Economics, University of Georgia. Prepared for the 2002 Labor Studies Summer Institute, National Bureau of Economic Research, Cambridge MA.

1.0 Introduction

In the early nineteenth century domestic manufacturing in the United States was a small-scale activity. The typical establishment employed a handful of workers, and produced custom made items for a highly localized market. Division of labor within the establishment was extremely limited, and for the most part, the production process utilized little in the way of capital other than hand tools, and little or no inanimate power.

As the century progressed small-scale production gradually gave way to the factory system. The typical factory employed many more workers in the context of extensive division of labor, and relatively more capital per unit of output, if not necessarily per worker. Factories were far more likely to use inanimate sources of power – water first, followed by steam, and beginning late in the century, electricity. Because of these differences, factories had an efficiency advantage over small-scale production. Although small-scale production never literally disappeared, over time an increasing share of production took place in factories and increasing shares of labor and other inputs were employed in them (Chandler 1977; Sokoloff 1984)[1]

Many economic historians believe that the shift from small to large scale production in manufacturing was accompanied by a decline in the skill intensity of the manufacturing labor force. The small-scale shop was the artisan shop, while the factory was the province of unskilled and semi-skilled "operatives". As the factory system spread, the relative demand for skilled artisans declined.

[1] Scranton (1997) documents how scale-scale production was transformed in the wake of the shift toward factory production, in particular, by concentrating on specialized intermediate inputs or final goods.

The stylized facts aside, it is surprising how little direct evidence there is the relationship between the relative use of and various establishment level characteristics like size or capital intensity (Acemoglu 2002). The gender and age composition of workers has often been used as a proxy for skill intensity. In the early years of the factory system in New England, children and young women made up a relatively large share of the manufacturing labor force, and they were concentrated in large establishments (Goldin and Sokoloff 1982). Few economic historians would seriously doubt that the children and young women employed in early factories were less skilled on average than adult male artisans. However, many industries used little or no female or child labor, and over time, the proportion of both types of labor declined as a fraction of all manufacturing workers. These and other factors make the gender and age composition of the manufacturing labor a less than perfect proxy for skill, either at a point in time or over time.

The central problem in documenting how skill intensity in nineteenth century manufacturing varied with such establishment characteristics as size, capital intensity, power use, and so on is that direct measures of skill were never collected by the federal census until 1890. Unfortunately, establishment level data for 1890 no longer exists in any form, because the manuscripts of the 1890 census were destroyed in a fire.

In this paper we make use of little-known information reported in the original manuscript records of the1880 Census of Manufactures, but which was not compiled in the published volumes. The evidence we assemble here is partly direct and partly indirect, and far less detailed than what would be possible if establishment data for 1890 had survived. However, because the point is moot, we believe the evidence presented in this paper is the best (and, currently, only) available on the relationship between skill intensity and various establishment characteristics for nineteenth century manufacturing.

As a theoretical framework for the empirical work, we draw on a recent model of manufacturing developed by Goldin and Katz (1998). This model predicts certain relationships between skill intensity and size, capital intensity, and energy usage that emerge as production shifts from small to larger scale production. We show that the specific predictions of the Goldin-Katz model with respect to these variables appear to hold in the 1880 data. In addition, we explore how skill intensity varied between urban and rural settings, region, and industry.

Our primary analysis derives from several pieces of inter-related information contained in the 1880 manuscripts -- in particular, data on average monthly wages, days per month, and the daily wages of common labor and artisans. We specify an equation for average monthly wages in which the coefficients of certain interaction terms show how skill intensity varied with establishment characteristics. For example, the coefficient of the relevant interaction term for establishment size is negative, indicating that the percent skilled was lower in large than in small establishments. A secondary analysis infers skill intensity from patterns of non-response to certain questions in the census, the basis for which derives from instructions to census enumerators. The results of this second approach, while not as sharp, are broadly consistent with the results of our primary analysis.

If, as just noted, skill intensity was decreasing in firm size, this would seem to imply that average wages at the establishment level were also a decreasing function of size. However, as we show in section 4, average monthly wages in the largest establishments (over 100 workers) were similar to those in smallest establishments. Daily wages of unskilled and skilled labor, however, were positively correlated with size, and the correlation was somewhat greater for skilled than for unskilled labor. Given the cross-sectional nature of the data as well as the limited information on establishment characteristics, we cannot claim to identify a causal impact of size on wage rates, nor can we identify the precise mechanisms at work. What we can say, however, is that as early as 1880, the positive relationship between wage rates and firm size so evident in modern data was evidently already present in American manufacturing.

2. Skill Intensity in Manufacturing: The Goldin-Katz model

In this section we sketch out a simple model of the relationship between skill intensity and certain establishment level characteristics. The model in its original form is due to Goldin and Katz (1998).

In the Goldin and Katz formulation, manufacturing undergoes several distinct phases in its evolution. Common to each phase is the presumption that the production of the final good occurs in a two-stage process. In the first stage, "raw" capital is combined with skilled labor to produce an intermediate input, called "workable" capital. A Leontief technology is specified for the first stage, so that skilled labor is always complementary to raw capital, in the production of workable capital.

In the second stage, workable capital is combined with unskilled labor to produce the finished product. Production in the second stage is Cobb-Douglas, or more generally, the possibility of substitution between unskilled labor and workable capital, depending on relative input prices, is permitted.

There are three phases of manufacturing, the first being the artisan shop. In the archetype artisan shop of the model, the required ratio of skilled labor to raw capital in the first stage of production is very high. In the second stage, the isoquants are shaped such that, at any given set of factor prices, the ratio of unskilled labor to workable capital is relatively low, compared with the factory. Consequently, the artisan shop uses relatively more skilled labor than unskilled labor, compared with the factory.

The second phase of manufacturing's evolution is the factory. In the first stage of production in the typical factory, workable capital requires, per unit of production, relatively more raw capital and relatively less skilled labor, perhaps because the "machines" are more standardized than in the artisan shop. Once workable capital is in place, it is again combined with unskilled labor to produce the final product. However, compared with the artisan shop, relatively more unskilled labor and relatively less workable capital is used to per unit of output, compared with the artisan shop. The nature of factory production is such that efficiency is achieved through division of labor into steps that can be performed by unskilled workers, in combination with workable capital. The division of labor is not automatic, but presumes the existence of a sufficiently dense market to be economically feasible. Falling transport costs, among other factors, enhanced market size in the U.S. during the antebellum period, leading to growth in the average size of firms (Chandler 1977; Atack 1977; Sokoloff 1984).

In the final phase, production shifts from the factory, with its ever more minute division of labor, to so-called "continuous-process" technologies. These technologies, according to Goldin and Katz, use much more capital per unit of unskilled labor in the final production stage, necessarily requiring more skilled labor in the first stage, at least compared with the simple factory. The shift to continuous process production was facilitated by the diffusion of electric power. Electric power eliminated the need to a large array of unskilled jobs on the shop floor, reducing the ratio of unskilled labor to workable capital in the second stage of production.

Goldin and Katz provide a number of empirical tests of their model. One of these, reported in their Table 3 (Goldin and Katz 1998, p. 711), is very similar to the approach taken below. Using industry level data, Goldin and Katz regress the proportion of blue-collar workers who were high school graduates -- a measure of skill -- on a variety of average establishment characteristics, including capital intensity, and the use of electricity. Their basic finding is that skill intensity was positively correlated with capital intensity and with electricity use. This evidence, as they point out, is problematic for two reasons. First, the data are highly aggregated. Second, and perhaps more importantly, the dependent variable is measured for 1940, while the capital intensity and energy use variables pertain to 1909 and 1919.

The analysis reported in this paper draws on the portion of the Goldin and Katz model that pertains to the shift from artisan to factory production. In particular, we consider whether the shift from the artisan shop to the factory is associated with a higher share of unskilled labor in production. Conditional on establishment size, we should observe a positive relationship between capital intensity and the percent skilled, again if the model is correct and if their results for the first half of the twentieth century can be projected back into the late nineteenth century. We also explore whether the predecessor of electricity -- steam and water -- altered skill intensity. Steam and water powered machinery certainly required installation and periodic maintenance, and thus, at least conditionally, with a relatively greater usage of skilled labor.

3. Estimating Skill Intensity in 1880

Our empirical work is based on a nationally representative sample of establishments drawn from the surviving manuscript records of the 1880 Census of Manufactures (Atack and Bateman 1999). The data pertain to manufacturing activities during the preceding (census) year.

We present two analyses of skill intensity. The first analysis makes use of the following identity

$$\{\text{Eq. 1}\}: \; W = (1-\alpha)W_{np} + \alpha W_p$$

In this equation W is the average monthly "establishment" wage -- that is, the average monthly wage of employees at the establishment (see Atack, Bateman, and Margo 2002c). The subscript "np" refers to non-production workers, the subscript "p" to production workers, and α is the share of production workers in total employment.

The 1880 census reported the total annual wage bill, and the number of adult male, female, and child employees, from which it is straightforward to compute the average annual wage. The census also reported the number of months of full-time operation, the number of months at three-quarter's time, the number of months at two-third's time, and the number of months at half-time. We use these data to estimate full-time equivalent months of operation.[2] Dividing FTE months into the average annual wage produces the estimate of W.

For a subset of establishments (see below) information is reported on the average daily wages of common labor, w_u, and of "mechanics", or skilled artisans, w_s. Our first analysis assumes that these daily wages are true averages. This assumption is strong and, at least for some establishments, probably unwarranted, but must be made for the analysis to proceed.[3]

Total months of operation, M, is the sum of months at the various margins of operating times (fulltime plus three-quarters time, and so on). Because we can estimate M as well as FTE months, it is possible to estimate days per month, D,

$$\{\text{Eq. 2}\}: D = (FTE/M) \times 25.75$$

Equation {2} assumes that a full-time equivalent month of operation consisted of 25.75 days. This figure is consistent with independent estimates of the length of the full-time work year in the 1870s and 1880s (see Atack, Bateman, and Margo 2002a,b).

Equation (1) may now be re-written

$$\{\text{Eq. 3}\}: W = (1-\alpha)W_{np} + \alpha(Dw_u + sD(w_s - w_u))$$

[2] FTE months = months on full-time + 0.75*months on three-quarter's time + 0.67*months on two-third's time + 0.5*months on half-time. We delete observations at zero months or months greater than twelve.
[3] The distribution of both daily wage variables are heaped on obvious integer values (for example, $1.75) to an extent that seems implausible if they were true establishment averages.

in which s = share of skilled workers among production employees.

The 1890 census was the first to report separately the wages of production and non-production workers. In what follows we treat α and W_{np}, in effect, as constants. In theory it would be straightforward to make both of these functions of establishment characteristics but in practice, this introduces a great deal of multi-collinearity into the analysis. Because non-production workers were probably more skilled on average than the typical operative, we believe that many, or most of the patterns that we observe would only be reinforced if we could control directly for α and W_{np}.

As a first approximation, then, we identify equation (1) with the regression

$$\{\text{Eq. 4}\}: W = \beta_0 + \beta_1 D w_u + \beta_2 D(w_s - w_u) + \varepsilon$$

Imagining for the moment that α, s and W_{np} literally were constants, and any errors (ε) were simple measurement errors in W uncorrelated with any of the right hand side variables, the ratio β_2/β_1 is an estimate of s, the share of production workers who were skilled. The coefficient β_1 estimates the share of production workers in total employment, from which it is possible to recover an estimate of W_{np}.

Our interest in this paper is primarily in how s, the share of skilled workers, varied with establishment characteristics. We introduce, therefore, an auxiliary equation for $s = Z\delta$, where Z is a vector of establishment characteristics. As long as the coefficient β_1 is positive (which it is in all of our estimations), there will be no sign reversals, that is, we can infer the sign of ds/dz from the sign of the coefficient of the relevant interaction term.

We imposed several constraints on the 1880 sample prior to estimation. First, we impose bounds on the extreme values of W. These bounds are constructed from the observed ranges of the daily unskilled and skilled wages, under the assumption of full-time equivalent operation (see Atack, Bateman, and Margo, 2002c for details).[4] Second, we require that establishments reported both an unskilled wage and a skilled wage, and that the reported skilled wage exceeded the reported unskilled wage. Third, we delete the relatively small number of observations from the far Western states. The resulting sample contains approximately 4,500 establishments.

Although the 1880 sample is nationally representative of the universe of surviving census manuscripts, not all of the manuscripts that once existed have survived. Some manuscripts vanished on the way to Washington, others after they had been stored or sent to various archives. Most such failures to survive, we believe, were random, and consequently should not affect our analysis. In one case, however, survival was clearly non-random. Certain industries (such as textiles, glass, and steel) were supposed to be enumerated by so-called "special agents" rather than regular census officials, ostensibly because the agents were more familiar with industry conditions. Unfortunately, despite an assiduous search of relevant archives, none of the schedules taken by these experts has ever been found (Delle Donne 1973). In practice, the line dividing the respective domains of regular enumerators and special agents was a blurry one; that is, some schedules that should have been prepared by special agents were, in fact, prepared by

[4] We also delete establishments with very low levels of gross value added; again, see Atack, Bateman, and Margo (2002c) for details.

regular enumerators. When chosen by the sampling process, these appear in the sample. However, there is no question that the special agent industries are under-enumerated. Fortunately, the special agent industries are known, and industry is reported in 1880. As it happens, none of the substantive findings reported below were affected by including a dummy variable for special agent industries, or by restricting the analysis to the non-special agent industries.

We estimate equation {4} using OLS. Given the definition of the dependent variable, we weight each establishment by reported employment. Coefficient estimates are shown in Table 1, along with robust standard errors in parentheses.

Column 1 shows the base specification with no interaction terms. The implied percent skilled for the overall sample of about 11 percent [= 0.078/0.724] seems quite low, but it should be remembered that we have weighted the data by reported employment. If the data are not weighted, the equivalent estimate is about 32 percent. Since weighting by employment gives more influence to the largest establishments, this is a clear indication that skill intensity must have declined with establishment size.

Columns 2 and 3 address this issue directly. Both regressions include establishment size, as measured by the number of workers. In column 2, establishment size is entered linearly, while in column 3 dummy variables are used. Also included are the log of the capital intensity, and dummy variables for steam and water power. The coefficient of the linear term for size is negative and statistically significant. The dummy variable specification, however, suggests that skill intensity did not differ very much among establishments between 1 and 100 employees, but very large establishments (>100) were significantly less skill intensive. Controlling for size, skill intensity was increasing in capital intensity, consistent with the Goldin-Katz model. There is also some indication that use of steam or water power, again controlling for size and the overall capital-labor ratio, was associated with a higher average level of skill, but neither coefficient is estimated with precision.

In column 4 we add interaction terms for an urban location and for census region. An establishment is considered to be urban if it was located within an incorporated place of population 2,500 or more. There is a slight indication that establishments in the South Central region were more skill intensive than in other regions, but the coefficient is not statistically significant. Urban establishments, however, do appear to have been more skill intensive, a finding that continues to be observed in the remaining columns even after including additional controls, including industry dummies. A possible explanation is that such establishments produced more specialized goods (see Scranton 1997) and, as such, required more specialized labor – which, in our approach, is labeled as skilled.

In column 5, we include dummy variables for industry at the two-digit SIC level, as well as a dummy variable for the special agent industries, as noted above.[5] As a group the industry dummies were significant, and some of the coefficients were relatively large (the left out category was construction). Most of the patterns seem plausible – the least skilled industries, in particular, were those in textiles and apparel. The coefficient of the special agent was small and statistically insignificant. Importantly, controlling for industry has little or no effect on the coefficients of the other variables in the regression.

In the last column, we add the percentage of workers who were women or children, the only directly observed characteristic of the workforce in the 1880 data. Previous work on the relationship between skill intensity and size in nineteenth century manufacturing has essentially used the percent female and child as a proxy for skill, finding that large establishments were more intensive in the use of both groups than small establishments (Goldin and Sokoloff 1982).[6] We find, not surprisingly, that establishments that were relative more intensive in the use of female and child labor were less skill intensive than other establishments.[7] However, controlling for the gender and age composition of the workforce does not substantially change the coefficient on the size dummy for the largest establishments. Gender and age, in other words, were far from a complete proxy for skill; size, as well, mattered.

Column 6 also includes dummy variable interactions for whether the establishments operated year round on a full-time equivalent basis and whether average daily hours were "short" by the standards of the day, that is, less than ten hours per day. Because the division of labor was limited by the extent of the market, and the market was more extensive (presumably) for establishments that were year round, it is plausible that such establishments were less skill intensive, which is what we observe.

Previous work with the 1880 sample suggests that workers at establishments with shorter daily hours tended to have higher hourly wage rates than workers with longer daily hours (see Atack, Bateman, and Margo 2002b). The majority of establishments in 1880 reported their average daily hours to be ten hours per day (Atack and Batement 1992). If the wage-hours pattern were due to skill, we would expect to see a positive coefficient on the dummy for daily hours less than ten, but in fact, the reverse was true. This is consistent with Costa's (2000) finding for somewhat later in the century that a

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[5] The industry coefficients are available on request from Robert A. Margo.
[6] This pattern is also apparent in our data; that is, a regression of the percent women and children produces a positive coefficient on size, controlling (or not) for other establishment characteristics.
[7] Goldin and Katz (1998) report a similar finding using industry level data.

negative correlation between daily hours and hourly wages was present for both skilled and unskilled workers, and thus was not primarily driven by differences in skill intensity.

An Alternative Measure of Skill Intensity: Patterns of Non-Response to the Census Questions on Daily Wages

Our approach to measuring skill intensity requires information on the daily wages of skilled and unskilled workers. Some establishments did not report one or the other of these.[8] Can the absence of a daily wage of either type be taken as evidence that the firm did not, in fact, employ one or the other type of labor?

As it happens, the instructions to enumerators of the 1880 census did allow for one of these possibilities. Specifically, the census recognized that "[I]n many establishments it will be found that no ordinary laborers are employed. In this case" the question "will not be filled [answered]" (Wright 1899, p. 316). Although we can find no record of a parallel instruction was given for cases in which no workers were deemed to be "skilled" such establishments are observed in the data, and we presume that a similar instruction, in practice, applied to these.

As a measure of skill intensity, the presence or absence of either a skilled or unskilled wage is an extremely very crude indicator, since it cannot reveal the level of skill – only, at best, whether the level exceeded zero, as perceived by the enumerator and whomever – presumably the manager or owner(s) – answered the census questions. As shown in the bottom two rows of Table 2, the vast majority of establishments reported a

[8] There are also establishments that failed to report either type of daily wage; however, the majority of these were evidently very small establishments that reported hiring no workers.

skilled wage, and there was little difference in the percentage doing so if the data are weighted or not by employment. However, while most establishments reported an unskilled wage, the proportion doing so is much higher when the data are weighted than when they not, an indication that the likelihood of reporting an unskilled wage was increasing in establishment size.

This indication is confirmed in Table 2, which display linear probability regressions of the reporting of an unskilled wage (columns 1 and 2) or a skilled wage (columns 3 and 4). The probability of reporting a skilled wage was essentially independent of establishment size, except for the very smallest establishments. However, the likelihood of reporting an unskilled wage was continuously increasing in establishment size.

Two of the regressions reported in Table 2 include the same additional controls other than establishment size as in Table 1. Given the high overall proportions of establishments reporting one or the other, or both wages, it is not surprising that few of these variables are statistically significant. We do, however, observe that urban establishments were less likely to report an unskilled wage than rural establishments, while establishments using steam power were more likely to report a skilled wage. Both patterns are consistent with the findings of Table 1, namely, that urban establishments and those utilizing steam were more skill intensive than other establishments.

4. Wages and Establishment Size

If skill intensity were declining in establishment size, it would seem plausible to hypothesize that the average establishment wage was also declining in establishment size, not controlling directly for skill intensity. However, a negative relationship between the average wage and size might not emerge if wage rates were themselves correlated with size. In modern data, wage rates tend to rise with establishment size for a variety of factors, including a positive correlation with respect to skill (see Brown and Medoff, 1989).[9] If this were the case in 1880, it is possible that the negative relationship between size and skill might be masked in a straightforward regression of establishment wages on establishment size.

In columns 1 and 2 of Table 3 we report regressions in which the dependent variable is the log of the monthly establishment wage. The sample is the same as in Table 1. In column 1, the only independent variables are the dummy variables for establishment size, while in column 2 we include the size dummies as well as the full set of other regression controls from Table 1. In column 1, the average wage at the very largest establishments was indeed below that at mid-size establishments, consistent with the patterns on skill intensity revealed in Table 1. However, the average wage at the largest establishments was essentially equal to the wage paid at the smallest (1-5 workers), and this is not consistent with the size pattern of skill intensity revealed by Table 1. Controlling for additional variables as in column 2 only adds to the puzzle.

In columns 3-6 we replicate the wage regressions using the log of the unskilled or skilled wage as the dependent variable. In both cases we find a positive gradient between establishment size and wage rates. In the case of unskilled wages, the gradient was

[9] Goldin and Katz (1998) find a positive correlation between average annual wages and average establishment size using industry level data for as early as 1909; see their Table 5 (p. 717).

relatively steep from the smallest size establishments (the omitted category) to the next size class, but comparatively flat thereafter, once other factors are controlled for. A similar jump in wage rates to the next size class is also observed for skilled wages. After this point the wage-size gradient was steeper for skilled than for unskilled labor, particularly for the largest establishments – the upshot being that, in the largest establishments, the skill differential – the ratio of the skilled to the unskilled wage – was higher than in smaller establishments. This difference in the skill differential, to some extent, counteracted the fall in skill intensity as size increased, resulting in the relatively flat wage profile with respect to size observed in column 2.

Why were skilled wage rates increasing in size, particularly in the very largest establishments? Given the limited information at hand on establishment characteristics, and the fact that these variables are already controlled for in the regression, we can do little more than speculate. It is possible, for example, that work intensity or responsibilities were greater in large establishments, causing skilled labor to demand a premium relative to other establishment sizes. In this regard, however, it is important to keep in mind that the regression controls, in effect, for daily hours, a measure of intensity, as well as the extent of the capital stock. Another possibility is that skilled workers in the very largest establishments were, perhaps, the most skilled among the artisan class.

5. Conclusion

This paper has presented what is, to our knowledge, the only establishment level evidence currently available on skill intensity in nineteenth century American manufacturing. The evidence is partly direct and partly indirect, that is, inference about skill intensity from the indirect evidence requires certain assumptions that are strong and possibly unwarranted for some establishments in the sample. However, given these assumptions, our results tend to support the Goldin-Katz model of manufacturing production. We find that large establishments, controlling for other factors, were less skill intensive than smaller establishments. Conditional on size, skill intensity was increasing in the use of capital per worker, and to a lesser and imprecisely measured extent, in the use of inanimate power sources. The use of child and female labor was associated with a lower level of skill.

We also investigated the relationship between wage rates and size. In modern data, wages tend to rise with establishment size for a variety of factors, including a positive correlation with skill. In our data, the largest establishments appear to be the least skill intensive, yet they did not have lower wages than the very smallest establishments. The reason, it appears, is that wage rates were increasing in size, from the very smallest to the next size class of establishments, and especially for skilled labor, for the largest establishments. These differences in wage rates partly offset the effects of skill intensity producing a flatter profile of average wages with respect to size than what would have been observed had wage rates been independent of size.

References

Acemogolu, D (2002), "Technical Change, Inequality, and the Labor Market," *Journal Of Economic Literature*, 40, 7-72.

Atack, J. (1977), "Returns to Scale in Antebellum United States Manufacturing." *Explorations in Economic History* 14, 337-359.

Atack, J. and Bateman, F. (1992), "How Long was the Workday in 1880?" *Journal of Economic History* 52, 129-160.

Atack, J. and Bateman, F. (1999), "U.S. Historical Statistics: Nineteenth-Century U.S. Industrial Development Through the Eyes of the Census of Manufactures: A New Resource for Historical Research." *Historical Methods* 32, 177-188.

Atack, J., Bateman, F. and Margo, R.A. (2002a), "Part-Year Operation in Nineteenth Century American Manufacturing: Evidence from the 1870 and 1880 Censuses," *Journal of Economic History*, forthcoming.

Atack, J., Bateman, F. and Margo, R.A. (2002b), "Productivity in Manufacturing and the Length of the Working Day: Evidence from the 1880 Census of Manufactures," Unpublished paper, Department of Economics, Vanderbilt University, June.

Atack, J., Bateman, F. and Margo, R.A. (2002c), "Rising Wage Dispersion Across American Manufacturing Establishments," unpublished paper, Department of Economics, Vanderbilt University, July.

Brown, C. and Medoff, J.H. (1989), "The Employer Size-Wage Effect." *Journal of Political Economy* 97, 1027-1059.

Chandler, A. (1977), *The Visible Hand*. Cambridge, MA: Harvard University Press.

Costa, D. (2000), "The Wage and the Length of the Working Day: From the 1890s to

1991." *Journal of Labor Economics* 18, 156-181.

Delle Donne, C.R. (1973), *Federal Census Schedules, 1850-1880: Primary Sources for Historical Research*. National Archives and Records Service Reference Information Paper No. 67, General Services Administration, Washington DC.

Goldin, C. and Sokoloff, K. (1982), "Women, Children, and Industrialization in the Early Republic: Evidence from the Manufacturing Censuses." *Journal of Economic History* 42, 741-774.

Goldin, C. and Katz, L. (1998), "The Origins of Technology-Skill Complementarity." *Quarterly Journal of Economics* 113, 693-732.

Sokoloff, K. (1984), "Was the Transition from the Artisanal Shop to the Non-Mechanized Factory Associated with Gains in Efficiency? Evidence from The U.S. Manufacturing Censuses of 1820 and 1850." *Explorations in Economic History 21*, 351-382.

Scranton, P. (1997), *Endless Novelty: Specialty Production and American Industrialization, 1865-1925.* Princeton, NJ: Princeton University Press.

Wright, C. (1899). *History and Growth of the United States Census*. Washington, DC: U.S. Government Printing Office.

Table 1: Estimates of Equation 4

Column	1	2	3	4	5	6
Constant	8.510 (5.605)	9.906 (3.550)	8.204 (3.933)	8.828 (3.942)	9.257 (3.544)	10.348 (3.520)
D x w_u	0.724 (0.166)	0.645 (0.109)	0.663 (0.128)	0.658 (0.133)	0.622 (0.125)	0.582 (0.126)
D x ($w_s - w_u$)	0.078 (0.074)	-0.107 (0.152)	-0.179 (0.155)	-0.280 (0.147)	-0.007 (0.139)	0.128 (0.131)
D x ($w_s - w_u$) x						
# employees x 10^{-2}		-0026 (0.008)				
6<=#emp<=15			-0.013 (0.029)	-0.032 (0.030)	-0.024 (0.032)	-0.019 (0.032)
16<=#emp<=50			-0.053 (0.035)	-0.070 (0.036)	-0.050 (0.040)	-0.038 (0.038)
51<=#emp<=100			0.047 (0.089)	0.013 (0.085)	0.045 (0.084)	0.088 (0.083)
101<#emp			-0.278 (0.113)	-0.263 (0.090)	-0.229 (0.080)	-0.256 (0.084)
Log(K/L)		0.036 (0.022)	0.062 (0.023)	0.061 (0.023)	0.058 (0.023)	0.041 (0.022)
Steam		0.128 0.065)	0.126 (0.073)	0.129 (0.076)	0.087 (0.065)	0.089 (0.062)
Water		0.055 (0.074)	0.072 (0.080)	0.098 (0.082)	0.059 (0.076)	0.051 (0.073)
% (Women+Children)						-0.308 (0.097)
Full Year Operation?						-0.129 (0.039)
Daily Hours < 10						-0.100 (0.049)
Urban				0.105 (0.051)	0.082 (0.048)	0.097 (0.046)
Midwest				0.053 (0.052)	0.013 (0.044)	-0.013 (0.044)
S. Atlantic				0.007 (0.114)	-0.035 (0.109)	-0.048 (0.110)
S. Central				0.160 (0.128)	0.136 (0.110)	0.155 (0.110)
Industry?	No	No	No	No	Yes	Yes
N	4476	4474	4474	4474	4474	4476
R^2	0.186	0.291	0.274	0.281	0.319	0.340

Dependent variable is monthly establishment wage, see text.

Table 2: Linear Probability Regressions: Reporting of an Unskilled or Skilled Wage

Dep. Var.	=1 if w_u reported	=1 if w_u reported	=1 if w_s reported	=1 if w_s reported
Constant	0.751 (0.067)	0.807 (0.080)	0.918 (0.004)	0.570 (0.119)
6<=#emp<=15	0.133 (0.010)	0.135 (0.013)	0.048 (0.007)	0.035 (0.009)
16<=#emp<=50	0.142 (0.012)	0.203 (0.017)	0.065 (0.007)	0.042 (0.010)
51<=#emp<=100	0.195 (0.023)	0.211 (0.028)	0.037 (0.019)	0.022 (0.022)
101<=#emp	0.223 (0.016)	0.256 (0.020)	0.065 (0.0101)	0.024 (0.022)
Log (K/L)		-0.002 (0.006)		0.0032 (0.0061)
Steam		0.022 (0.021)		0.032 (0.014)
Water		0.031 (0.012)		-0.0004 (0.018)
% (Women+Children)		0.014 (0.034)		-0.050 (0.039)
Full year operation?		-0.002 (0.018)		-0.0004 (0.010)
Daily hours <10		0.019 (0.014)		0.005 (0.006)
Urban		-0.076 (0.010)		0.016 (0.009)
Midwest		-0.002 (0.020)		0.006 (0.012)
S. Atlantic		0.018 (0.016)		-0.026 (0.020)
S. Central		-0.018 (0.039)		-0.023 (0.026)
Industry?	No	Yes	No	Yes
N	6607	6603	6607	6603
R^2	0.076	0.121	0.017	0.084
Mean Dep. Var., Emp. Weighted	0.921		0.969	
Mean Dep. Var., Unweighted	0.751		0.918	

W_u: daily wage of common labor. W_s: daily wage of mechanics.

Table 3: Log Wage Regressions: The Effects of Establishment Size

Dep. Variable	Ln W	Ln W	Ln w_u	Ln w_u	Ln w_s	Ln w_s
Controls?	No	Yes	No	Yes	No	Yes
Constant	3.237 (0.013)	2.122 (0.207)	-0.034 (0.007)	-0.500 (0.125)	0.548 (0.006)	-0.044 (0.191)
6<=#emp<=15	0.112 (0.022)	0.101 (0.025)	0.116 (0.103)	0.119 (0.015)	0.127 (0.011)	0.100 (0.016)
16<=#emp<=50	0.186 (0.026)	0.143 (0.035)	0.157 (0.017)	0.144 (0.024)	0.203 (0.015)	0.147 (0.030)
51<=#emp<=100	0.155 (0.052)	0.145 (0.062)	0.142 (0.036)	0.155 (0.038)	0.184 (0.033)	0.153 (0.045)
101<=#emp	-0.015 (0.017)	0.0.094 (0.065	0.080 (0.051)	0.156 (0.053)	0.257 (0.047)	0.263 (0.058)
N	4476	4476	4478	4476	4476	4476
R^2	0.026	0.354	0.017	0.317	0.054	0.293

Dependent variable is log of monthly establishment wage; see text.