Online Appendix to *"'Mechanization Takes Command?': Powered Machinery and Production Times in Late Nineteenth-Century American Manufacturing."*

JEREMY ATACK, ROBERT A. MARGO, AND PAUL W. RHODE

This is the online Appendix for our paper, "'Mechanization Takes Command'? Inanimate Power and Labor Productivity in Late Nineteenth-Century American Manufacturing." It contains additional details on calculations in the paper and on the robustness checks that we performed.

Coverage of the HLM Study

Online Appendix Table 1 shows the distribution of the HML study units in the regression sample (see Table 1 in the paper) by two-digit standard industrial classification (SIC) code compared with establishments shares in manufacturing in 1899 as reported in Historical Statistics (U.S. Bureau of the Census 1975, pp. 666 and 669-80). Except for two industry groups (Petroleum and Coal Products, Rubber and Plastic Products), the HML study included units in all industry codes of that time although not in proportion to the establishment shares in the 1900 census – that is, the HML units were a broad, but not representative, sample of manufactured products of the time. Appendix Table 1 also shows the mean values of *Mechanized* and of Δ *ln T* by SIC codes. Larger positive values of *Mechanized* indicate greater mechanization and larger negative values of Δ *ln T* indicate greater productivity change. Sectors that were important in the First Industrial Revolution, such as Textiles (SIC 22) and Primary Metals (33) experienced greater mechanization and greater productivity change.

Estimating the Share of Value Added in Establishments using Inanimate Power: 1904

In footnote 9 of the paper, we report that 94 percent of manufacturing value-added was produced in establishments using inanimate power. This was computed as follows. According to the 1910 Census of Manufactures (U.S. Bureau of the Census 1913, p. 332) there were 216,180 establishments, 134,481 of which (62 percent) used inanimate power, almost entirely by steam (95 percent). The Census (U.S. Bureau of the Census 1913, p. 180) also reported the distribution of establishments across five value-of-product categories. There were 81,699 non-powered establishments in 1904. If we assume that all of these establishments were small in terms of output, the non-powered establishments then account for all of the establishments in the first category (< $5,000) plus approximately 15 percent of the second ($5,000-20,000). Together, this implies that the non-powered establishments produced 2.8 percent of aggregate value-added (see online Appendix Table 2). We believe 2.8 percent is too small, because some small establishments probably used power and some large establishments may not. We have made a conservative adjustment by doubling the share to 5.6 percent, implying that 94.4 percent [= 100 – 5.6] of manufacturing value added in 1904 was produced in establishments using power.

While this estimate is very rough, it is arguably in the ballpark of the true figure. For example, computing the share of value-added produced in establishments using inanimate power in 1850 and 1870 using the national samples of establishments discussed in Atack and Bateman (AtackBateman 1999; see Atacket al.BatemanWeiss 2006 for the data themselves) produces estimates of 57.3 percent and 71.1 percent. A linear projection of this upward trend in the value-added share between 1850 and 1870 shows an increase of 6.9 percentage points per decade implying that 91.8 percent of value added was produced in powered establishments in 1900, just slightly below our estimate for 1904.

OLS Estimates of λ: With and Without Controls for Worker Gender and Age

The HML study reported some information on worker gender and age. This information is sufficient to measure the differences between machine and hand labor in the fraction of workers who were male, Δ *Male*, and the fraction of child workers ages 14 and under, Δ *Child14*, at the block line level. Using the regression sample, we re-estimated equation 1, including these two additional variables. The coefficient of Δ *Male* is negative and significant, -0.177 (s.e. = 0.080), indicating that production times were lower for male workers. The coefficient of Δ *Child14* is positive, 0.381 (s.e. = 0.361), indicating that children took longer to complete the operation, although the impact is not statistically significant. Importantly, including both variables has virtually no effect on the estimated coefficient (λ) of *Mechanized*, -1.036 (s.e. = 0.060) compared with the base specification (λ = -1.037), suggesting that endogeneity bias due to omitted worker characteristics is probably a minor concern in the HML study.

Robustness Checks: OLS and IV estimates of λ for Different Subsamples

Our regression analysis yields three substantive findings. First, the OLS and 2SLS coefficients of *Mechanized* (λ) are negative and statistically significant. Second, there is some evidence of reverse causality in so far as the 2SLS estimate of the coefficient is smaller in absolute value than the OLS estimate. Third, the percent explained by mechanization of the mean value of Δ *ln T*, the dependent variable, is approximately 33 percent for OLS and somewhat less for 2SLS.

We tested the robustness of these findings by estimating equation 1 (OLS and 2SLS) for various sub-samples:

a) 1-1 versus non-1:1 block links,

b) restricting to observations from the 1890s only,

c) units for which the machine labor version good was deemed to be of "superior quality" to the hand labor good,

d) units for which the reverse was true (hand labor superior to machine labor or no difference, including no opinion).

Results are shown in online Appendix Table 3. Except in rows 3 and 5 of the table, all regressions include unit fixed effects. For the subsamples comprised of the H:1, 1:M, and H:M block links (row 3), and the blocks links for which the quality of the hand unit was judged to be better or no different from the machine unit quality (row 5), we were unable to obtain 2SLS results that converged with unit fixed effects and substituted 4-digit SIC codes instead for both OLS and 2SLS.

The OLS estimates range from -0.863 to -1.092, which we view as similar to the overall OLS estimate (-1.037). The 2SLS coefficients are not as precisely estimated but, like the main results reported in the paper, all are smaller in absolute value than the corresponding OLS coefficients. Using the OLS coefficients, the percent explained ranges from 26.2 to 34.3 percent, again not very different from the base specification for the overall regression sample (32.5 percent). Consequently, we conclude that our substantive findings are robust to restricting the analysis to various sub-samples of the overall regression sample.

Online Appendix Table 1
Distribution by Two-Digit SIC Code: HML Units and Manufacturing Establishments in 1899

SIC	SIC Industry	Percent of HML Units	Mean Value, *Mechanized*	Mean Value, Δ *ln T*	Percent of 1899 Establishments
20	Food and Kindred	6.4	0.380	-1.244	NA
21	Tobacco	1.3	0.432	-1.102	7.3
22	Textile	8.2	0.772	-2.748	2.9
23	Apparel	8.3	0.237	-1.222	6.2
24	Lumber and Wood	10.2	0.745	-2.056	15.9
25	Furniture	7.4	0.635	-1.920	1.3
26	Paper	4.0	0.641	-1.420	0.9
27	Printing	8.2	0.414	-1.817	11.9
28	Chemical	0.5	0.625	-1.776	3.7
29	Petroleum and Coal	0	NA	NA	0.2
30	Rubber and Plastic	0	NA	NA	0.1
31	Leather	5.4	0.517	-1.796	2.8
32	Stone, Clay, and Glass	5.8	0.378	-0.995	5.7
33	Primary Metal	2.5	0.755	-2.709	NA
34	Fabricated Metal	10.3	0.728	-2.167	NA
35	Industrial Machinery	0.9	0.735	-2.411	NA
36	Electric Equipment	0.2	0.444	-0.698	0.3
37	Transportation	8.3	0.716	-2.226	NA
38	Instruments	0.2	0.833	-2.588	0.5
39	Miscellaneous	11.8	0.532	-1.350	NA

Notes and Sources: Columns 3, 4 and 5 are computed from the digitized HML study (U.S. Department of Labor 1899) and pertain to the regression sample in the paper (see Table 1 of the paper). There are 551 units in the regression sample. The overall mean of *Mechanized* is 0.552 and the overall mean of Δ *ln T* is -1.761 (see Table 1 of published paper).
Column 6 is the share of establishments in 1899 in the SIC category, computed from (U.S. Bureau of the Census 1975, pp. 669-80). The denominator is total establishments in 1899 (204,734) excluding hand and neighborhood industries (U.S. Bureau of the Census 1975, p. 666, Series P1). NA: 1899 establishment count not available for the SIC code.

Online Appendix Table 2
Manufacturing Establishments in 1904, Distributed by Value of Product

Value of Product:	Total	<$5k	$5k-20k	$20k-100k	$100k-1,000k	$1,000k+
Establishments	216,180	71,147	72,791	48,096	22,246	1,900
Wage-earners	5,468,383	106,353	419,466	1,027,047	2,515,064	1,400,453
Value of Product ($k)	14,793,903	176,128	751,048	2,129,258	6,109,013	5,628,456
Value Added ($k)	6,293,695	114,781	424,130	1,090,271	2,782,642	1,881,870
Percentage shares						
Establishments	100.0	32.9	33.7	22.2	10.3	0.9
Wage-earners	100.0	1.9	7.7	18.8	46.0	25.6
Value of Product	100.0	1.2	5.1	14.4	41.3	38.0
Value Added	100.0	1.8	6.7	17.3	44.2	29.9

Source: (U.S. Bureau of the Census 1913, p. 180)

Online Appendix Table 3
Subsample Estimates of the Coefficient of Mechanization, and Percent Explained: OLS and 2SLS

Row	Sub-Sample	N	Mean Value, Mechanized	Mean Value, Δ ln T	OLS	Percent Explained	2SLS	Percent Explained
1	Base (Table 2))	4,405	0.552	-1.761	-1.037 (0.060)	32.5	-0.749 (0.165)	23.5
2	1:1 Block Links	3,412	0.484	-1.646	-1.086 (0.069)	31.9	-0.744 (0.193)	21.9
3	1:M, H:1, H:M Block Links	993	0.785	-2.157	-0.863 (0.1031)	34.3	-0.859 (0.347)	31.3
4	Only 1890s Observations	998	0.460	-1.513	-0.863 (0.102)	26.2	-0.796 (0.373)	24.2
5	Hand Product Better Quality or No Quality Difference	1,621	0.472	-1.630	-1.092 (0.095)	31.6	-0.661 (0.362)	19.1
6	Machine Product of Better Quality	2,784	0.598	-1.837	-0.986 (0.070)	32.1	-0.742 (0.170)	24.2

Source: see Table 1 of published paper.
Notes: Hand quality Better or No Difference: includes units where no opinion on quality differences was expressed by the HML staff. All regressions, except rows 3 and 5 include unit fixed effects; rows 3 and 5 substitute four-digit SIC fixed effects (see online Appendix text). Standard errors, shown in parentheses, are clustered at the unit level. Rows 1, 4, 5, and 6 include the full set of block-link dummies (1:1 is the left-out dummy). Row 3 includes block link dummies for H:1 and H:M (M:1 is the excluded dummy).

References

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