Occupational Switching During the Second Industrial Revolution

Bart Hobijn and Robert S. Kaplan

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Bart Hobijn [*] Robert S. Kaplan[†]

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Abstract

During the Second Industrial Revolution, in the late nineteenth century, the proliferation of automation technologies coincided with substantial job creation but also a "hollowing out" of middle-skilled job opportunities, which historically offered reliable paths to prosperity. We use recently linked U.S. census data to document three main facts: (*i*) declining demand for middle-skilled labor in manufacturing corresponded to greater reallocation of workers into comparatively less-skilled occupations; (*ii*) older workers were more likely to switch to unskilled physical labor; (*iii*) younger workers led switching into growing occupations affected by automation technologies.

Keywords: automation, occupational choice, technological displacement

JEL Codes: J62, N31, N32, O33

[*]Federal Reserve Bank of Chicago. Email: bart.hobijn@barthobijn.net
[†]Federal Reserve Bank of Chicago. Email: robert.s.kaplan@chi.frb.org

We offer new historical evidence about occupational switching during the Second Industrial Revolution from 1850 to 1940. While technologies from the First Industrial Revolution allowed mechanized methods to replace routine manual production, substituting labor demand for artisinal craftsmen with less-skilled machine operators, the Second Industrial Revolution accelerated this process while causing large-scale displacement in agriculture (Manuelli and Seshadri, 2014; Mokyr, 1992). Second Industrial Revolution automation technologies increased the efficiency and scope of mechanized production, requiring fewer operators but more engineers, managers, and other new occupations (Mokyr, 1992). As automation created fewer middle-skill jobs than it made obsolete (Katz and Margo, 2014), the net result was a "hollowing out" of the skill distribution in manufacturing.

Newly linked U.S. Census data allow us to follow workers over consecutive decades of the Second Industrial Revolution and reveal three facts. The declining demand for middle-skilled labor in manufacturing manifested as increased reallocation of workers into comparatively less skilled occupations. Older workers were likelier to remain in middle-skilled occupations or switch to unskilled physical labor. Younger workers led switching into growing sectors and occupations affected by automation technologies. This historical evidence implies that age plays a prominent role in the adoption of new technologies, who enjoys their benefits, and who bears their costs.

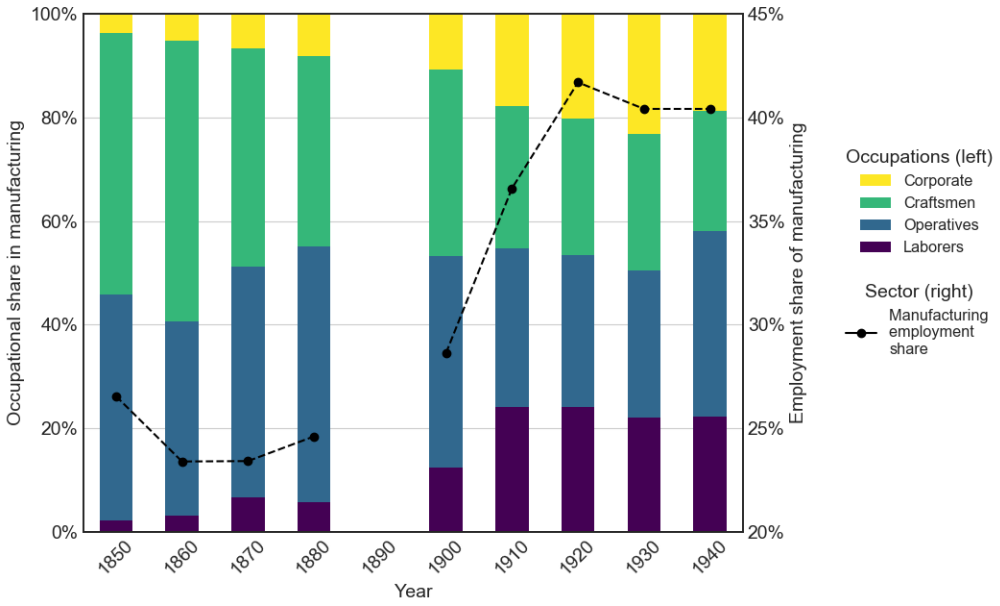
It also puts discussions about more recent waves of automation in historical context. The "hollowing out" of the skill distribution from 1850 to 1940 evokes the rising "polarization" of the labor market between low- and high-skill jobs (Autor et al., 2003) during the 3rd Industrial Revolution, which was driven by computerization in the mid-twentieth century. Like technological change during the era we analyze, this period experienced substantial job creation: about 60% of workers in 2018 held occupations that did not exist in 1940 (Autor et al., 2022). As advances in automation technologies, such as tools employing artificial intelligence, continue, these historical parallels provide useful guidance for thinking about their impact.

Hollowing out: 1850-1940

To capture the substitutability of manufacturing workers with automated machinery, we group occupations into categories roughly corresponding to skill level. Following Katz and Margo (2014), we classify laborers as unskilled, operatives as low-skilled, craftsmen as middle-skilled, and "corporate" workers as high-skilled.[1]

Figure 1 illustrates two transformations — occupational and structural — in the manufacturing sector. The dashed line shows how structural transformation involved an increase in the manufacturing employment share across Decennial Censuses.[2] This coincided with falling agricultural employment, when new technologies, mostly adopted after the U.S. Civil War (1861-65), improved agricultural labor productivity and lowered agricultural labor demand (Manuelli and Seshadri, 2014).

Figure 1: Structural and occupational transformation in U.S. manufacturing



Source: U.S. Census Microdata (MLP) and authors' calculations

Simultaneously, new automation technologies in manufacturing transformed the occupational-

[1]Laborers perform general labor, requiring no specific skills; operatives operate machinery, requiring skills specific to the machinery they operate; craftsmen create or maintain products, requiring knowledge covering the domain of that product; and corporate (or 'non-production') workers include professional, sales, clerical, and managerial roles, which often required secondary or post-secondary education.

[2]Census records for 1890 are unavailable. They were destroyed by fire in January 1921.

skill distribution. In 1850, operatives and craftsmen comprised nearly all of manufacturing employment, which roughly correspond to low- and middle-skilled occupations. By 1940, however, nearly half of manufacturing workers were unskilled laborers or high-skilled corporate workers. The relative decline of operatives and especially craftsmen reflects the shift in manufacturing activity away from middle-skilled tasks that "hollowed out" the occupational skill distribution in manufacturing.

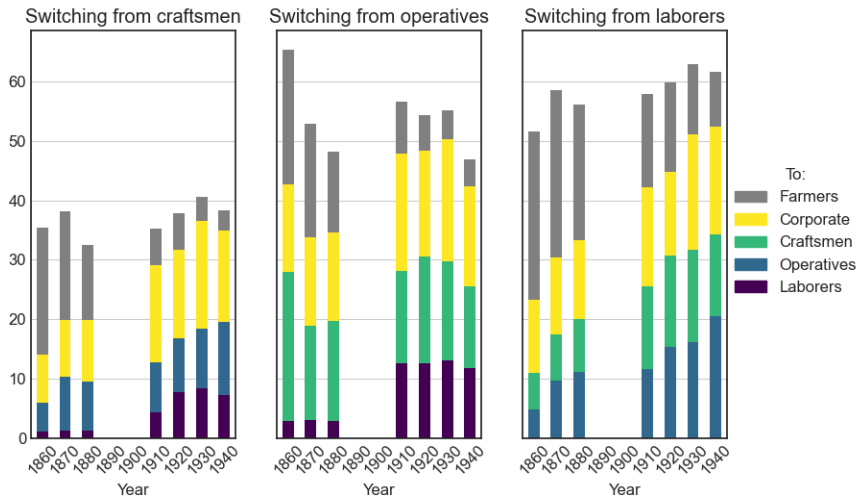
Following displacement through job switching

Differences between cohorts of workers over time, which have been previously documented using cross-sectional data, partly account for the changing skill distribution in manufacturing during the late nineteenth and early twentieth centuries (Katz and Margo, 2014). Due to the sparseness of nineteenth century data, however, previous research has not documented how incumbent workers switched jobs to accommodate changes in the skill distribution of labor demand, which requires panel data.

Only recently have computational and methodological advances made it possible to construct a large representative sample of workers across occupations during periods of automation in the nineteenth century. Using the newly released Multigenerational Longitudinal Panel (MLP), which links individuals over successive census years, we calculate occupational switching statistics for workers in manufacturing between 1850 and 1940. An innovative record linkage procedure means the MLP contains reliable linkages for millions of working age adults each decade; unlike other linked census datasets, this provides statistical power to calculate occupational transitions conditional on age (Helgertz et al., 2023; Ruggles et al., 2021).

Figure 2 shows patterns of occupational switching over the century for which we have data. It reveals two trends that contributed to the "hollowing out" of the occupational-skill distribution in manufacturing: (*i*) the decline of farming, and (*ii*) the increase in switching to lower-skilled occupations.

Figure 2: Switching between occupational-skill groups



Source: U.S. Census Microdata (MLP) and authors' calculations

Note: Fraction of manufacturing workers by initial occupation working in a different occupation a decade later, split up by destination occupation. 1890 and 1900 data are missing because of unavailability of 1890 Census data.

Mechanization in farming reduced agricultural labor demand, so exits from manufacturing to farming became increasingly rare. Workers vulnerable to technological displacement (i.e., new technologies making a worker's job obsolete, regardless whether their exit was voluntary) might have preferred leaving manufacturing for farming, particularly in the nineteenth century (Katz and Margo, 2014). The data imply, however, this was either increasingly difficult to achieve or that workers preferred less-skilled manufacturing jobs over farming: While in 1860 half of switching craftsmen were farmers 10 years later, by 1940 this was less than 10%.

Simultaneously, changes in the destinations of switching manufacturing workers indicate a prominent role for technological displacement. For craftsmen, switching to lower-skilled jobs (i.e., operatives and laborers) almost entirely offsets the decline in farming as a destination after 1910, although switching to operatives was persistently likelier than to laborers. This suggests that technological displacement among craftsmen was more likely to cause a step *down* the occupational-skill ladder than a drop to the bottom. The fortunes of switching operatives also support a prominent role for technological displacement. The fraction

of operatives working as laborers a decade later, switching down the occupational skill distribution, increased substantially after 1900. 25% of switching operatives became laborers in 1940, 21 percentage points higher than in 1860. As switching to lower-skilled jobs increased, switching that ascended the occupational-skill ladder declined. While nearly 40% of switching operatives became craftsmen in 1860, only 29% did so by 1940.

The destinations of switching laborers, however, suggest that neither skill-polarized labor demand nor technological displacement created one-way streets for affected workers. After 1910, laborers switched into higher-skill occupations increasingly frequently.

The young and the mobile

The obsolescence of occupation-specific human capital, in which workers accumulate skills and knowledge useful in their current job but not others, can rationalize the contrasting outcomes of craftsmen, operatives, and laborers. For older workers, switching occupations involves a higher loss of these accumulated skills and, because of their age, a shorter period to re-accumulate skills in a new occupation. As the proliferation of automating technologies made some occupations obsolete while creating others, younger workers were better poised than older workers to enter newly emerging occupations, as Autor and Dorn (2009) show for the late twentieth century.

Our historical evidence supports this. Younger workers led switching into growing occupations, while older workers were more vulnerable to being displaced by the changing technological landscape. This is clear among craftsmen and operatives. Table 1 illustrates how younger and older workers in these manufacturing occupations reacted differently to the onset of late nineteenth century automation technologies.

Younger craftsmen disproportionately departed for other occupations when their share of jobs in manufacturing declined, suggesting a prominent role for occupation-specific human capital. Indeed, before 1880 about 60% of younger craftsmen and 66% of older craftsmen remained so a decade later. When automation technologies increasingly made obsolete some craftsmen jobs between 1910 and 1940, only 49% of younger craftsmen remained so a decade

later, compared to 64% of older craftsmen. Simultaneously, younger craftsmen were increasingly more likely than older craftsmen to enter corporate occupations after 1880, for which older workers' occupation-specific skills would have been least transferable.

Table 1: Differences by age in switching between occupational-skill groups

	Switching to:							
	Laborers		Operatives		Craftsmen		Corporate	
	20-29	45-69	20-29	45-69	20-29	45-69	20-29	45-69
A: From Craftsmen								
1860-80	1.6	1.2	16.1	7.0	60.4	66.3	11.2	8.0
1910-40	8.6	7.3	17.9	8.6	49.2	64.6	17.6	11.4
B: From Operatives								
1860-80	2.8	2.7	49.7	49.6	26.2	14.3	11.0	12.8
1910-40	11.4	14.0	45.6	48.3	19.5	13.6	16.4	12.1

Source: U.S. Census Microdata (MLP) and authors' calculations

Note: Percentage of manufacturing workers by initial occupation and age working in manufacturing occupations a decade later, pooled into census-year groups. The panel heading denotes initial occupation, column headings denote initial age and subsequent occupation. Farmers omitted.

Younger operatives, like younger craftsmen, entered growing occupations more frequently, but the "hollowing out" of middle-skill manufacturing jobs was concentrated among younger workers. Younger operatives were about 7 percentage points less likely to enter craftsmen occupations in 1910-40 compared to 1860-80, while older operatives were only about 1 percentage point less likely. Increased switching to emerging corporate jobs in 1910-40, however, offset most of the declining upward mobility for younger operatives.

In contrast, switching down the occupational-skill ladder increased most for older operatives. Unlike craftsmen, older operatives were about 3 percentage points likelier to switch to laborers than younger operatives in 1910-40, even though there was little difference by age in 1860-80. This may indicate that older operatives were the most disadvantaged during

technological displacement. With occupation-specific human capital less transferable to a new occupation than similarly aged craftsmen and less time to retrain, older operatives were much likelier to enter generalized, unskilled labor.

Conclusion

Newly linked census data show that younger workers played a prominent role in the process of adjustment to automation technologies. They disproportionately switched into growing occupations. Older workers, however, were more likely to remain in declining occupations or switch to unskilled physical labor.

References

Autor, David, Caroline Chin, Anna Salomons, and Bryan Seegmiller (2022) "New Frontiers: The Origins and Content of New Work, 1940–2018," August, Working paper.

Autor, David and David Dorn (2009) "This job is 'getting old': measuring changes in job opportunities using occupational age structure," *American Economic Review*, 99 (2), 45–51.

Autor, David H., Frank Levy, and Richard J. Murnane (2003) "The Skill Content of Recent Technological Change: An Empirical Exploration," *The Quarterly Journal of Economics*, 118 (4), 1279–1333.

Helgertz, Jonas, Steven Ruggles, John Robert Warren, J. David Hacker Catherine A. Fitch, Matt A. Nelson, Joseph P. Price, Evan Roberts, and Matthew Sobek (2023) "IPUMS Multigenerational Longitudinal Panel: Version 1.1 [dataset]," Minneapolis, MN: IPUMS.

Katz, Lawrence F. and Robert A. Margo (2014) "Technical change and the relative demand for skilled labor: The united states in historical perspective," in *Human capital in history: The American record*, 15–57: University of Chicago Press.

Manuelli, Rodolfo E. and Ananth Seshadri (2014) "Frictionless Technology Diffusion: The Case of Tractors," *American Economic Review*, 104 (4), 1368–91.

Mokyr, Joel (1992) *Lever of Riches: Technological Creativity and Economic Progress*: Oxford University Press.

Ruggles, Steven, Catherine A. Fitch, Ronald Goeken et al. (2021) "IPUMS Ancestry Full Count Data: Version 3.0 [dataset]," Minneapolis, MN: IPUMS.