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Taking technology to task: The skill content of technological change in early twentieth century United States

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Abstract

This paper uses new data on the task content of occupations to present a new picture of the labor market effects of technological change in pre-WWII United States. I show that, similar to the recent computerization episode, the electrification of the manufacturing sector led to a "hollowing out" of the skill distribution whereby workers in the middle of the distribution lost out to those at the extremes. OLS estimates show that electrification increased the demand for clerical, numerical, planning and people skills relative to manual skills while simultaneously reducing relative demand for the dexterity-intensive jobs which comprised the middle of the skill distribution. Thus, early twentieth century technological change was unskill-biased for blue collar tasks but skill-biased on aggregate. These results are in line with the downward trend in wage differentials within U.S. manufacturing up to 1950.

JEL classification: J23; O33; N32; N33
Keywords: Technological change; Skill bias; Electrification

1. Introduction

Electricity has been described by Jovanovic and Rousseau (2005, p. 1) as one of the "two most important general purpose technologies", along with computerization. Electrification of factories transformed the ways in which goods were manufactured in the United States after 1900. Economic historians have long been interested in this episode but typically the research focus has been on identifying the energy input savings and productivity gains.[1] However, other interesting questions remain—how did the relative position of labor change during this time, and were workers of various skill levels affected differently? Here, I focus on these labor market effects from 1900 to 1940. Specifically, I use new data on workplace tasks to show that electrification caused a "hollowing out" of the skill distribution in manufacturing, similar to the phenomenon described in studies of computerization and inequality in the United States since 1960. In doing so, the paper helps explain why Goldin and Katz (2008) find evidence of skill-bias while Lindert and Williamson (1980) document a fall in the skill premium earned by high-skill blue-collar workers.

This paper takes the most direct approach yet to identifying the skill content of technological change pre-WWII. Previous research has used indirect measures of skill such as average establishment wages as the variable of interest.[2] Furthermore, pre-1940 there

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[1] For instance, Woolf (1980) focused on electrification's effect on energy demand.

[2] Previous treatments include Atack et al. (2004) and Goldin and Katz (1998).

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are no consistent and nationally-representative measures of education and which motivates the focus on quantity variables in this paper. Here, skill is measured directly, according to the task composition of each job, and the impact of technological change on the relative demand for managerial, clerical, dexterity and manual tasks is identified. I define a task as a particular activity that is required of an occupation, or the intensity with which a particular skill is used. For example, the "manual" measure describes the extent to which strength is needed in an occupation, while the "clerical" measure details the degree of numerical and office skills required in a job.[3] Evidence from manufacturing suggests that relative demand for workers intensive in clerical and managerial skills increased compared to those specializing in manual and dexterity skills while, focusing on the factory floor, workers intensive in manual skills increased in importance relative to those using dexterity and craft skills. This pattern of polarization in the skill distribution is a new result for the electrification era.[4] Indeed, the task data shows a 15 percentage point decline in dexterity intensity relative to manual intensity from 1880 to 1920 and electricity explains 80% of that change.[5] These results are also supported by new evidence presented by Katz and Margo (2013) which documents hollowing out in U.S. manufacturing during this period, using more conventional data on employment shares of broad occupational groups.

This result has potential implications for the historical literature on inequality. Previous research portrayed technological change in this era as being simply skill-biased or education-biased at all levels of production. In particular, Goldin and Katz (2008) looked across industries that were adopting electric power at different rates over the period 1909 to 1940 and showed that in 1940 industries that had adopted electricity more quickly over the period 1909 to 1929 employed more educated blue collar workers. Thus, they concluded that technology was skill-biased and that the downward trend in the education premium to 1950 must be explained by the increased supply of educated workers as a result of the "high-school revolution". However, I show here that, for the bulk of workers (the 80% employed on the factory floor), electrification led to unskill-biased technological change, which may provide an alternative explanation for falling wage differentials between artisanal and manual workers.[6] In this paper, I will focus simply on showing the effects of electrification on the skill distribution and leave the full implications of these results on the wage distribution for future research.

Technological change has had remarkably consistent labor market effects over at least a century and a half. Various authors, notably Atack et al. (2004), have shown that the move from artisanal to factory work in the mid-nineteenth century may have been de-skilling, or at least not biased in favor of skilled workers.[7] They used detailed plant-level data from 1850 to 1880 and found that the advent of the factory likely led to an increased division of labor so that teams of unskilled workers could perform tasks previously done by a handful of skilled workers. Late in the period, as steam power predominated, there may have been an increase in the use of skilled labor which partially offset the bias in favor of unskilled workers. Bessen's (2011) study of New England textile factories found evidence that new technologies simultaneously eradicated the need for certain tasks while increasing the value of the remaining tasks used in production. Autor et al. (2003) used a post-1960 U.S. dataset on the tasks required of occupations to investigate the skill content of computerization. They found that demand for non-routine tasks increased while demand for routine-cognitive and routine-manual skills fell, suggesting that computers are complementary to the former but substitute for the latter. This skill bias explains a substantial part of the increase in inequality for that period, and dwarfs the contribution of other causes, including the growth of trade and outsourcing and the decline of unions.[8] The results of this paper show that technological change up to 1940 exhibited characteristics of both of these episodes, the unskill-biased component and the hollowing out effect.

2. Electrification

Fig. 1 shows that steam power was dominant through the 1900s but by 1910 electricity was catching up rapidly, overtaking steam sometime in the 1910s, spurred by the

[3] See Section 4.1, Table 1 and Appendix A for more information on the task variables.

[4] Chin et al. (2006) also find evidence of "hollowing out" but they use data from only one industry, the merchant marine. They uncover overall unskill-biased technological change in this industry at the same time as new professional jobs such as merchant engineer emerged.

[5] Author's calculations based on task and IPUMS census datasets.

[6] Lindert and Williamson (1980), pp. 78–9 showed this trend using a variety of wage series.

[7] See also Field (1980). He analyzed the skill composition of the Massachusetts workforce from 1820 to 1880 and found no great increase in skill intensity before 1870.

[8] For summaries of polarization in the wage distribution see: Autor et al. (2006), Autor et al. (1998), Acemoglu (1999) and Machin and Van Reenen (1998) among others.