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## Automation and the Fate of Young Workers

Evidence from Telephone Operation in the Early 20th Century

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**A**utomation anxiety is surging in the United States and other developed economies, fueled by warnings of an impending, sweeping, permanent reduction in labor demand. Especially concerning is that automation often replaces routine, entry-level jobs, which provide young adults a pathway into the workforce. The elimination of these jobs not only risks increasing unemployment but may also erode chances of upward mobility and give rise to employment sclerosis, long-term labor force detachment, or even political dislocation and social unrest. Rising entry-level workers may also be an especially vulnerable subset of the labor force, lacking the employment protections, unions, or job transfers available to many incumbent workers. How the next generation of young adults entering the labor force adjusts to automation may bear even greater economic consequence than technology's effects on existing, incumbent workers.

We study one of the largest youth-specific automation shocks in modern history: the automation of telephone operation. In the 1920s, telephone operation was among the most common jobs for young women, at its peak accounting for around 4 percent of the nearly three million young, white, American-born women in the workforce. But between 1920 and 1940, telephone exchanges serving more than half the U.S. telephone network were mechanized, replacing most functions of local operators. The fraction of U.S. female employment exposed to this shock was comparable to the fraction of today's U.S. workforce employed as cashiers, office

clerks, or customer service workers—common entry-level jobs that the U.S. Bureau of Labor Statistics projects will decline over the next decade due to automation, similar to the recent decline in executive assistant employment, which exceeds that of U.S. manufacturing.

From AT&T's founding in the mid-1870s to the late 1910s, telephone calls were manually connected by operators working the switchboards at telephone exchanges around the country. Though initially male, by the early 1900s operators were almost entirely young women. By 1920, not only was AT&T the largest U.S. employer—at roughly 1 percent of the U.S. workforce—but telephone operation in the telephone industry was the third-largest occupation-industry pair for white, American-born women younger than 25 and the single largest for those under 20. Around this time, however, AT&T began advising its operating companies to automate telephone operation, beginning in large cities. Under the automatic technology, telephone sets were given rotary dials, and each turn of the dial actuated switching equipment at the telephone exchange, allowing users to place their own calls. The effect of adopting mechanical switching was to nearly eliminate an entire major category of entry-level work, one city or exchange at a time. By 1940, 60 percent of telephone exchanges in the AT&T system were dial.

We combine individual-level census data for the complete U.S. population from 1910 to 1940 with a new, hand-collected data set of cutovers to mechanical switching to study the effects of this shock. Complete count census data provide the

information recorded by census enumerators, including occupation and industry, which we aggregate to a fine-grained city-demographic group panel for population studies and link across censuses for longitudinal analysis of existing operators. Because traditional census-record-linking techniques are not capable of following young women over time (due to name changes prompted by marriage), we introduce a new, generalizable approach to census linking: to build our linked sample, we use public genealogical data from the genealogy platform FamilySearch, match to complete count census records, and reweight to account for the representativeness of FamilySearch data and our linking procedure.

We measure cutovers across the continental United States using AT&T archival records and data collected from thousands of newspaper articles. Of roughly 3,000 cities reported as a city of residence in all years from 1910 to 1940 with at least 2,000 people in 1920, 332 have their first cutover by 1940. We focus our attention on the subset of these with less than 100,000 people in 1920, where subscribers were typically converted to dial all at once.

Our goal is to provide a unified view of the effects of automation on both existing workers and future generations of workers who might have been likely to enter this occupation were it not automated away (an even larger at-risk population). The analysis is thus organized around two complementary but distinct questions, data structures, and empirical designs. To study the effects of dial on future generations of young women who might have been operators were it not for mechanization, we use an event study design, comparing outcomes for successive cohorts before a city's first cutover versus after. To trace the effects on incumbent operators, we link women in 1920 and 1930 to the next decennial census and compare operators to (extremely) similar working women—matched on age, race, nativity, marital status, fertility, and neighborhood—initially living in cities where telephone operation was or was not automated over the following decade.

We find that the automation of telephone operation led to a large, swift, permanent decline of 50–80 percent in the number of young, white, American-born women working as operators—roughly 2 percent of total employment for the group (in any job). As it was for many women a transitory job (often a first job), far more were exposed. For an automation shock, we consider this large, especially for a vulnerable subset of the labor supply. Our question is: What happened

after these jobs disappeared? Did the elimination of a major entry-level job cut off future generations from entering the workforce? After accounting for concurrent trends taking place in cities of similar size around the country independent of cutovers, we do not find that the shock reduced later cohorts' employment. We also see no substitution into marriage or childbearing. The negative shock to labor demand was instead counteracted by growth in other occupations, especially secretarial and restaurant work, which absorbed the women who might have otherwise been telephone operators. On average, working women aged 19–22 were employed in similar-paying jobs after cutovers, while those aged 16–18 were more likely to be in lower-paying jobs.

What became of incumbent operators after cutovers? Comparing telephone-industry operators to demographically similar women in cities with and without cutovers to dial, we show that operators in treated cities were significantly less likely to be telephone operators 10 years later. While some became operators at private switchboards, others left the workforce, and those who remained employed were more likely to have switched to lower-paying occupations. Though the effects are large relative to the control group's outcomes, the absolute magnitudes are modest, possibly because telephone operation was already a high-turnover occupation, and at this time many young women organically exited the labor market as they aged (and married).

Collectively, our results suggest that local economies can adjust to automation shocks over relatively short horizons and continue to absorb the steady stream of young workers entering the labor market. In the 1920s and 1930s, much like now, contemporaries feared that these opportunities were gone and never coming back—and those fears proved to be misplaced, as other jobs grew to take their place. However, our finding that incumbent operators were affected also demonstrates that automation is not entirely benign to the workers whose functions it performs.

#### **NOTE:**

This research brief is based on James Feigenbaum and Daniel P. Gross, "Automation and the Fate of Young Workers: Evidence from Telephone Operation in the Early 20th Century," NBER Working Paper no. 28061, November 2020, <http://doi.org/10.3386/w28061>.