Teacher Supply and Long-Run Student Outcomes: Evidence from World War II*

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Abstract

World War II spurred an unprecedented exodus of teachers from American schools, primarily men leaving for military service. Using a difference-in-differences framework that exploits geographic variation in the pre-war gender composition of the teacher workforce and students' ages, I estimate the effects of childhood exposure to this teacher supply shock on educational attainment and labor market outcomes. Increased exposure reduces high school and college completion, as well as adult income. States more affected by this shock responded by hiring more teachers on emergency licenses, resulting in a decrease in teachers' educational attainment. These changes in the composition of the teacher workforce persisted long after the war, suggesting that even temporary shocks to teacher supply can have lasting impacts on student outcomes through changes in teacher quality.

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1 Introduction

Staffing schools with enough qualified teachers to meet students' needs is one of the core challenges in K-12 education. Entering the 2023-24 school year, 86% of public schools in the U.S. reported difficulties hiring teachers, and 45% reported that their school was understaffed (National Center for Education Statistics, 2023). This problem becomes particularly acute in times of crisis, such as recessions, wars, or pandemics, that threaten the supply of teachers. There is little evidence, however, on how shocks to teacher supply affect long-run student outcomes. Given that teachers have well-known, meaningful impacts on students, any shock to the teacher labor market that affects the quantity, quality, and composition of the teacher workforce may also have important impacts on students. This paper investigates how a large shock to teacher supply affected the teacher workforce and long-run educational and economic outcomes for students.

World War II was one of the largest teacher supply shocks in American history. Writing soon after the war, New York Times education reporter Benjamin Fine underscored the severity of this shock, claiming "[n]ever before in our history has such an exodus of teachers taken place" (Fine, 1947b). Education scholar I.L. Kandel echoed this point, arguing that "[t]he gravest problem in education during the war was the exodus of teachers from the schools and the consequent shortage of teachers" (Kandel, 1948). The U.S. entered the war in December 1941, and by the 1944-45 school year, one third of teachers in the country had left the profession, one in seven was new to their position, and one in ten held an emergency teaching license (Eliassen and Anderson, 1945). Between 1940 and 1944, the total number of public school teachers decreased by 5.4%, a larger relative decrease than any other four-year period from 1920-2023, including the 3.5% decrease from 2008-2012 during the Great Recession.[1]

I leverage this large historical disruption to provide the first causal evidence on how teacher labor market shocks affect long-run student outcomes. Specifically, I estimate the effects of childhood exposure to the negative teacher supply

[1] Author's calculations from various years of the Biennial Survey of Education in the United States, the Digest of Education Statistics (National Center for Education Statistics, 2024), and the National Education Association's Rankings of the States and Estimates of School Statistics (National Education Association, 2023, 2024, 2025).

shock during WWII on educational attainment and labor market outcomes like income and occupation. In contrast to more modern settings, the historical nature of this shock makes it possible to trace its effects on student outcomes beyond the classroom and well into adulthood. Although the reasons for the WWII teacher shortages and the educational landscape in the 1940s differ from modern contexts, the effects of teacher labor market disruptions on student outcomes remain highly relevant today as schools across the country grapple with staffing challenges.[2] Many of the approaches used to address this historical crisis, such as hiring underqualified replacement teachers or increasing class sizes, remain commonly used tactics today. This setting therefore provides valuable insights into how shocks to teacher supply and changes in teacher qualifications can affect human capital development and long-run economic outcomes.

Due to the large-scale military mobilization for the war, the pre-existing gender composition of local teacher workforces affected the severity of this national shock. I leverage geographic variation in the pre-war gender composition of teachers to create a shift-share that measures each state's exposure to this shock. With newly digitized data from the Biennial Survey of Education in the U.S., I calculate "missing teachers" by sex nationally during the war by comparing the predicted number of teachers from historical trends to the actual number observed during the war. I then allocate these missing teachers to each state based on pre-war male and female teacher shares, resulting in more missing teachers in states that had more male teachers prior to the war. The pre-war male teacher share is uncorrelated with several pre-war economic and demographic characteristics, as well as other changes during the war, like the overall mobilization rate of men, that might affect student outcomes.

An individual student's exposure to the shock depends on the missing teachers in their state and their age during the war. I use a difference-in-differences (DD) framework that compares students born in more vs. less affected states (first difference) and from cohorts in school vs. too old to be in school during the war (second difference). I estimate the effects of childhood exposure to this shock on

[2]Policymakers remain concerned about the COVID-19 pandemic's toll on teacher turnover and burnout. In 2022, 44% of the nation's public schools reported having vacancies (National Center for Education Statistics, 2022). Estimates from recent years suggest that there are at least 55,000 vacant teaching positions and 270,000 underqualified teachers (Nguyen et al., 2022, 2024).

adult outcomes using pooled, individual-level samples from the decennial census where I observe the "exposed" children, as well as "unexposed" individuals who finished their schooling before the war, as adults.

The wartime teacher shortage has no effect on outcomes for the unexposed cohorts but is associated with lower educational attainment and worse labor market outcomes for students who were school-aged during and soon after the war. A one standard deviation increase in missing teachers reduces the likelihood of graduating high school by 1.6 percentage points, a relative decrease of 2.5%. This increase in missing teachers also reduces the likelihood of any college attendance by 0.8 pp (3.5%) and reduces college completion by 0.4 pp (3.6%).

These students also have lower earnings as adults in the labor market. A one standard deviation increase in missing teachers reduces weekly wages between ages 25 and 64 by 1.9%. A back-of-the-envelope calculation suggests that this effect translates into decrease of about $38,000 in lifetime earnings for a full-time worker. In addition to weekly wages, I find negative effects on other economic indicators like total income, occupation score, and likelihood of holding a professional, managerial, or STEM occupation. Using variation in missing teachers at the birth county level (as opposed to birth state), I also find a small, but statistically significant negative effect on lifespan in Social Security mortality records.

Rather than dissipating over time, these negative effects on educational attainment and economic outcomes continue even for cohorts born after the war, who were too young to experience the immediate consequences of this shock. To investigate potential mechanisms explaining these negative and lasting effects on students, I digitize historical data from the U.S. Office of Education and the National Education Association on teacher salaries, student-teacher ratios, private school enrollment, educational expenditures, and emergency licenses. I also use individual-level census data to study how the war changed the composition of the teacher workforce in areas more affected by the wartime shock.

Hiring underqualified teachers on emergency licenses was the main policy response to the teaching crisis in the short-run. states more affected by the shock hired a larger share of emergency teachers during and soon after the war. Using the complete count 1940 and 1950 census, I show that the educational background of teachers decreased in these states. A one standard deviation increase in missing

teachers is associated with a 2.4 pp decrease in the share of teachers with at least two years of college education and a 2.2 pp decrease in the share with four years of college over this decade. Although I am unable to measure teacher value-added directly, this decrease in teacher qualifications is likely indicative of a decrease in teacher quality. Given that the shock primarily affected men, the war is also associated with an increase in the share of female teachers, particularly married women. While policymakers tried to raise teacher salaries in an effort to mitigate the crisis and attract qualified replacements, this effort was likely hampered by rigid salary schedules, district budget constraints, high wartime inflation, and increases in the outside option of potential teachers. On average, the more affected states had a larger increase in teacher salaries during the war, but this effect is small, imprecise, and short-lived.

Importantly, these changes in teachers' educational background are not short-lived. Rather, I find that states with more missing teachers during the war experienced a decrease in the share of teachers with at least two years of college education that persists for several decades after the war. Further, the wartime shock is associated with a persistent increase in the student-teacher ratio at least twenty years after the end of the war. This decrease in teacher qualifications and increase in class sizes harmed not only the children in school during the war, but also the subsequent generation who still experienced the fallout from this shock. These results highlight how even temporary shocks to the teacher labor market can have persistent, long-run impacts on the teacher workforce and consequently on students.

This study contributes to the extensive literature on the critical role of teachers in building human capital. It is "widely accepted that high quality teachers are the most important asset of schools" (Hanushek, 2011). Many studies find that higher teacher quality raises student test scores (Rockoff, 2004; Rivkin et al., 2005; Kane and Staiger, 2008) and improves noncognitive skills (Jackson, 2018). Beyond the classroom, teacher experience and value-added are associated with an increased likelihood of attending college and higher earnings in young adulthood (Chetty et al., 2011, 2014). I provide new evidence on the long-run effects of teachers on student outcomes by focusing on the consequences of a large, national shock to the teacher labor market. I am also able to observe the effects of this shock over the life cycle, compared to existing studies that measure the effects of teacher

quality on student outcomes at a single snapshot in young adulthood. Given that a primary response to the WWII teacher shortages was to hire underqualified replacement teachers, my findings are consistent with this literature and suggest that lower teacher quality is a key mechanism through which teacher shortages affect long-run student outcomes.

Prior literature demonstrates how labor market conditions affect the composition and quality of teachers. For example, Nagler et al. (2020) demonstrate that teachers who start their careers during economic recessions tend to be more effective, as weak labor markets attract higher-quality candidates to the teaching profession due to limited outside options. In contrast, during WWII, the draft and large-scale industrial mobilization created new labor market opportunities, potentially improving outside options and inducing higher-quality teachers to leave the profession. Corcoran et al. (2004) and Bacolod (2007) both highlight how the expansion of professional opportunities for women led to a decline in teacher quality over the second half of the 20th century, as more high-ability women sorted into higher-paying professions outside of teaching. During WWII, the increased demand for labor due to men joining the military brought many women into the workforce (Goldin, 1991; Acemoglu et al., 2004; Goldin and Olivetti, 2013; Jaworski, 2014). This shift likely drew some high-quality women (and high-quality men who did not join the military) out of teaching, contributing to an overall decline in teacher quality.

I contribute directly to the literature on teachers shortages by providing new evidence on how they affect long-run student outcomes. Much of the existing literature provides descriptive evidence on characteristics of schools that are predictive of vacancies, such as lower salaries, worse working conditions, and higher shares of low-income students and students of color (Jacob, 2007; Engel et al., 2014; Cowan et al., 2016; McVey and Trinidad, 2019; James et al., 2023; Edwards et al., 2024). Few studies explicitly test the effects of teacher shortages on student outcomes, though Papay and Kraft (2016) find that filling vacancies by hiring teachers during the school year is associated with a decrease in student test scores. Several studies indicate that higher teacher turnover reduces student achievement (Ronfeldt et al., 2013; Hanushek et al., 2016; Henry and Redding, 2020). In addition to documenting the negative effects of turnover on student achievement, Sorensen and Ladd (2020) find that turnover is associated with an increase in

inexperienced and underqualified teachers, consistent with the response to the WWII teacher shortages. Preliminary evidence from COVID-19-induced teacher shortages in Massachusetts (Backes et al., 2024) and Texas (Kirksey, 2024) suggests that emergency-licensed teachers are associated with lower student achievement. Overall, the existing literature on teacher shortages is largely descriptive and does not address the long-run impacts of shortages on students. I add to this literature by studying the consequences of teacher shortages at a large, national scale and documenting their previously unexplored long-term effects. Moreover, I bridge the literature on the effects of labor market conditions on teachers and the effects of teachers on students by providing new evidence on how teacher labor market shocks affect long-run student outcomes.

This study is also one of the first to examine the indirect effects of war on American K-12 education. Several studies document the negative effects of exposure to war on educational outcomes, focusing on physical destruction from war in settings outside of the U.S. (Akbulut-Yuksel, 2014; Havari and Peracchi, 2017; Bertoni et al., 2019; Brück et al., 2019). Ichino and Winter-Ebmer (2004) find that cohorts in school during WWII in war-torn Germany and Austria had lower educational attainment and earnings relative to the same cohorts in Switzerland and Sweden. In America, education experts, policymakers, and journalists documented the worsening WWII teacher shortage and warned of its potential harms to students (Carr and Mallam, 1943; Dawson, 1943; Foster and Frazier, 1943; Foster, 1944a; Eliassen and Anderson, 1945; Fine, 1947b). Other studies have shown descriptively that high school graduation rates dropped sharply during the war (Goldin and Katz, 2009; Jaworski, 2014). Jaworski (2014) shows that women of high-school age during the war in states with higher mobilization rates had lower educational attainment, employment, and earnings in 1960, though these differences largely disappeared by 1970 after some of these women returned to school. Bound and Turner (2002) show that the G.I. bill increased college attendance among WWII veterans. But the lasting effects of WWII on American public elementary and secondary education are understudied. This paper illuminates the ways in which this war transformed American education and harmed a generation of children.

The rest of the paper proceeds as follows: Section 2 describes the extent of the shock and the policy responses to it. Section 3 describes the data sources. Section

4 describes the methodology. Section 5 presents long-run results on students who were school-aged during or soon after the war. Section 6 describes the robustness of the main results. Section 7 discusses how the shock affected the composition, quality, and quantity of the teacher workforce and discusses other mechanisms. Section 8 discusses effects on the post-war cohorts and possible spillover effects of this shock on long-run economic growth. Section 9 concludes.

2 Historical Background

> *"Teachers leaving the profession since 1939 have formed one of the greatest vocational migrations in our Nation's history. The exodus has taken place in every state and territory, from every type of school, and from every field of teaching."*
>
> — Addresses and Proceedings of the National Education Association (National Education Association, 1946a)

This section describes the relevant historical background on the causes and consequences of the WWII teacher shortages. Section 2.1 describes the scope of the shock and contemporaneous concerns about its long-run effects, while section 2.2 details the ways in which policymakers tried to address the crisis.

2.1 Extent of the Shock

World War II had an immediate and drastic effect on the number and gender composition of teachers. Figure 1 shows the number of public elementary and secondary school teachers by sex and overall nationally across several years. There is a clear decline in the number of teachers during the war, relative to pre-war years, and this overall decline is overwhelmingly driven by a decrease in the number of men.[3] From the 1939-40 school year to the 1943-44 school year, the number of male teachers decreased by 35% (from 22% to 15% of all teachers), while the number of

[3]The National Education Association noted that "more men than women have left the classrooms" and "the loss of male teachers has been particularly severe" (National Education Association, 1946a).

female teachers actually increased by 3%, likely to offset the departures of men. Many of the teachers who left the profession were replaced, typically by less-qualified teachers. Policymakers acknowledged that "[t]here have been serious losses in the number and quality of teacher personnel," reflecting the notion that these two dimensions are intertwined when describing the severity of a teacher shortage (Frazier, 1944b).[4]

The effects of the wartime teacher shortages were felt immediately. Already in the 1942-43 school year, it is estimated that 189,000 teachers were new to their positions (relative to about 875,000 total during the 1939-40 school year) (Frazier, 1943). Approximately 13,000 positions were abolished and another 7,500 remained unfilled. Between the end of the 1941-42 school year and the start of the 1942-43 school year, an estimated 27,000 male teachers entered the armed services (Foster and Frazier, 1943). An estimated 39,000 teachers joined the armed forces during the 1942-43 school year (Dawson, 1943), with another 15,700 leaving for the military between the end of that school year and the start of the 1943-44 school year. (Foster, 1944b). In 1943, the number of public school teacher replacements needed was estimated at 150,000-200,000, with one third of those to replace teachers who took other teaching jobs and two thirds to replace those who quit teaching altogether (Eliassen and Anderson, 1944). Teacher turnover was "at least 20 per cent," double the pre-war rate of 10% (Eliassen and Anderson, 1944).[5]

For the 1943-44 school year, 15,100 teaching positions were abandoned entirely and another 7,700 remained unfilled at the start of the year. There were 132,100 new teachers employed, 56,900 of whom (43%) held emergency licenses and did not meet their state's usual certification requirements (U.S. Office of Education, 1944). In December 1944, Commissioner John W. Studebaker of the U.S. Office of Education estimated there were 115,000 "missing teachers" since the start of the war, with 65,000 who left for the military and another 50,000 to industry and government jobs (Studebaker, 1944). By the 1946-47 school year, more than 350,000 teachers had left the public schools since 1940, one in seven teachers held a "substandard, emergency license" (relative to one in 400 before the outbreak of

[4]According to Ralph McDonald, Executive Secretary of the Department of Higher Education of the NEA, "[t]he deterioration in quality of replacements is more serious than the loss of numbers" (McDonald, 1945).

[5]As a comparison to modern turnover rates, Bryant et al. (2023) claim "the annual teacher turnover rate has hovered around 8 percent nationally" in the past decade.

the war), and 70,000 teaching positions remained vacant (Fine, 1947a).

Though shortages were common across the country and across grade level and subject, they were most heavily concentrated in subjects taught disproportionately by men, including mathematics, physics, chemistry, physical education, and vocational subjects (Frazier, 1943, 1944b; Eliassen and Anderson, 1943; Kandel, 1948).[6] According to Fine (1947b), "during the war, the number of men teaching in our public schools dropped considerably" with nearly 100,000 enlisting in the military—about half of the roughly 194,000 male teachers employed in the 1939-40 school year.

In addition to the large share of men leaving for the military, both male and female teachers "found out they could make more in one week in a factory than they could in a month at a school" and left teaching for industry jobs, while "[t]housands of others found good office jobs with the government or in civil service" (Fine, 1947b). Survey evidence collected by the U.S. Office of Education in the early years of the war confirms these anecdotes and provides evidence on the reasons why men and women left the teaching profession (US Office of Education, 1943b; Foster, 1944b). Appendix Figure A3 visualizes the responses to this survey and shows that while both men and women left the profession for a variety of reasons, the majority of men who left did so to join the armed forces.

Policymakers, scholars, educators, journalists, and parents all realized the potentially devastating consequences of the teacher shortages on students. Education scholar I.L. Kandel noted that "[b]y the middle of 1943, it was realized that the teacher shortage was a threat to the generation then in school." (Kandel, 1948). Howard Dawson, head of the National Education Association's rural education department, argued that "educational opportunity is being reduced more drastically than any mere statistics on teacher shortages or lower qualification standards might reflect" (Dawson, 1943). Benjamin Frazier, Senior Specialist in Teacher Training at the U.S. Office of Education, argued that "the teacher shortage is directly and adversely affecting the war effort as well as the civic and vocational competency of the next generation of Americans" (Frazier, 1943).

[6] Although male teachers were overrepresented in secondary schools, male elementary teachers may have left at higher rates. Appendix Figures A1 and A2 show the number of teachers by sex and overall separately for elementary and secondary schools. Though the number of male teachers dropped sharply at both levels, the relative drop is larger for male elementary school teachers.

Thomas G. Boushall, chairman of the Chamber of Commerce Committee on Education warned that "[t]he present crisis affecting the teaching profession throughout the country is of such gravity as to threaten the future of the American way of life" (Fine, 1947b). The consensus of "informed educators everywhere" was that "the United States cannot neglect its teacher shortage any longer. Poor teachers and undermanned schools today inevitably mean poor citizens tomorrow" (Fine, 1947a).

The pipeline for new teachers was also disrupted by the war. From 1941-42 to 1942-43, enrollment dropped 22.2% in teacher colleges and 27.6% in normal schools (Taba, 1943). According to Frazier (1944a), "[d]uring the past three years, the teachers' colleges and normal schools have lost about 60 per cent of their civilian enrollments," with particularly large losses of men to the military. During the 1946-47 school year, only 7% of college students were enrolled in teachers colleges, compared to 22% in 1920 and 17% in 1930 (Fine, 1947a; National Education Association, 1946a). In a scramble to attract new teachers, state governments sent direct appeals to high school students to steer them towards a career in teaching. Appendix Figure A4 shows examples of two advertisements addressed by the office of the Ohio governor to high school students encouraging them to consider a teaching career (Bowers, 1944). Appendix Figure A5 shows a similar ad from the Pennsylvania Department of Instruction (Pennsylvania Department of Public Instruction, 1943). Given the sharp decreases in teacher-training enrollments, policymakers recognized that "the period of poor teaching will be prolonged after the war" (Foster, 1944a).

Indeed, according to the NEA, "the end of the war has brought no relief; the situation has become steadily more critical" (National Education Association, 1946a). There was a widespread understanding in the post-war years that "[e]very state in the Union suffers from a shortage of qualified teachers" (Fine, 1947a). New York Times education reporter Benjamin Fine visited schools across the country during the post-war 1946-47 school year and argued that American schools "were not bombed as were the European schools" but "more than two years after the end of the war they are being wrecked just as surely as though they had been blasted by a fleet of heavy bombers."

2.2 Response to the Shock

State and local governments responded to this shock in a variety of ways, with many policies similar to those still used to address shortages today. The U.S. Office of Education surveyed school superintendents during the 1942-43 and 1943-44 school years to determine which tactics to address teacher shortages were most widely used (Foster, 1944a). Figure A7 shows the share of superintendent respondents who used each of several different strategies to combat the teacher shortage crisis. Some methods, such as raising salaries, hiring inexperienced teachers, and increasing class loads, are commonly used policies to address teacher shortages today. Others, such as reinstating married teachers and replacing men with women, were unique to this period but speak to the important changes in the composition of teachers spurred by the wartime shock. These responses suggest several testable hypotheses to determine whether more exposed states were more likely to pursue these policies. In Section 7, I provide evidence supporting these survey results, showing that more affected states were more likely to raise salaries (temporarily), hire married women, replace men with women, and hire inexperienced teachers.

Finding replacement teachers was no easy task for school superintendents, who "desperate and at wit's end, have hired taxicab drivers, mechanics, telephone operators, or retired janitors to become teachers" (Fine, 1947b). Filling vacancies with qualified teachers became more and more difficult given the enlistment of male teachers, higher-paying opportunities in industry, reductions in enrollment in teacher training programs, and the seeming unwillingness of those who left teaching to return (Eliassen and Anderson, 1945). Soon after the war began to drain the supply of qualified teachers, it was "commonly the expectation" that "when a teacher is lost he will be replaced by a teacher with lower qualifications" (Frazier, 1943). Superintendents began "scraping the bottom of the barrel" to find replacement teachers who were typically hired on emergency licenses, meaning they did not meet their state's usual certification standards (Fine, 1947b). While some had prior teaching experience, the majority were inexperienced and inadequately trained (Studebaker, 1944; Fine, 1947a),

Schools also turned to married women, who prior to the war were often barred from teaching, to alleviate the wartime shortages. Goldin (1988) uses a National

Education Association (NEA) survey to highlight the striking decrease in marriage bars for teachers during the 1940s. In 1942, 82% of school boards would not hire married women and 70% would not retain a single woman who married. By 1951, those numbers had declined to 18% and 10%, respectively. Married women who were former teachers "saved the day" (Frazier, 1943) and "have kept thousands of classrooms from closing" (Frazier, 1944a). But despite efforts by state and local governments to mitigate the teacher shortage crisis through these various strategies, "[n]one of these methods was effective to stem the tide," and the shortages and subsequent decline in teacher quality were widespread (Kandel, 1948).

3 Data

This section describes the data sources used to estimate the effects of the WWII teacher shortages on teachers, students, and schools. Long-run outcomes for students and changes in the composition of teachers come from individual-level data, while other inputs to education like per-pupil expenditures and teacher salaries are drawn from historical state-level data.

3.1 Individual-Level Census Data

3.1.1 Long-Run Outcomes for Students

To analyze long-run outcomes for students who were of school age during WWII, I use individual-level census data where I can observe these cohorts later in life as adults. I pool the individual-level 5% or 1% samples for each decennial census from 1940-2020 (Ruggles et al., 2024), meaning that I observe a sample of each birth cohort of interest (but not the same individuals) multiple times over the course of their lifetime. I restrict to individuals between the ages 25 and 64, as they had likely finished their education and were of working age. I observe a sample of the 1930 birth cohort, for example, four times: when they are 30 years old in 1960, 40 in 1970, 50 in 1980, and 60 in 1990. For my primary results, I focus on cohorts born before the U.S. entered WWII, specifically those born

between 1912 to 1940. Those born in these earlier cohorts would have finished their education before the U.S.'s entry into the war and thus provide a useful set of unexposed "placebo cohorts" who should not be affected by wartime shocks to teacher labor markets. Given that I find persistent effects of the war on teacher qualifications and student-teacher ratios, I also consider the effects of the wartime shock through the 1960 birth cohort, who I observe through age 60 in 2020.

I assign the treatment of missing teachers to individuals by their state of birth, the most granular available indicator of where they likely received their education. This approach therefore restricts to native-born Americans. For educational attainment, I consider whether an individual completed at least high school, at least some college, or at least four years of college. The primary labor market outcome of interest is wage income. Specifically, I calculate the natural logarithm of weekly wages and restrict to full-time workers with non-missing values. I follow Margo (1995) by removing workers with wages less than half the federal minimum wage and by replacing top-coded values with the maximum value multiplied by 1.4. I also estimate the effects of teacher shortages on other labor market outcomes like total income, occupation, labor force participation, employment, share of the poverty level, and likelihood of holding a STEM, professional, or managerial occupation.[7]

3.1.2 Short-Run and Long-Run Teacher Characteristics

I also use individual-level census data to observe characteristics of the teacher workforce (e.g., educational attainment) and how they evolve over time. I define teachers as individuals at least 18 years old in the labor force with an occupation code of "Teachers (not elsewhere classified)". The complete count 1940 and 1950 census allow me to observe characteristics of the entire teacher workforce and how they changed in response to the wartime shock in the short run. For example, I study the effects of the war on educational background, gender composition, and prevalence of married women. While the main results explore state-level changes in these characteristics to be consistent with the level of variation in the long-run student outcomes, the complete nature of the 1940 and 1950 data also allow me to

[7]See Appendix B for details on the census samples.

study changes in teacher characteristics at the state economic area level—county groupings within states. Beyond 1950, I use the same 1% and 5% samples of the census described in section 3.1.1 but restricted to teachers. These data allow me to create a state-year panel over many decades and trace long-run effects of the war on teachers' educational background.

3.2 Lifespan Data from Numident

I estimate the effects of teacher shortages on lifespan using the Berkeley Unified Numident Mortality Database (BUNMD), a cleaned version of the Social Security Administration's Numident File (Breen and Goldstein, 2022; Goldstein et al., 2023). The BUNMD contains mortality records for 95%+ of deaths for individuals 65+ occurring between 1988-2005. These dates align well with birth cohorts of interest in this study, those who were school-aged during WWII, as well as earlier cohorts who had finished school prior to the war.

Crucially, this database contains information on an individual's county of birth. This detailed geographic information offers a distinct advantage over the IPUMS census samples where I only observe an individual's state of birth. County of birth in the BUNMD allows me to assess the effects of teacher shortages at a more granular level, comparing individuals exposed to more severe or less severe shortages across counties within the same state.

3.3 State-by-Year Data from Biennial Surveys

To track important education outcomes and policy responses in states affected by teacher shortages before, during, and after the war, I digitize state-by-year data from various editions of the "Biennial Survey of Education in the United States" reports issued every two years by the U.S. Office of Education. I use data from the 1930s through the 1950s, with the exact years depending on the outcome and data availability. The contents and structure of these reports differ somewhat across years, but they contain a wealth of information on characteristics of students, teachers, and schools at the state level. I utilize information on the

number of students and teachers, student-teacher ratios, teacher salaries, per-pupil expenditures, and private school enrollment.

4 Methodology

> *"War ... has placed an added responsibility on schools to guide the younger generation toward self-reliant stability. Yet, at a time when the nation must have more and better education,* ***many teachers are missing****."*
>
> — John W. Studebaker, Commissioner of the U.S. Office of Education (Studebaker, 1944)

This section describes how I measure each state's and each student's exposure to the teacher supply shock. I then motivate the difference-in-differences strategy and discuss threats to identification.

4.1 Measuring "Missing Teachers"

Although "[t]he teacher shortage reaches into every state, almost into every town, village, and hamlet" (Fine, 1947b), this shock was likely more severe in states that had a higher pre-war share of male teachers, as these men left in large numbers to join the military. Though teaching had become a predominantly female occupation by the turn of the 20th century (Perlmann and Margo, 2001), men comprised 22% of teachers nationally during the pre-war 1939-1940 school year. This share varied widely across states, from 12% in Vermont to 38% in Utah (Figure 2).

Despite this substantial variation in the male teacher share across states, this share is uncorrelated with several pre-war state characteristics, as well as changes during the war that might affect students. Figure 3 plots the coefficient and confidence interval from separate regressions of the 1940 male teacher share on several state characteristics, all standardized to have mean zero and standard deviation one. Aside from a negative correlation with the Black share of the population, the share of male teachers is uncorrelated with other demographic characteristics

like population, share urban, and share with a high school or college degree. The male teacher share also has an insignificant relationship with economic characteristics like the share of the labor force in manufacturing and agriculture, features of the teaching profession like licensing requirements, labor market restrictions for women (proxied by an indicator for states that introduced marriage bar legislation for women in the 1930s), and wartime factors like the mobilization rate of men and government contracts.

I use this pre-war distribution of male teachers to determine which states were most exposed to the wartime teacher shortages. Following Ager et al. (2023), who predict "missing immigrants" under 1920s immigration quotas in U.S. cities, I predict "missing teachers" during WWII in U.S. states. First, using pre-war data on the national number of teachers, I predict how many teachers there would have been in the U.S. had the war not occurred. Specifically, I run regressions separately for $g \in \{Men, Women\}$ as

$$Teach_{gt} = \beta_1 \ln t + \beta_2 (\ln t)^2 + \varepsilon_{gt} \tag{1}$$

where $Teach_{gt}$ is the actual number of teachers of sex g in year t for the pre-war years 1926-1940.[8] The fitted values from this regression can then be used to generate predictions for each sex during the war years. I denote the average number of predicted, or counterfactual, teachers during the war as $\widehat{Teach}_{g,1942-46}$ and the actual average number of teachers as $Teach_{g,1942-46}$. As seen in Figure 4, the shaded difference between this counterfactual number of teachers and the actual number observed during the war represents missing teachers nationally.

Second, I then allocate this national number of missing teachers across all the states using states' pre-war male and female teacher shares, resulting in a measure of missing teachers per capita that is higher in states with a higher share of pre-war male teachers. Formally, I define missing teachers per capita for each state s as:

$$MissingTeach_s = \frac{1,000}{Pop_{s,1940}} \sum_g \left(\widehat{Teach}_{g,1942-46} - Teach_{g,1942-46} \right) \frac{Teach_{sg,1940}}{Teach_{g,1940}}. \tag{2}$$

[8] This is the baseline functional form chosen by Ager et al. (2023), but in Section 6.3 I describe robustness to alternative functional form assumptions when predicting missing teachers.

The term in parentheses is the average number of missing teachers (counterfactual minus actual) of sex g nationally during the war.[9] The term $\frac{Teach_{sg,1940}}{Teach_{g,1940}}$ distributes these missing teachers across states based on the share of teachers of sex g living in state s in the pre-war year 1940. Summing over male and female teachers and normalizing by the 1940 population of 5-17 year olds enrolled in school results in the number of missing teachers per 1,000 students in state s, which can be interpreted as each state's exposure to the shock. I predict the average state to have 1.8 missing teachers per 1,000 students, with a standard deviation of 0.79.

This measure shares similarities with a shift-share instrument, as it interacts a national shock with predetermined local shares. The "shift" component is the average number of predicted missing teachers nationally during WWII. This national shock is unrelated to specific state conditions and reflects aggregate changes due to the war, not local factors. The "share" component uses pre-war distributions of male and female teachers across states to capture each state's exposure to the shock. These shares are predetermined and unaffected by the war. This method thus isolates variation in WWII teacher shortages across states that is plausibly exogenous to student outcomes. Despite the similarities to a shift-share, I do not use this measure as an instrument. Rather, I use it to determine which states are more or less exposed to this national shock to the teacher labor market.[10] Given that many of the teachers who left the profession were replaced, instrumenting for the number of teachers or change in the number of teachers would likely violate the exclusion restriction, as changes in teacher composition and quality also have important effects on students.[11]

[9] I use the 1941-42 through 1945-46 school years as the war period. The U.S. joined the war after the attack on Pearl Harbor on December 7, 1941. The war formally ended with Japan's surrender on September 2, 1945 at the beginning of the 1945-46 school year, though I consider this year part of the wartime period, as demobilization continued through 1946 and 1947.

[10] This approach is similar to Collins and Niemesh (2019), Abramitzky et al. (2023), and Ager et al. (2023), which all create an exposure measure similar to a shift-share but use it as the main independent variable of interest and not as an instrument.

[11] Still, I show in Appendix Figure A6 that this measure of missing teachers has a positive, statistically significant relationship with NEA estimates of the number of teachers who left the profession to join the military (National Education Association, 1946b).

4.2 Long-Run Individual-Level Analyses

I leverage two sources of variation to identify the long-run effects of teacher shortages on students: student birth cohorts and predicted wartime missing teachers at the state level. Intuitively, individuals in their 20's at the onset of the war are "unexposed" and should not be affected by wartime teacher shortages, as they had likely already completed their education. However, teacher shortages may have negative effects on "exposed" children who were school-aged during the war. Further, those effects on students should be larger in states with more missing teachers. Thus, students who were school-aged during the war and from states with more missing teachers should be negatively affected.

To test these hypotheses, I use a difference-in-differences (DD) framework. The first difference compares outcomes between individuals from states with varying exposure to the shock (more vs. fewer missing teachers). The second difference compares individuals from more and less affected birth cohorts (those school-aged during the war vs. those too old to be in school).[12] Formally, I run event study regressions of the form

$$Y_{isbt} = \alpha + \sum_{b=1912}^{1940} \delta_b MissingTeach_s \times I_b + \theta_b + \eta_s + \lambda_t + X_{sb}\Gamma + \varepsilon_{isbt} \qquad (3)$$

where Y_{isbt} is an educational or labor market outcome for individual i who was born in state s in birth cohort b and observed in census year t. I control for birth state fixed effects η_s, birth cohort fixed effects θ_b, and a census year fixed effect λ_t. The main coefficients of interest are the δ_b's, the coefficients on the interaction term between missing teachers at the state level and birth cohort dummies. These coefficients capture the effect of more missing teachers per capita on the outcome of interest, among individuals of a given birth cohort. Baseline specifications include additional controls X_{sb} for the wartime mobilization rate and wartime government spending in an individual's birth state, both interacted with birth cohort. The omitted group is the 1922 birth cohort, who would have been about 20 years old at the start of the war. Older cohorts had likely finished their contact

[12] This setup is similar conceptually to other studies using natural experiments to identify the effects of differential childhood exposure to some education treatment on long-run outcomes (e.g., Bailey et al. (2021) and Jackson et al. (2016)), with the simplification that there is no staggered treatment timing.

with the public school system by that time, but individuals born later may have been affected by the wartime shortages.[13]

The δ_b coefficients can therefore be visualized in an event study plot, with a separate coefficient for each cohort. This analysis relies on a parallel trends assumption: in the absence of WWII, educational and labor market outcomes would have evolved similarly in more and less affected states for the birth cohorts in school during and after the war. While this assumption is not directly testable, I provide evidence that these outcomes were following similar trends in more and less affected states across several birth cohorts that were too old to be affected by the wartime shock.

4.3 Threats to Identification

The main threat to identification would be other factors or events concurrent with WWII that affected outcomes for students differentially in states with more missing teachers. An obvious concern might be that states with more pre-war male teachers also had higher military mobilization rates, meaning that any negative effects on students might actually be attributable to missing fathers, uncles, and older brothers, not missing teachers. To quell this concern, I show in Figure 5 that there is no correlation between a state's missing teachers and its overall mobilization rate of men 18-44 years old, suggesting that the effects I find are indeed driven by missing teachers and not by missing men overall.

Another potential concern would be if children exposed to more severe teacher shortages also had better access to wartime industry jobs. If this were the case, lower educational attainment may reflect a decision to drop out of school sooner to take advantage of new labor market opportunities, rather than a negative effect of teacher shortages. In Appendix Figure A8, I show that this is unlikely to be the case. States with more wartime missing teachers had slightly lower government wartime spending per capita, though this correlation is weak. While I find no evidence that my measure of missing teachers is correlated with WWII government

[13] Appendix Table A1 shows the share of 17-20 year-olds enrolled in secondary school in 1940. I allow 18- and 19-year olds to be treated; between 7.8% to 13.6% of 19-year-olds were still enrolled in secondary school in 1940.

spending or the mobilization rate, my main specifications nevertheless control for these characteristics, interacted with birth cohort dummies.[14]

5 Long-Run Results on Students

The primary goal of this study is to estimate the effects of childhood exposure to teacher shortages for school-aged students on their adult outcomes. This section presents event study and difference-in-differences analyses of the effects of missing teachers on educational attainment, labor market outcomes, and lifespan.

5.1 Lower Educational Attainment

Increased childhood exposure to teacher shortages reduces educational attainment. Figure 6 plots the δ_b event study coefficients and 95% confidence intervals from Equation 3 for three separate binary indicators: high school completion, at least some college, and at least four years of college.[15] I standardize the missing teachers measure, so coefficients can be interpreted as the effect of a one standard deviation increase in missing teachers per capita. Standard errors are clustered by birth state.

For all outcomes, unexposed cohorts are unaffected, but an increase in missing teachers reduces educational attainment for the exposed cohorts. Each plot displays a similar pattern. For those too old to be in school when the war started, all "pre-period" coefficients are small and statistically indistinguishable from zero. However, negative effects of missing teachers on education start to appear for cohorts who were high school age during the war, and these negative effects continue for younger cohorts. For example, for an individual born in 1930, who was

[14]Missing teachers are also not correlated with other wartime changes affecting children. Appendix Figure A9 shows no correlation with Lanham Act funding per capita for preschools (Goldin et al., 2025), and Appendix Figure A10 shows no correlation with the decrease in physicians from 1940 and 1944 (Lahey and Kaukonen, 1944).

[15]For computational efficiency, I collapse to means of the outcome variables (weighted by person weights) by birth state, birth cohort, race, and sex. Regressions are weighted by the sum of person weights in each cell. This approach is numerically equivalent to running the full weighted regression in the individual-level data.

about 12 years old at the start of the war, a one standard deviation increase in missing teachers is associated with a 1.4 percentage point decrease in the high school graduation rate, a 0.7 pp decrease in the likelihood of any college attendance, and a 0.4 pp decrease in college completion. Children who were younger during the war spent more years in school exposed to the shock and its fallout than those who were in high school, explaining why this effect seems to worsen over successive cohorts. Appendix Figure A11 shows the results separately for men and women, with generally similar patterns for both groups.

To capture the average DD effect for the pre-war cohorts exposed to this shock, I replace the individual birth cohort dummies in Equation 3 with a dummy variable for whether an individual was born between 1923-1940. Table 1 shows the relevant coefficient, the interaction between missing teachers and this dummy variable, for high school completion, some college, and college graduation, respectively. Panel A reports overall effects, while panels B and C report results separately by sex. A one standard deviation increase in missing teachers per capita decreases the likelihood of graduating high school by 1.6 pp, with similar effects for men and women (-1.4 and -1.7 pp respectively). The overall effect amounts to 2.5% of the baseline mean high school completion rate of 63.4%.[16] A one standard deviation increase in missing teachers also reduces any college attendance by 0.8 pp (3.5%) and college attendance by 0.4 pp (3.6%). The effects on some college are similar by sex, though I find larger effects on college graduation for women. These results demonstrate that childhood exposure to a teacher labor market shock can cause a meaningful decrease in educational attainment.

5.2 Worse Labor Market Outcomes

Increased childhood exposure to teacher shortages also reduces several indicators of economic well-being in adulthood. Similar to section 5.1, I now estimate Equation 3 with different labor market outcomes. In Figure 7, I plot the coefficient and 95% confidence interval for each birth cohort showing the effect of an increase in missing teachers on log weekly wage, log total income, log family income as

[16]The relative effect of a one standard deviation *decrease* in missing teachers is therefore similar to the 2.7% increase in high school completion from participating in a Head Start preschool (Bailey et al., 2021).

a share of the poverty level, log occupation score, the likelihood of holding a high-skill (professional or managerial) occupation.[17] Given that men disproportionately taught math and science subjects, I also explore the effects of missing teachers on the likelihood of holding a STEM occupation.[18] For weekly wage, occupation score, high-skill occupation status, and STEM occupation status, I restrict to full-time employed workers. For poverty and total income, I restrict to individuals with positive, non-missing values of the outcome variable.

In accordance with the education results, individuals who were too old to be in school during the war are unaffected, but exposed students fare worse if they are from a state with more missing teachers. For all outcomes, all coefficients in the "pre-period" are small and statistically insignificant, suggesting that economic outcomes were trending similarly for unexposed cohorts in states more and less affected by the wartime teacher shock. By contrast, I start to detect a negative effect beginning with children who experienced the shock during their high school age years, and this effect worsens for younger cohorts. For an individual born in 1930, a one standard deviation increase in missing teachers per capita reduces weekly wages by about 1%. Given that I observe each birth cohort multiple times at various points throughout their working years, this number can roughly be interpreted as an average effect on weekly wages over a worker's lifetime in the labor force.

The effects on wages, total income and share of the poverty level are similar for men and women across birth cohorts, as seen in Appendix Figure A12. However, the effects on occupation score and likelihood of holding a high-skill occupation are slightly worse for women, suggesting that occupational downgrading may explain a larger fraction of the decrease in wages for women than for men. These negative labor market effects are concentrated on the intensive margin; in Appendix Figures A13 and A14 I find no effect of missing teachers on labor force participation or employment.

To explore the average effects on the treated cohorts, Tables 2 and 3 report

[17] Occupation score is an occupation-level proxy for income that represents the median total income for all people within a given occupation. I define high-skill occupations are those within the "Professional, Technical" and "Managers, Officials, and Proprietors" categories of 1950 occupation codes.

[18] See Appendix B for a list of STEM occupation codes.

the DD estimates on these income and occupation measures respectively. Among birth cohorts 1923-1940, a one standard deviation increase in missing teachers reduces weekly wages by 1.9%, total income by 1.8%, family income as a share of the poverty level by 1.2%, occupation score by 0.9%, the share with a high-skill job by 0.9 pp (3.3%), and the share with a STEM job by 0.1 pp (2.8%). All of these results, with the exception of the effect on family income, are statistically significant at the 1% level. Effects on weekly wages are similar for men and women, but slightly larger for women on total income. As seen in the event studies, the effects on occupation score and high-skill occupation are also slightly worse for women.

A back-of-the-envelope calculation suggests that a one standard deviation increase in missing teachers may reduce lifetime earnings by nearly $38,000 for full-time workers. I use the CPI to convert weekly wage income for each individual in each census year into 2023 dollars. The DD estimate on this weekly wage income for cohorts born through 1940 is -$18.62, and the average full-time worker in this sample worked 50.57 weeks in the past year. Multiplying -$18.62 by 50.57 weeks by 40 years (ages 25-64) results in a total loss of $37,645. Childhood exposure to teacher labor market shocks can therefore have a meaningful negative impact on lifetime earnings.

5.3 Heterogeneity by Race

The overall effects on educational attainment and earnings are driven by white individuals, with little detectable effects on the cohorts of Black students in school during and after the war. Figures A24 and A25 show the event studies on educational attainment and log weekly wages separately for Black and white individuals. For high school and college completion as well as weekly wages, the overall effects observed in Section 5 are driven by white students. Effects on Black students are much noisier and not significantly worse for the school-aged cohorts compared to the unexposed older cohorts.[19]

[19] In the 1942 Biennial Survey report, the U.S. Office education stated: "While the effect of the war in creating shortages of teachers affects Negro as well as white schools, its impact upon Negro schools is less marked to date. This may be interpreted in terms of the fact that the alternatives to teaching offer fewer inducements to Negroes than to whites."

There are several plausible reasons why Black students may have been spared the harms of WWII teacher shortages, relative to their white peers. First, the military mobilization rate was much higher for white men than Black men (Qian and Tabellini, 2025), posing a greater threat to the white teacher supply. Second, the pre-war share of men was slightly higher among white teachers than Black teachers.[20] Third, increases in the Black-white per-pupil expenditure ratio in the 1940s and 1950s South may have provided benefits to Black students that offset any negative effects of teacher shortages (Margo, 1991). Fourth, convergence between Black and white teacher salaries in the 1940s and 1950s, driven in large part by NAACP legal action, may have helped retain high-quality Black teachers and attract new ones to the profession (Margo, 1991; Cascio and Lewis, 2024). Fifth, birth state may be a noisier measure of childhood education for Black vs. white individuals given the second wave of the Great Migration in the 1940s-1960s. I assign an individual the treatment of missing teachers depending on their birth state, but Black individuals born in the 1940s and 1950s may have been more likely than their white peers from the same birth state to receive their education in a different state.[21]

5.4 Heterogeneity by Age

The effects of exposure to educational shocks may vary over the life cycle. In Figure A26, I show the main DD effects on log weekly wages across eight different age bins of five years each (ages 25-29 through 60-64). Interestingly, the negative effects are not statistically significant until a worker's mid-30's. It is possible that at younger ages, any negative income effects caused by exposure to childhood teacher shortages may be offset by higher wages from entering the labor force sooner, given lower educational attainment. The effects are relatively consistent across subsequent age groups, though the largest effect is on the oldest workers aged 60-64. Overall, these finding suggest that other studies evaluating the long-

[20] According to the 1940 complete count census, 26% of white teachers nationally were men, compared to 23% of Black teachers. These shares are almost identical (25% of white teachers and 23% of Black teachers) in the South.

[21] For example, for an individual born in Mississippi (a state with a low 1940 male teacher share) who moved to Illinois (a state with a higher male teacher share) when they were young, I may be underestimating their exposure to treatment.

run effects of education interventions prior to age 30 (e.g., Chetty et al. (2014) and Chetty et al. (2011)) could understate effects later in the life cycle.

5.5 Health Outcomes

Beyond the negative effects of teacher shortages on educational and labor market outcomes, I also find that students more exposed to this shock during childhood have slightly lower life expectancy. This finding contributes to the literature documenting positive relationships between education, income, and health. It is well-established that higher education is associated with better health outcomes and longer lifespan.[22] Higher income is also associated with longer lifespan (Chetty et al., 2016). Given that exposure to teacher shortages reduces both educational attainment and income, it stands to reason that this childhood exposure may also have long-term health effects.

I use the Berkeley Unified Numident Mortality Database (BUNMD) provided by CenSoc to analyze mortality for the relevant cohorts (Breen and Goldstein, 2022; Goldstein et al., 2023). The BUNMD is a cleaned version of the Social Security Numident File and contains 95%+ of all deaths in the U.S. occurring between 1988-2005 for individuals 65 and older. I therefore do not observe outcomes for individuals born after 1940. While the analyses thus far rely on variation in missing teachers at the birth state level, birth county information in the BUNMD allows me to explore the effect of teacher shortages on lifespan at a more granular level. I define wartime missing teachers per capita at the county level as:

$$MissingTeach_c = \frac{1,000}{Pop_{c,1940}} \sum_g \left(\widehat{Teach}_{g,1942-46} - Teach_{g,1942-46} \right) \frac{Teach_{cg,1940}}{Teach_{g,1940}}. \quad (4)$$

This definition is the same as in Equation 2, except that I allocate missing teachers nationally to each county c rather than each state s.[23]

[22] Galama et al. (2018) provide an excellent overview of the causal effects of education on health and mortality from several studies.

[23] The state-level version defined in Equation 2 allocates missing teachers to states based on male and female teacher shares from the 1940 Biennial Survey. Since these reports do not contain county-level information, I allocate missing teachers to counties based on their 1940 male and female teacher shares from the complete count census. Appendix Figure A15 provides a map showing variation in the 1940 male teacher share at the county level.

I then estimate the effect of missing teachers in an individual's birth county on lifespan in an event study:

$$DeathAge_{iscb} = \alpha + \sum_{b=1912}^{1940} \delta_b MissingTeach_c \times I_b + \psi_c + \theta_b + \varepsilon_{iscb}. \quad (5)$$

Again, this specification is the same as in Equation 3 used to estimate long-run effects on education and earnings, except that an individual's exposure to missing teachers now depends on their birth county c. All regressions on age at death include birth county and birth cohort fixed effects. I cluster standard errors at the birth county level.

The resulting event study in Figure 8 shows that school-aged individuals during WWII have lower lifespans if they were born in a county with more missing teachers. Similar to the educational and labor market results, individuals who were too old to be in school during the war are not affected. Appendix Figure A16 shows the same result separately by sex, with similar effects for men and women.

In Table 4, I replace the individual birth cohort dummies with a single dummy variable for the treated cohorts born between 1923-1940. A one standard deviation increase in missing teachers per capita is associated with a 0.031 year reduction in lifespan. The average effect is slightly larger for men (-0.041) than for women (-0.025). However, these difference by gender flip when adding a birth state by birth cohort fixed effect, which controls for statewide policies or factors that may affect health outcomes differently for each birth cohort. This control reduces the overall effect to -0.023 years, with larger effects on women (-0.026) than men (-0.016). These findings are largely unaffected by controlling for census region at time of death in Appendix Table A2, suggesting that these differences are unlikely to be explained by migration. Though these effects are small—0.023-0.031 years corresponds to 8.4-11.3 days—the estimates are all statistically significant and suggest that adverse shocks to education during childhood can have long-run health effects, perhaps through the reduction in educational attainment and income.

6 Robustness

In this section, I demonstrate that the main results on education and labor market outcomes are robust to additional controls, alternative constructions of the missing teachers variable, alternative sources of variation, and alternative specifications. I also demonstrate that the main results are not driven by any one particular state. All robustness figures and tables can be found in Appendix C.

6.1 Additional Controls

While Figure 3 shows that the pre-war 1940 male share is uncorrelated with a host of state characteristics, I nevertheless augment the baseline specifications—which already control for mobilization rate and government spending, interacted with birth cohort dummies—to control for additional state characteristics. Appendix Figures C1 and C2 show the main results on education and labor market outcomes controlling for the following additional 1940 birth state characteristics interacted with birth cohort dummies: log population, share Black, share of the labor force in manufacturing, and share of the population 25 and older with a high school degree. Doing so slightly increases the magnitude of the education effects and slightly reduces the magnitude of the income effects. Aside from total income, where the effect is smaller and no longer significant, effects for all other outcomes that were statistically significant in the baseline specifications remain so with these additional controls.

6.2 Accounting for Regional Trends and Migration

In an effort to address concerns about migration and regional trends, Appendix Figures C1 and C2 also show results under various alternative specifications. First, I restrict to non-migrants—those who reside in their state of birth. While migration decisions may be endogenous, this approach helps demonstrate that these results are not driven by labor market conditions or education in states outside of one's birth state, Second, to address similar concerns, I directly control for census division of residence. Third, to account for any unobserved regional

trends that may affect cohorts differently, I add census birth division by birth cohort fixed effects. Fourth, to account for time-varying regional economic and labor market shocks, I include residence division by census year fixed effects. Fifth, to account for similar time-varying shocks affecting individuals' birth regions, I include birth division by census year fixed effects. The effects on education and labor market outcomes are robust to these additional controls. Point estimates are negative for all outcomes, with very similar magnitudes and statistical significance compared to the baseline results.

6.3 Alternative "Missing Teacher" Definitions

I show that my results are robust to different ways of predicting the counterfactual number of teachers during the war in Equation 1. Following Ager et al. (2023), I use fractional polynomials, a cubic in log time, and a quartic in log time, as well as a simple linear prediction. Appendix Figures C3 and C4 show the results on education and labor market outcomes, respectively when using these alternative methods. Point estimates are very similar across different specifications, and all are significant at the 5% level except for three of the estimates on college completion.

6.4 Alternative Sources of Variation

I also find similar results when using two different (closely related) sources of variation aside from my missing teachers measure: the actual 1940 state male teacher share, or the state share of 18-44 year old male teachers.[24] The latter attempts to exploit additional variation in the age structure of male teachers, as younger men were more likely to be drafted. Appendix Figures C5 and C6 show the main results on high school, college, and several economic outcomes where the DD estimates are based on these alternative treatment measures, rather than missing teachers. Across nearly all outcomes, these two alternative approaches yield very similar point estimates and confidence intervals. One exception is total

[24]The 1940 male teacher share is from the Biennial Survey of Education in the United States, while the share of 18-44 year old male teachers is from the complete count 1940 census.

income, where the estimate becomes smaller and less precise, though all effects on weekly wage are similar still highly significant.

6.5 Alternatives to OLS

The main education outcomes are binary variables for high school completion, some college, or college completion. While my main specifications use OLS for ease of interpretation, OLS can generate predicted outcomes outside [0,1] with a binary outcome. As such, in Appendix Table C1 I run the regressions from Table 1 using a logistic regression model instead. The estimates for all outcomes are negative and statistically significant at the 1% level, aside from an insignificant effect on college graduation for men. Overall, these results suggest that a one standard deviation increase in missing teachers reduces the odds of graduating high school by 7.0%, the odds of attending some college by 4.6%, and the odds of graduating college by 3.2%.

Analyses for holding a high-skill or STEM occupation are also robust to this approach. Table C2 shows that a 1 SD increase in missing teachers reduces the odds of having a high-skill occupation by 7.5% and the odds of having a STEM occupation by 7.3%. The effect on high-skill occupations is larger for women than men (10.1% vs. 6.0%), but the effect on STEM occupations is larger and only statistically significant for men.

Income variables in the census may contain zeros for those not participating in the labor force or where income is not reported. Following recommendations by Chen and Roth (2024) when the outcome variable contains zeros, I run Poisson regressions for wage income and total income, allowing for outcome values of zero and imposing no restrictions on hours worked, employment, labor force status, or earnings below the federal minimum wage. The sample sizes are therefore much larger than in Table 3. Table C3 shows that under this new specification and larger sample, a one standard deviation increase in missing teachers per capita is associated with a highly significant 2.9% decrease in wage income but a small, insignificant 0.6% decrease in total income.

6.6 Leave-One-Out Analysis

In a DD framework with U.S. states, Hoehn-Velasco et al. (2024) suggest a "leave-one-out" analysis to ensure that no single state drives the results. Appendix Figures C7 and C8 show the main DD effects on high school graduation and log weekly wages when separately omitting each state. The results are all similar and statistically significant at the 5% level, confirming that no single state is disproportionately affecting the main results.

6.7 Randomization Test

To further address concerns that any results may be driven by a small number of states, I randomly assign the measure of missing teachers per capita across states and re-estimate the baseline DD specification 1,000 times (Fisher, 1935; Young, 2019). The resulting distributions of coefficients in Appendix Figures C9a and C9b show that the baseline results on high school completion and log weekly wages are highly unlikely to be driven by chance. My baseline effect on wages is larger than in any of these simulations, and my baseline effect on high school completion is larger than all but fourteen out of 1,000 iterations.

7 Teacher Labor Market Response

This section explores how the mass exodus of teachers during the war changed the composition and quality of the teacher workforce. To replace teachers who left the profession, principals and superintendents turned to underqualified teachers on emergency licenses. As a result, between 1940 and 1950, the share of teachers with at least two or four years of college education fell in the states with more missing teachers. This decrease in the educational background of teachers continues for decades after the war, along with a lasting increase in the student-teacher ratio, contributing to the negative, long-run effects on students in school during the war, as well as post-war cohorts.

7.1 Increase in Emergency Licenses

In times of dire need, states may lower the bar for entry into teaching, prioritizing having a teacher in the classroom at the potential cost of that teacher being less qualified. Policymakers realized this tradeoff during WWII, noting that although "the primary purpose of teacher certification is to protect the school against incompetent teachers," when those standards are "lowered or abandoned, an increased number of legally qualified applicants is gained only with a distinct loss of quality in the teaching staff" (Frazier and United States, 1943). State-issued emergency teacher licenses became the primary method to address the wartime teacher shortage, with few changes to the regular certification process (Frazier and United States, 1943; Frazier, 1944a).[25]

These emergency teachers had less education than those they replaced, with the Office of Education expressing concern during the war that "[t]he employment of teachers whose qualifications are considerably lower, on the average, than those of teachers entering service immediately before the war has ... increased materially" (Frazier and United States, 1943). During the 1946-47 school year, the average teacher had one less year of college education than the average teacher in 1939-40, the number of teachers without any college education had doubled, almost two-thirds of the emergency teachers had less than two years of college experience, and nearly one third had no experience beyond high school (Fine, 1947b).

Figure A20 shows that the total number of teachers on emergency licenses skyrocketed after the U.S. joined the war and continued to increase in the immediate post-war years (Foster and United States, 1949). In 1946, one in every eight public school teachers nationally held an emergency teaching license.[26] I digitize state-level data on emergency licenses from the NEA to demonstrate that states with more missing teachers were more likely to hire emergency teachers. Figure

[25] In Appendix Figures A21a and A21b I show some of the minimum requirements for a typical teaching license in each state in 1940. The most common requirement for an elementary school license was two years of post-secondary experience, compared to four years for a high school license.

[26] By comparison, in 2022, less than 5% of teachers were underqualified. Nguyen et al. (2022) estimate 160,000 underqualified teachers nationally and National Education Association (2023) counts about 3.79 million teachers in 2021-22 and 2022-23.

9 shows a positive, statistically significant relationship between a state's wartime missing teachers and the share of teachers holding an emergency certificate during the 1944-45 school year. A one standard deviation increase in missing teachers is associated with a 2.8 pp increase in the share of emergency teachers. Appendix Figure A19 shows similar patterns for the 1943-44 and 1948-49 school years.

The persistence of the shortages even after the end of the war ensured that many of these emergency teachers remained in the profession. The Office of Education supported this point, noting that "[o]f the persons now certificated many will remain in the profession for years to come even though not qualified according to standards now prevailing or which will later prevail" (U.S. Office of Education, 1943a). Given that these emergency teachers were less qualified and likely remained in classrooms after the war, a persistent reduction in teacher quality in states with more severe shortages helps explain the negative long-run effects on student outcomes, even for those too young to be in school during the war.

7.2 Changes in Teacher Composition (1940-1950)

Replacement teachers may differ from the teachers they replace along many characteristics. In this section, I use the complete count 1940 and 1950 census to document how the war affected the composition of the teacher workforce (Ruggles et al., 2024). These data allow me to observe detailed characteristics of teachers (e.g., marital status and educational background) not available in the Biennial Survey reports or other sources. I show that between 1940 and 1950, states with more missing wartime teachers had larger decreases in the share of male teachers and larger increases in the share of married women but experienced a decrease in the share of teachers with at least two or four years of college education.[27]

[27] I focus primarily on state-level changes in the teacher workforce given that the long-run results on educational attainment and labor market outcomes in Section 5 are based on state-level variation. However, in section 7.2.5 I find similar results within states.

7.2.1 Decrease in Men

Consistent with the reasoning behind my identification strategy, I find that states with more missing teachers had a larger decrease in the share of male teachers between 1940 and 1950. Column (1) of Table 5 shows that there is a strong, statistically significant, negative relationship between missing teachers and the change in the male share over this decade. A one standard deviation increase in missing teachers is associated with a 1.5 pp decrease in the share of male teachers.[28] This raw correlation is unaffected by controlling for the mobilization rate and wartime government spending in column (2). Although men had returned to the civilian workforce by the end of this decade, the shock to the teaching profession clearly had an effect on the gender composition of the teacher workforce over this decade.

7.2.2 Increase in Married Women

I find a large increase in the share of married women teachers in the states most affected by the wartime shock. Marriage bars, which legally prevented married women from teaching, were widespread in the pre-war era but were largely repealed by the early 1950s (Goldin, 1988). Recent work finds that the introduction of teacher marriage bars reduced the share of married women teachers (Yang and Brough, 2024), while the repeal of marriage bars (in North Carolina and Kentucky in the 1930s) increased the share of these teachers (Kim and Tsao, 2024).

There was a large national increase in the share of married female teachers between 1940 and 1950, and that increase was even larger in states with more missing wartime teachers. From 1940 to 1950, the share of teachers who were married women increased from 19% to 34% nationally. At the state level, columns (3)-(4) of Table 5 show that one standard deviation increase in missing teachers is associated with a 3.0 pp increase in the share of married women teachers. This result supports the notion that removing marriage bars was a policy choice designed at least in part to address the wartime teacher shortages.

[28] This is not the first instance of war contributing to the feminization of teaching; Perlmann and Margo (2001) argue that the Civil War had a similar effect.

7.2.3 Decrease in Teacher Retention

Using Multigenerational Longitudinal Panel (MLP) links from IPUMS (Ruggles et al., 2025), I link individual teachers from the 1940 census forward to 1950 to see what share of teachers remained in the profession over this decade. I restrict to teachers aged 20-54 years old in 1940, i.e. those 30-64 in 1950. I am able to link 72.4% of teachers in 1940 forward to 1950. Among this linked set of teachers in 1940, 27.6% were still teachers in 1950. This share is a rough proxy for teacher retention or experience. In Appendix Figure A22 I show that there is a negative, statistically significant relationship between missing teachers during the war and this share of teachers from 1940 who were also teachers in 1950. A one standard deviation increase in missing teachers is associated with a 1.5 pp reduction in this retention rate. The second panel shows a similar result from this exercise in reverse: what share of 1950 teachers were also previously teachers in 1940? Once again this share is lower in states with more missing teachers. This exercise provides further evidence that the teacher workforce became less experienced in the states most affected by the wartime shock.

7.2.4 Decrease in Educational Background of Teachers

Consistent with the evidence on emergency certificates and the hypothesis that emergency teachers remained in the profession, I find that the teacher workforce became less educated in states with more severe shortages. Specifically, I show that between 1940 and 1950, states with more missing teachers had less growth in the share of teachers with at least two or four years of college experience. Columns (5) and (7) of Table 5 show that a one standard deviation increase in missing teachers is associated with a 2.4 pp decrease in the share of teachers with at least two years of college education and a 2.2 pp decrease in the share with four years of college. These magnitudes are largely unchanged after controlling for the mobilization rate of men and wartime government spending. Appendix Figure A23 show that this decrease is driven by women, with little change in the educational background of male teachers. Although education may be a noisy proxy for teacher quality, these results demonstrate a clear decrease in teacher qualifications in states more affected by this teacher labor market shock.

7.2.5 Changes in Local Teacher Labor Markets

Although my analysis of long-run student outcomes is limited to the birth state level, I extend the teacher workforce analysis to a more granular level to show that the same teacher composition changes that affect students at the state level also occurred locally. I extend these analyses to the state economic area (SEA) level. SEAs are groupings of counties that can be consistently identified in the census data and reflect meaningful local labor market areas. I assign missing teachers across SEAs according to their pre-war male/female teacher shares from the 1940 complete count census and explore the relationship between missing teachers and changes in teacher characteristics.

Similar to the state-level results, SEAs with more missing teachers had a relative decrease in the share of male teachers, an increase in the share of married female teachers, and a decrease in teachers' educational attainment. Table 6 summarizes these results. The second column under each outcome variable adds a state fixed effect and can thus be interpreted as the effects of missing teachers on the composition of the local teaching force, controlling for any statewide factors or policies. With the exception of the effect on the share of teachers with four years of college, all other outcomes remain negative and statistically significant at the 1% level after controlling for this state fixed effect. Though I am unable to directly test the long-run effects of missing teachers on education and labor market outcomes for students at a more granular level, this section shows that policy responses and changes to the composition of teachers observed at the state level are similar at more local levels.

7.3 Lasting Decrease in Teachers' Educational Background

While section 7.2 documents short-term changes to the composition of the teacher workforce from 1940 to 1950, this section shows that the decrease in teacher qualifications persists for decades after the war. I run event studies of the form

$$Y_{st} = \alpha + \sum_{t=1931}^{1980} \beta_t MissingTeach_s \times I_t + \eta_s + \lambda_t + X_{st}\Gamma + \varepsilon_{st} \tag{6}$$

where Y_{st} is the share of teachers with at least two or four years of college education for state s in year t, and $MissingTeach_s$ is the standardized WWII missing teachers per capita number for the state, interacted with year dummies (I_t). I control for the WWII mobilization rate and government wartime spending, both interacted with year dummies (X_{st}). The reference year is 1940. Using complete count 1940 and 1950 census data combined with census samples for subsequent census years, I construct a state-level decennial panel of teacher qualifications. To address the shortcoming that the census does not record education prior to 1940, meaning there is no available pre-period with census data, I digitize data from the "National Survey of the Education of Teachers," a report compiled by the U.S. Office of Education containing state-level data on teacher education from the 1930-31 school year (Evenden et al., 1935).

An increase in missing teachers during WWII is associated with a lasting decrease in teachers' educational background in the decades following the war. Figures 10a and 10b show event study plots on the share of teachers with at least two or four years of college education from 1931 through 2000. There is only one pre-period, making it difficult to assess pre-trends. However, this 1931 estimate is statistically indistinguishable from zero in both figures (though barely so in Panel A). A one standard deviation increase in missing teachers during WWII is associated with about a two percentage point decrease in the share of teachers with at least four years of college in 1950 and 1960, but this effect largely fades by 1970. By contrast, the share of teachers with at least two years of college education decreases by about three percentage points and remains depressed for at least three decades. Taken together, these figures suggest that the shock of the war stunted teacher qualifications for at least 15 years, with an even more persistent effect for the least-qualified teachers with under two years of college education. Students in the most affected states were therefore subject to less-qualified teachers for many years after the end of the war, contributing to the highly persistent negative effects on student outcomes.

7.4 Lasting Increase in Student-Teacher Ratios

A sharp decrease in the number of teachers as in WWII may increase the student-teacher ratio and class sizes, reducing educational quality. Indeed, several studies find that smaller class sizes are associated with long-run benefits for students (Chetty et al., 2011; Dynarski et al., 2013; Fredriksson et al., 2013; Athey et al., 2025). Using an event study approach similar to Equation 6, I explore how the student-teacher ratio evolved before, during, and after the war in states with more missing teachers.

An increase in missing teachers during WWII is associated with a persistent increase in the student-teacher ratio for at least two decades following the end of the war. Figure 11 shows the corresponding event study estimates. Before the war, the student-teacher ratio was evolving similarly in states that later had more vs. fewer missing wartime teachers. Soon after the U.S. joined the war, the ratio began to increase in more affected states. For example, for the 1943-44 school year, a one standard deviation increase in missing teachers is associated with a statistically significant 0.53 increase in the student-teacher ratio. This increase in the student-teacher ratio continues to grow and persists at least until 1964, meaning that students in the most affected states were likely subject to larger class sizes long after the end of the war. Given the benefits of smaller class sizes, larger class sizes brought on by the wartime shortages may be another mechanism that helps explain part of the persistent negative long-run effects I find on students.

However, this increase class size alone is unlikely to explain a large fraction of my results, suggesting a larger role for teacher quality. These two mechanisms are inherently difficult to disentangle in this setting since the more-affected states experienced both larger class sizes and a decrease in teacher qualifications at the same time. Prior work suggests that teachers may play a more important role than class size in affecting long-run student outcomes like earnings. Chetty et al. (2011) separately estimate the effects of class size, teacher experience, and "class effects" (a combination of unobservable teacher effects and peer effects) on earnings and find that the later two have significant effects on earnings whereas class size does not. A back of the envelope calculation using estimates from Chetty et al. (2011) suggests that the increase in class size in my setting is unlikely to explain more

than one third of the negative effects I find on college attendance and wages.[29]

7.5 Investigating Other Mechanisms

In this section, I digitize data from the Biennial Survey of Education in the U.S. to study changes in other inputs to education (teacher salaries and per-pupil expenditures) and educational experience (private school enrollment) that might affect quality of schooling for students exposed to this shock. To analyze changes in these outcomes at the state level, I use an event study design similar to Equation 6 that compares states more and less exposed to teacher shortages before and after the war.[30] I present event study plots of the β_t coefficients and their 95% confidence intervals to visualize these dynamic effects of teacher shortages on state-level outcomes during and after the war.

7.5.1 Small, Temporary Increase in Teacher Salaries

When asked how they were attempting to address the wartime teacher shortage crisis, the most common response by school superintendents was that they increased raise teacher salaries (Figure A7). I find some evidence to support this claim by showing that states with more missing teachers had larger increases in teacher salaries during the war. In Figure 12, I plot the β_t event study coefficients from Equation 6 where the outcome is log average teacher salaries at the state level. Before the war, teacher salaries in states that later had more missing wartime teachers were trending similarly to states with fewer missing teachers. But as soon as the U.S. entered the war, there is a small increase in teacher salaries in more affected states. For example in 1944, a one standard deviation increase in missing teachers is associated with a 1.5% increase in average teacher salaries. However, these effects are not statistically significant for any individual year, and any positive effect during the war fades by the end of the decade.

Despite efforts to raise teacher salaries, these increases were likely not large

[29] See Appendix Table A3 for details.

[30] The only difference from Equation 6 is the years, as these analyses focus on shorter-term outcomes. All analyses include pre-war, wartime, and post-war years.

enough to attract well-qualified candidates and fill vacancies. According to the NEA, although average teacher salaries increased nationally by about 24% between 1940 and 1945, high inflation during the war (closer to 28%) meant that "[i]n actual purchasing power the salary of the average teacher is less in 1945 than it was in 1940" (National Education Association, 1946a).[31] A negative supply shock does not necessarily portend a shortage if teacher salaries increase enough to once again bring quantity supplied equal to quantity demanded at this new, higher wage. But local school district budget constraints, rigidity of teacher salary schedules, slow-moving district processes, increased salaries in outside options, and high inflation likely prevented teacher salaries from adjusting, resulting in a shortage.

7.5.2 No Change in Per-Pupil Expenditures

Despite the modest increase in teacher salaries in more affected states during the war, I find no evidence in Figure A17 that overall expenditures per pupil (in average daily attendance) increased. While states may have temporarily reallocated some expenditures toward higher teacher salaries, these results suggest that school districts were unable to meaningfully combat the teacher shortage crisis with higher spending. These results also suggest that the changes in teacher educational background and class size are more likely to drive the negative results on students than these other changes in the inputs to education.

7.5.3 No Change in Private School Enrollment

When public schools are in crisis, parents sometimes turn to private schooling as a substitute for their children. This phenomenon has been observed most recently in response to COVID-19 (Irwin et al., 2022; Musaddiq et al., 2022; Bacher-Hicks et al., 2024). In Appendix Figure A18, I find no evidence to support this

[31] By contrast, average teacher salaries more than doubled between 1917 and 1923. The NEA argued that the "critical shortage of teachers" during WWI, though much less severe than during WWII, was mitigated by this large increase in teacher salaries. They advocated for higher teacher salaries to address the WWII teacher shortage crisis, claiming that "the education of a generation of our children will be curtailed" without "a new concept of a teacher's worth in terms of pay" (National Education Association, 1946a).

hypothesis in this setting. There is no increase in private school enrollment in states with more severe shortages during or after the war. Changes in the quality of public education, not a massive flow of students from public to private schools, are therefore likely to drive the negative long-run effects on students.

8 Long-Run Effects on Post-War Cohorts

The lasting effects on teacher qualifications and class sizes described in section 7 suggest that the effects of the war may have continued to affect the post-war Baby Boom cohorts. Fine (1947b) argued that "[t]he effects of the war will be felt for generations to come" and that "[m]illions of children yet unborn will be cheated and deprived of a decent education" because of the teaching crisis spurred by the war. This section extends the event studies from section 5 through the 1960 birth cohort and discusses the possibility of negative spillovers of this shock on long-run economic growth.

8.1 Negative Effects Continue for Post-War Cohorts

If the war were just a temporary shock that only affected education for those in school at the time, we would expect these effects to fade out for cohorts born after the war. Instead, although the estimates are less precise for later cohorts, Figure 13 shows that the wartime shock is associated with negative educational attainment and lower earnings for children born as long as 15 years after the end of the war.[32] The negative effects on education continue for post-war cohorts but remain at a similar magnitude, whereas the effects on wages become even worse for later cohorts. Given the persistence of the negative effects on education, negative effects on wages for the post-war cohorts are not surprising. Further, previous work showing increasing high school and college wage premiums throughout the second half of the twentieth century (Goldin and Katz, 2009) is consistent with

[32]These event studies extend through the 1960 birth cohort and use additional census data from 2010 and 2020, compared to the event studies ending with the 1940 cohort, which used census data through 2000. Appendix Figure A27 shows the corresponding event study figures for some college attendance and for other labor market outcomes.

a worsening wage effect. If the WWII teacher shock persistently reduces high school and college completion, and the returns to those degrees are increasing over time, then the effect on wage will continue to worsen for later cohorts even if the effect on education stays constant.

Across all outcomes, I continue to find negative effects on these post-war cohorts. Appendix Tables A4, A5, and A6, report DD estimates through the 1940 cohort, through the 1960 cohort, and separately for the 1923-40 and 1941-60 cohorts. In all cases, the magnitude of the effect is larger for the later cohorts. However, it is important to note that overall educational attainment is increasing over this period, so the relative effect does not change much over time. For example, I find a larger effect on high school graduation when considering all cohorts through 1960 vs. through 1940 (-2.2 pp vs. -1.6 pp), but the baseline mean is also higher (81.2% vs. 63.4%), meaning that I find a relative effect of -2.7%, hardly different than the -2.5% effect when restricting to cohorts through 1940.

These results on post-war cohorts should be viewed cautiously, as many other factors could affect education and labor market outcomes after WWII. If any of these omitted factors are correlated with missing teachers during the war, then these negative effects for the post-war cohorts may not be causally attributable to the WWII shock. Nevertheless, this section provides suggestive evidence that the war had lasting effects not only on school-aged cohorts but also for the next generation of students.

8.2 Effects on Long-Run Growth and Productivity

While the analyses thus far have focused on individuals, human capital attainment could have spillover effects on the larger macroeconomy. Given the large and persistent effect that WWII had on human capital, this shock may have harmed the productivity of a generation of workers and affected long-run economic growth. I estimate the relationship between missing teachers during WWII and the growth in state-level total factor productivity (TFP) from 1940-2000 using the same approach as Lange and Topel (2006). This approach uses individual-level census data from 1940-2000 and decomposes log weekly wages into separate components for observable human capital (educational attainment and experience), a

"skill" component reflecting an individual's birth state and birth cohort, and a state-specific productivity term defined as a state-year fixed effect for the individual's state of residence in the given year. Collapsing to means at the state-year level gives them a state panel of average education, wages, labor force skill, and state-level productivity, which they use to investigate relationships in the growth of these factors over time.

After following this same procedure, I find that my measure of missing teachers during WWII is negatively associated with the growth in all of these state characteristics between 1940 and 2000. Table 7 summarizes these relationships. Unsurprisingly, I find lower growth in educational attainment and wages in states that had more missing teachers during WWII. A one standard deviation increase in missing teachers is associated with a 0.36 decrease in years of education and an 8.2% decrease in weekly wage. But beyond this negative effect on individual human capital, I also find a negative relationship between missing teachers and skill growth (significant at the 10% level) as well as TFP growth (significant at the 5% level). A one standard deviation increase in missing teachers during WWII is associated with a 3.8% lower growth in TFP over 1940-2000. Other omitted factors could confound this relationship, and the lack of pre-1940 individual-level income and education data makes it difficult to say whether these patterns are influenced by pre-existing trends. Nevertheless, this section provides suggestive evidence that the wartime teacher shock may have had long-term consequences not just for individual students, but also for long-run economic productivity.

9 Conclusion

This paper provides the first causal evidence demonstrating that shocks to the teacher labor market can have profound and consequences for students' long-run outcomes. The exodus of teachers from the profession during WWII was one of the largest teacher supply shocks in American history, with lasting effects on both the teacher workforce and on students. Children more exposed to this shock had lower educational attainment and earnings as adults and even died at slightly younger ages. The effects on education and labor market outcomes are both statistically significant and economically meaningful, underscoring that

childhood exposure to teacher labor market shocks can have important impacts on human capital development and long-run economic outcomes.

I provide evidence that a reduction in teacher quality was a key mechanism through which shortages affected student outcomes, as states more affected by the shock hired more teachers on emergency credentials and fewer teachers with college experience. These changes in the composition of the teacher workforce persisted long after the war, exposing a generation of children to less-qualified teachers. While prior research has documented the importance of teacher quality for student outcomes, this study provides new evidence that negative shocks to teacher supply can reduce quality in ways that damage educational opportunity and long-run well-being for students.

While the specific historical circumstances of WWII are unique, the lessons from this era remain relevant today as schools struggle to fill vacancies and attract qualified teachers. Short-term, temporary measures, like dramatically lowering standards to enter the profession, can have long-term costs for students. This historical evidence demonstrates that ensuring a stable and qualified teacher workforce is not merely a short-term staffing goal, but a critical investment in long-term human capital and economic prosperity.

References

Abramitzky, Ran, Philipp Ager, Leah Boustan, Elior Cohen, and Casper W. Hansen, "The Effect of Immigration Restrictions on Local Labor Markets: Lessons from the 1920s Border Closure," *American Economic Journal: Applied Economics*, January 2023, *15* (1), 164–191.

Acemoglu, Daron, David H. Autor, and David Lyle, "Women, War, and Wages: The Effect of Female Labor Supply on the Wage Structure at Midcentury," *Journal of Political Economy*, June 2004, *112* (3), 497–551. Publisher: The University of Chicago Press.

Ager, Philipp, James J Feigenbaum, Casper W Hansen, and Hui Ren Tan, "How the Other Half Died: Immigration and Mortality in U.S. Cities," *The Review of Economic Studies*, March 2023, p. rdad035.

Akbulut-Yuksel, Mevlude, "Children of War: The Long-Run Effects of Large-Scale Physical Destruction and Warfare on Children," *The Journal of Human Resources*, 2014, *49* (3), 634–662. Publisher: [University of Wisconsin Press, Board of Regents of the University of Wisconsin System].

Athey, Susan, Raj Chetty, and Guido Imbens, "The Experimental Selection Correction Estimator: Using Experiments to Remove Biases in Observational Estimates," May 2025.

Bacher-Hicks, Andrew, Tareena Musaddiq, Joshua Goodman, and Kevin Stange, "The stickiness of pandemic-driven disenrollment from public schools," *Economics of Education Review*, June 2024, *100*, 102527.

Backes, Ben, James Cowan, Dan Goldhaber, and Roddy Theobald, "Four Years of Pandemic-Era Emergency Licenses: Retention and Effectiveness of Emergency-Licensed Massachusetts Teachers Over Time | CALDER," *National Center for Analysis of Longitudinal Data in Education Research*, 2024.

Bacolod, Marigee P., "Do Alternative Opportunities Matter? The Role of Female Labor Markets in the Decline of Teacher Quality," *Review of Economics and Statistics*, November 2007, *89* (4), 737–751.

Bailey, Martha J., Shuqiao Sun, and Brenden Timpe, "Prep School for Poor Kids: The Long-Run Impacts of Head Start on Human Capital and Economic Self-Sufficiency," *American Economic Review*, December 2021, *111* (12), 3963–4001.

Bertoni, Eleonora, Michele Di Maio, Vasco Molini, and Roberto Nisticò, "Education is forbidden: The effect of the Boko Haram conflict on education in North-East Nigeria," *Journal of Development Economics*, November 2019, *141*, 102249.

Bound, John and Sarah Turner, "Going to War and Going to College: Did World War II and the G.I. Bill Increase Educational Attainment for Returning Veterans?," *Journal of Labor Economics*, 2002, *20* (4), 784–815. Publisher: [The University of Chicago Press, Society of Labor Economists, NORC at the University of Chicago].

Bowers, Harold Jennings, *Let Us Consider Teaching*, Ohio Department of Education, 1944. Google-Books-ID: JBYiAQAAMAAJ.

Breen, Casey and Joshua R. Goldstein, "Berkeley Unified Numident Mortality Database: Public administrative records for individual-level mortality research," *Demographic Research*, July 2022, *47*, 111–142.

Bryant, Jake, Samvitha Ram, Doug Scott, and Claire Williams, "K–12 Teachers Are Quitting. What Would Make Them Stay?," *McKinsey & Company*, March 2023.

Brück, Tilman, Michele Di Maio, and Sami H Miaari, "Learning The Hard Way: The Effect of Violent Conflict on Student Academic Achievement," *Journal of the European Economic Association*, October 2019, *17* (5), 1502–1537.

Carr, William G. and Mary Louise Mallam, "Chapter II: Effects of the World War on American Education," *Review of Educational Research*, February 1943, *13* (1), 13–20. Publisher: American Educational Research Association.

Cascio, Elizabeth U. and Ethan G. Lewis, "Teacher Salaries and Racial Inequality in Educational Attainment in the Midcentury South," *Journal of Labor Economics*, April 2024, *42* (S1), S95–S131. Publisher: The University of Chicago Press.

Chen, Jiafeng and Jonathan Roth, "Logs with Zeros? Some Problems and Solutions*," *The Quarterly Journal of Economics*, May 2024, *139* (2), 891–936.

Chetty, Raj, John N. Friedman, and Jonah E. Rockoff, "Measuring the Impacts of Teachers II: Teacher Value-Added and Student Outcomes in Adulthood," *American Economic Review*, September 2014, *104* (9), 2633–2679.

_ , _ , Nathaniel Hilger, Emmanuel Saez, Diane Whitmore Schanzenbach, and Danny Yagan, "How Does Your Kindergarten Classroom Affect Your Earnings? Evidence from Project Star," *The Quarterly Journal of Economics*, November 2011, *126* (4), 1593–1660.

_ , Michael Stepner, Sarah Abraham, Shelby Lin, Benjamin Scuderi, Nicholas Turner, Augustin Bergeron, and David Cutler, "The Association Between Income and Life Expectancy in the United States, 2001-2014," *JAMA*, April 2016, *315* (16), 1750–1766.

Collins, William J. and Gregory T. Niemesh, "Unions and the Great Compression of wage inequality in the US at mid-century: evidence from local labour markets," *The Economic History Review*, 2019, *72* (2), 691–715. Publisher: [Economic History Society, Wiley].

Corcoran, Sean P., William N. Evans, and Robert M. Schwab, "Changing Labor-Market Opportunities for Women and the Quality of Teachers, 1957-2000," *American Economic Review*, May 2004, *94* (2), 230–235.

Cowan, James, Dan Goldhaber, Kyle Hayes, and Roddy Theobald, "Missing Elements in the Discussion of Teacher Shortages," *Educational Researcher*, November 2016, *45* (8), 460–462.

Dawson, Howard A., "What We're Up Against," *Educational Leadership*, 1943, *1*, 6–8.

Dynarski, Susan, Joshua Hyman, and Diane Whitmore Schanzenbach, "Experimental Evidence on the Effect of Childhood Investments on Postsecondary Attainment and Degree Completion," *Journal of Policy Analysis and Management*, 2013, *32* (4), 692–717. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/pam.21715.

Edwards, Danielle Sanderson, Matthew A. Kraft, Alvin Christian, and Christopher A. Candelaria, "Teacher Shortages: A Framework for Understanding and Predicting Vacancies," *Educational Evaluation and Policy Analysis*, April 2024, p. 01623737241235224. Publisher: American Educational Research Association.

Eliassen, R. H. and Earl W. Anderson, "Investigations of Teacher Supply and Demand in 1942," *Educational Research Bulletin*, 1943, *22* (5), 126–134. Publisher: Taylor & Francis, Ltd.

_ **and** _ , "Teacher Supply and Demand: Investigations Reported in 1943," *Educational Research Bulletin*, 1944, *23* (2), 46–51. Publisher: Taylor & Francis, Ltd.

_ **and** _ , "Teacher Supply and Demand: Investigations Reported in 1944," *Educational Research Bulletin*, 1945, *24* (5), 119–126. Publisher: Taylor & Francis, Ltd.

Engel, Mimi, Brian A. Jacob, and F. Chris Curran, "New Evidence on Teacher Labor Supply," *American Educational Research Journal*, 2014, *51* (1), 36–72. Publisher: [American Educational Research Association, Sage Publications, Inc.].

Evenden, Edward S., Guy C. Gamble, and Harold G. Blue, "National Survey of the Education of Teachers. Bulletin, 1933, No. 10. Volume II: Teacher Personnel in the United States," Technical Report, Office of Education, United States Department of the Interior. 1935. Publication Title: Office of Education, United States Department of the Interior ERIC Number: ED543650.

Fine, Benjamin, "Breakdown in the Schools," *Survey Graphic*, 1947, *36*, 243–45.

_ , *Our children are cheated: the crisis in American education.*, New York: H. Holt, 1947.

Fisher, Ronald A., *The design of experiments*, Oxford, England: Oliver & Boyd, 1935. Pages: xi, 242.

Foster, Emery M., "Effects of the War on Public Schools," *Education Digest*, 1944, *9*, 43–45.

_ **and Benjamin W. Frazier**, *Some Early Effects of the War Upon Public Schools*, Federal Security Agency, U.S. Office of Education, 1943. Google-Books-ID: A1QxzgEACAAJ.

_ **and United States**, *The seriousness of the public school situation* Circular ;no. 249, Washington, D.C.: Federal Security Agency, Office of Education, 1949.

Foster, Emery Milton, *Some Effects of the War Upon Public Schools, 1942-43 and 1943-44*, Federal Security Agency, U. S. Office of Education, 1944. Google-Books-ID: ztIhzwEACAAJ.

Frazier, Benjamin W., "Minimum Certification Requirements for Teachers," *School Life*, 1940, *26*, 27–29.

_ , "The Teacher Shortage," in "Survey Graphic," Vol. 32, Survey Associates, 1943.

_ , "How Teacher Shortages Are Being Met," *American School Board Journal*, 1944, *108* (2), 39–41.

_ **and United States**, *Relief of teacher shortages by state departments of education* Circular ;no. 221, Washington, D.C.: Federal Security Agency, U.S. Office of Education, 1943.

Frazier, Benjamin William, *Teaching as a Profession* number 95, US Government Printing Office, 1944.

Fredriksson, Peter, Björn Öckert, and Hessel Oosterbeek, "Long-Term Effects of Class Size," *The Quarterly Journal of Economics*, 2013, *128* (1), 249–285. Publisher: Oxford University Press.

Galama, Titus, Adriana Lleras-Muney, and Hans van Kippersluis, "The Effect of Education on Health and Mortality: A Review of Experimental and Quasi-Experimental Evidence," in "Oxford Research Encyclopedia of Economics and Finance" May 2018.

Goldin, Claudia, "Marriage Bars: Discrimination Against Married Women Workers, 1920's to 1950's," October 1988.

_ **and Claudia Olivetti**, "Shocking Labor Supply: A Reassessment of the Role of World War II on Women's Labor Supply," *American Economic Review: Papers & Proceedings*, May 2013, *103* (3), 257–262.

_ **and Lawrence F. Katz**, *The Race between Education and Technology*, Harvard University Press, July 2009. Google-Books-ID: yGlCFqnakCoC.

_ **, Claudia Olivetti, and Joseph Ferrie**, "Mobilizing the manpower of mothers: Childcare under the Lanham Act during WWII," *Explorations in Economic History*, July 2025, *97*, 101684.

Goldin, Claudia D., "The Role of World War II in the Rise of Women's Employment," *The American Economic Review*, 1991, *81* (4), 741–756. Publisher: American Economic Association.

Goldstein, Joshua R., Monica Alexander, Casey Breen, Miranda González, Felipe Menares, Maria Osborne, Mallika Snyder, and Ugur Yildirim, "CenSoc Mortality File: Version 3.0," 2023.

Haines, Michael R., "Historical, Demographic, Economic, and Social Data: The United States, 1790-2002: Version 3," 2005.

Hanushek, Eric A., "The Economic Value of Higher Teacher Quality," *Economics of Education Review*, June 2011, *30* (3), 466–479.

_ **, Steven G. Rivkin, and Jeffrey C. Schiman**, "Dynamic effects of teacher turnover on the quality of instruction," *Economics of Education Review*, December 2016, *55*, 132–148.

Havari, Enkelejda and Franco Peracchi, "Growing up in wartime: Evidence from the era of two world wars," *Economics and Human Biology*, May 2017, *25*, 9–32.

Henry, Gary T. and Christopher Redding, "The Consequences of Leaving School Early: The Effects of Within-Year and End-of-Year Teacher Turnover," *Education Finance and Policy*, March 2020, *15* (2), 332–356.

Hoehn-Velasco, Lauren, Jacob Penglase, Michael Pesko, and Hasan Shahid, "When Policies Overlap: The Fragility of Effects Amidst Multiple Treatments," April 2024.

Ichino, Andrea and Rudolf Winter-Ebmer, "The Long-Run Educational Cost of World War II," *Journal of Labor Economics*, January 2004, *22* (1), 57–87. Publisher: The University of Chicago Press.

Irwin, Véronique, Ke Wang, Sarah Hein, Jijun Zhang, Riley Burr, Ashley Roberts, Amy Barmer, Farrah Bullock Mann, Rita Dilig, Stephanie Parker, Thomas Nachazel, Megan Barnett, and Stephen Purcell, "Report on the Condition of Education 2022," *Institute of Education Sciences*, May 2022.

Jackson, C. Kirabo, "What Do Test Scores Miss? The Importance of Teacher Effects on Non–Test Score Outcomes," *Journal of Political Economy*, 2018, *126* (5), 2072–2107. Publisher: The University of Chicago Press.

_ , Rucker C. Johnson, and Claudia Persico, "The Effects of School Spending on Educational and Economic Outcomes: Evidence from School Finance Reforms *," *The Quarterly Journal of Economics*, February 2016, *131* (1), 157–218.

Jacob, Brian Aaron, "The Challenges of Staffing Urban Schools with Effective Teachers," *The Future of Children*, March 2007, *17* (1), 129–153.

James, Jessalynn, Matthew A. Kraft, and John P. Papay, "Local supply, temporal dynamics, and unrealized potential in teacher hiring," *Journal of Policy Analysis and Management*, 2023, *42* (4), 1010–1044. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/pam.22496.

Jaworski, Taylor, ""You're in the Army Now:" The Impact of World War II on Women's Education, Work, and Family," *The Journal of Economic History*, March 2014, *74* (1), 169–195.

Kandel, I. L., *The impact of the war upon American education.*, Chapel Hill: Univ. of North Carolina Press, 1948.

Kane, Thomas J. and Douglas O. Staiger, "Estimating Teacher Impacts on Student Achievement: An Experimental Evaluation," December 2008.

Kim, Amy and Carolyn Tsao, "The Effects of Prohibiting Marriage Bars: The Case of U.S. Teachers," 2024.

Kirksey, Jacob, "Amid Rising Number of Uncertified Teachers, Previous Classroom Experience Proves Vital in Texas," 2024.

Lahey, Frank H. and J.L. Kaukonen, "A Summary of the Activities of the Procurement and Assignment Service," *War Medicine*, July 1944, *6* (1), 10–17.

Lange, Fabian and Robert Topel, "Chapter 8 The Social Value of Education and Human Capital," in E. Hanushek and F. Welch, eds., *Handbook of the Economics of Education*, Vol. 1, Elsevier, January 2006, pp. 459–509.

Margo, Robert A., *Race and Schooling in the South, 1880-1950: An Economic History*, Chicago, UNITED STATES: University of Chicago Press, 1991.

_ , "Explaining Black-White Wage Convergence, 1940-1950," *Industrial and Labor Relations Review*, 1995, *48* (3), 470–481. Publisher: Sage Publications, Inc.

McDonald, Ralph, "The Teacher Crisis," in "Proceedings, 80th Annual Meeting, National Education Association" The National Education Association of the United States 1945.

McVey, Kaitlin Pennington and Justin Trinidad, "Nuance in the Noise: The Complex Reality of Teacher Shortages," Technical Report, Bellwether Education Partners January 2019. Publication Title: Bellwether Education Partners ERIC Number: ED596444.

Musaddiq, Tareena, Kevin Stange, Andrew Bacher-Hicks, and Joshua Goodman, "The Pandemic's effect on demand for public schools, homeschooling, and private schools," *Journal of Public Economics*, August 2022, *212*, 104710.

Nagler, Markus, Marc Piopiunik, and Martin R. West, "Weak Markets, Strong Teachers: Recession at Career Start and Teacher Effectiveness," *Journal of Labor Economics*, April 2020, *38* (2), 453–500. Publisher: The University of Chicago Press.

National Center for Education Statistics, "US schools report increased teacher vacancies due to COVID-19 pandemic, new NCES data show," 2022.

_ , "Most Public Schools Face Challenges in Hiring Teachers and Other Personnel Entering the 2023-24 Academic Year," 2023.

_ , "Table 208.20. Public and private elementary and secondary teachers, enrollment, pupil/teacher ratios, and new teacher hires: Selected years, fall 1955 through fall 2031.," 2024.

National Education Association, *Addresses and Proceedings of the National Education Association*, National Education Association of the United States, 1946.

_ , *NEA Handbook and Manual for Local, State, and National Associations*, National Education Association of the United States, 1946. Google-Books-ID: vTM8pA4OEcEC.

_ , "Admission to the Teaching Profession," *Research Bulletin of the National Education Association*, December 1949, *27* (4).

_ , "Rankings of the States 2022 and Estimates of School Statistics 2023," Technical Report, National Education Association Research Department April 2023. Publication Title: National Education Association ERIC Number: ED628838.

_ , "Rankings of the States 2023 and Estimates of School Statistics 2024," Technical Report, National Education Association Research Department April 2024.

_ , "Rankings of the States 2024 and Estimates of School Statistics 2025," Technical Report, National Education Association Research Department April 2025.

Nguyen, Tuan D., Chanh B. Lam, and Paul Bruno, "Is there a national teacher shortage? A systematic examination of reports of teacher shortages in the United States," Technical Report, Annenberg Institute at Brown University August 2022. Publication Title: EdWorkingPapers.com.

_ , _ , _ , **Josh Bleiberg, and Patricia Saenz-Armstrong**, "Teacher shortages in the United States: A systematic examination of reports of teacher vacancy and shortages. https://www.teachershortages.com/," 2024.

Papay, John P. and Matthew A. Kraft, "The Productivity Costs of Inefficient Hiring Practices: Evidence From Late Teacher Hiring," *Journal of Policy Analysis and Management*, 2016, *35* (4), 791–817. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/pam.21930.

Pennsylvania Department of Public Instruction, *Enlist in the Forces of Education ...*, Pennsylvania. Department of Public Instruction, 1943.

Perlmann, Joel and Robert A. Margo, *Women's Work?: American Schoolteachers, 1650-1920*, Chicago, UNITED STATES: University of Chicago Press, 2001.

Qian, Nancy and Marco Tabellini, "Racial Discrimination and the Social Contract: Evidence from U.S. Army Enlistment During WWII," *The Review of Economic Studies*, May 2025, p. rdaf038.

Rivkin, Steven G., Eric A. Hanushek, and John F. Kain, "Teachers, Schools, and Academic Achievement," *Econometrica*, 2005, *73* (2), 417–458. Publisher: [Wiley, Econometric Society].

Rockoff, Jonah E., "The Impact of Individual Teachers on Student Achievement: Evidence from Panel Data," *The American Economic Review*, 2004, *94* (2), 247–252. Publisher: American Economic Association.

Ronfeldt, Matthew, Susanna Loeb, and James Wyckoff, "How Teacher Turnover Harms Student Achievement," *American Educational Research Journal*, February 2013, *50* (1), 4–36. Publisher: American Educational Research Association.

Ruggles, Steven, Nesile Ozder, Catherine A. Fitch, Matthew Sobek, Julia A. Rivera Drew, J. David Hacker, Jonas Helgertz, Cheyenne Lonobile, Matt A. Nelson, Evan Roberts, and John Robert Warren, "IPUMS Multigenerational Longitudinal Panel: Version 2.0," 2025.

_ **, Sarah Flood, Matthew Sobek, Daniel Backman, Annie Chen, Grace Cooper, Stephanie Richards, Renae Rodgers, and Megan Schouweiler**, "IPUMS USA: Version 15.0 [dataset]. Minneapolis, MN: IPUMS," 2024.

Shallcross, Ruth Enalda, *Should Married Women Work?* number 49, Public Affairs Committee, Incorporated, 1940.

Sorensen, Lucy C. and Helen F. Ladd, "The Hidden Costs of Teacher Turnover," *AERA Open*, January 2020, *6* (1), 2332858420905812. Publisher: SAGE Publications Inc.

Studebaker, John W., "Missing: 115,000 Teachers," *Click*, 1944, *7* (12), 65–67.

Taba, Hilda, "Educational News and Editorial Comment," *The Elementary School Journal*, 1943, *44* (4), 187–201. Publisher: University of Chicago Press.

United States Congress Senate Committee on Education and Labor, *Federal Aid for Education: Hearings Before the Committee on Education and Labor, U. S. Senate, 79th Congress, 1st Session, on S. 181, a Bill to Authorize the Appropriation of Funds to Assist the States and Territories in More Adequately Financing Their Systems of Public Education During Emergency, and in Reducing the Inequalities of Educational Opportunities Through Public Elementary and Secondary Schools...*, U.S. Government Printing Office, 1945. Google-Books-ID: orCVKCzYkfkC.

U.S. Census Bureau, "Educational Characteristics of the Population of the United States, by Age: 1940," Technical Report No. 4, U.S. Department of Commerce, Bureau of the Census December 1943.

U.S. Office of Education, "The Teacher Shortage—Are We Meeting It?," *Education for Victory*, August 1943, *2* (3).

US Office of Education, "Why Are Teachers Leaving Public Schools?," *Education For Victory*, 1943, *1*, 14–15.

U.S. Office of Education, "Problem of Teacher Shortage," *Education for Victory*, January 1944, *2* (14).

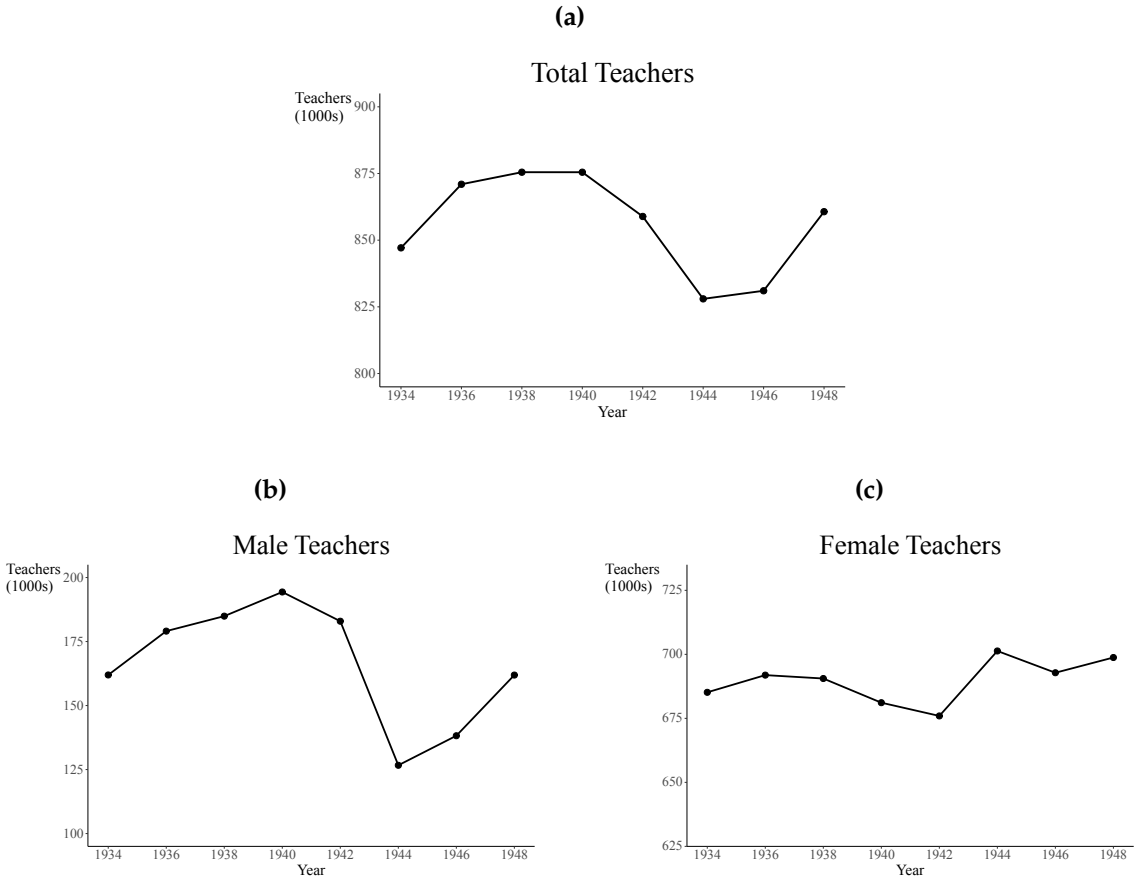
_ , "Biennial Survey of Education in the United States," Technical Report. issued: {1918-1958}.

Yang, Wenni and Rebecca Brough, "Marriage Bar, Representation, and Selection," 2024.

Young, Alwyn, "Channeling Fisher: Randomization Tests and the Statistical Insignificance of Seemingly Significant Experimental Results*," *The Quarterly Journal of Economics*, May 2019, *134* (2), 557–598.

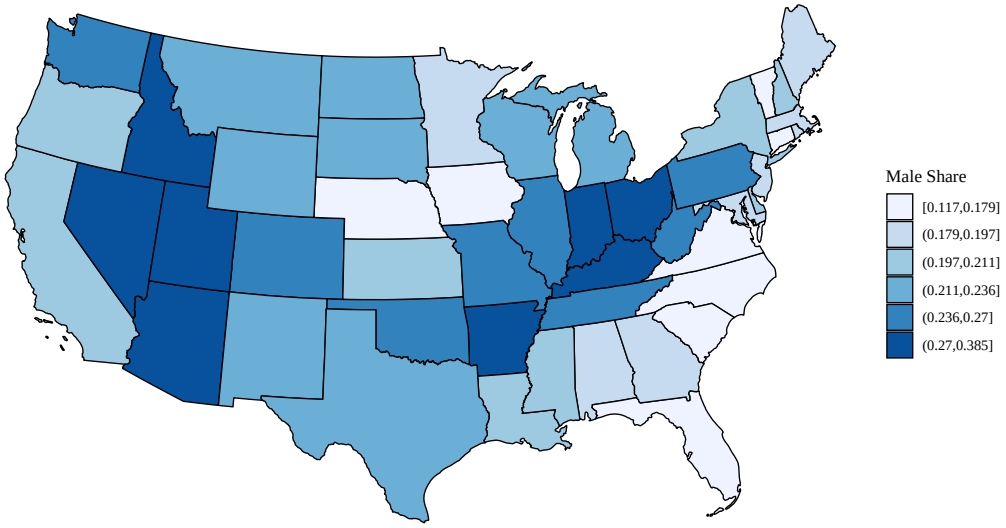
10 Figures and Tables

Figure 1. Public School Teachers



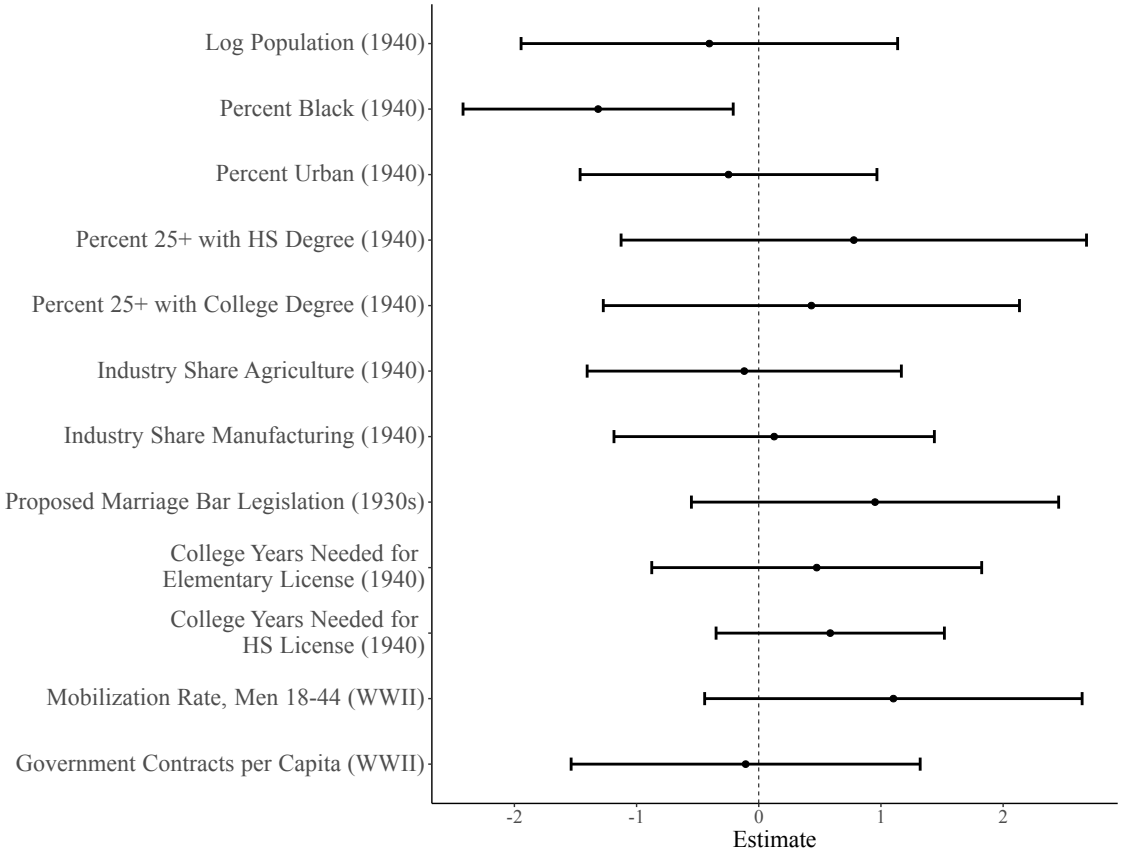
Notes: This figure shows the total number of public school teachers in the continental U.S. across several years, overall (Panel A) and by sex (Panels B and C). Counts are from various editions of the Biennial Survey of Education in the United States (U.S. Office of Education, n.d.).

Figure 2. Pre-War (1940) Variation in Male Teacher Shares



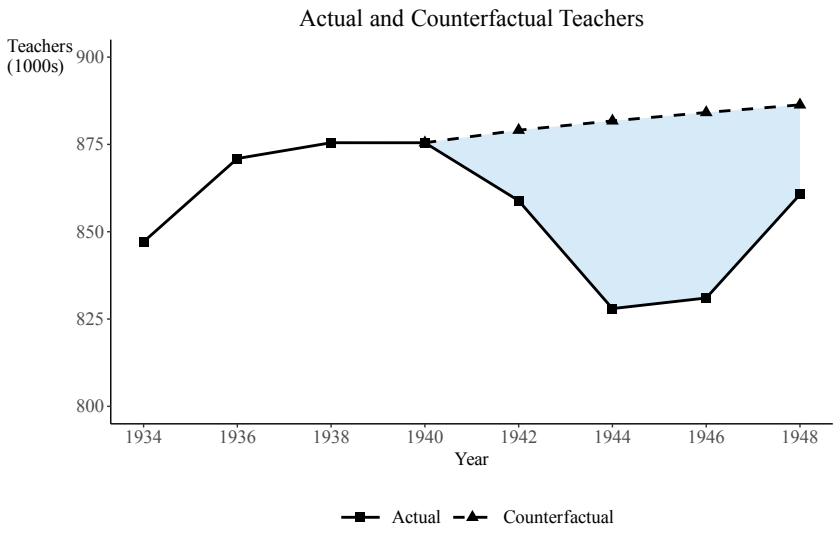
Notes: This figure shows the share of male teachers in each state from the 1939-1940 school year. Data are from the Biennial Survey of Education in the United States (U.S. Office of Education, n.d.).

Figure 3. Regression of 1940 Male Teacher Share on State Characteristics



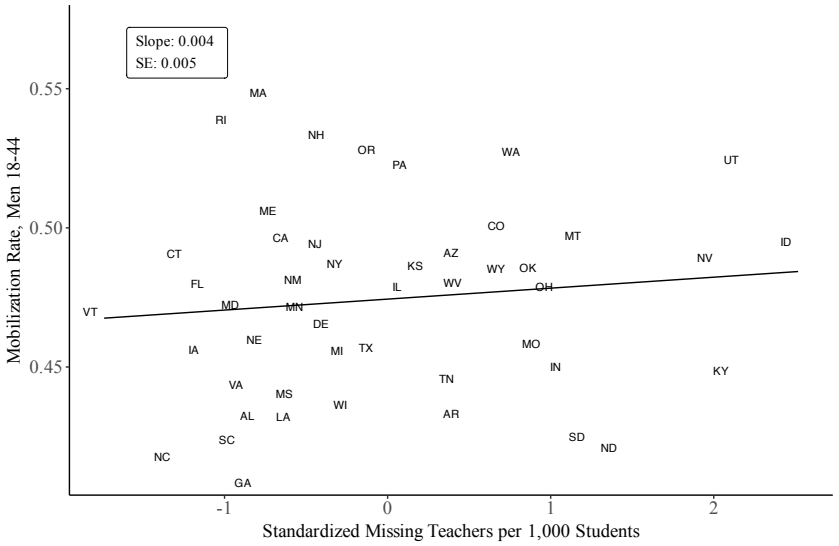
Notes: This figure plots the estimate and 95% confidence intervals from separate regressions of the 1940 male teacher on several state characteristics. All characteristics are standardized to have mean zero and standard deviation one. Demographic and industry characteristics come from the 1940 census. Teacher licensing information comes from Frazier (1940). Marriage bar legislation information is from Shallcross (1940). The mobilization rate is from Acemoglu et al. (2004). Wartime government spending is from Haines (2005).

Figure 4



Notes: The actual number of teachers comes from various editions of the Biennial Survey of Education in the United States (U.S. Office of Education, n.d.) and is the same as in Figure 1a. The counterfactual number of teachers is derived from Equation 1. I define "missing teachers" during WWII as the difference between these two lines between 1942 and 1946.

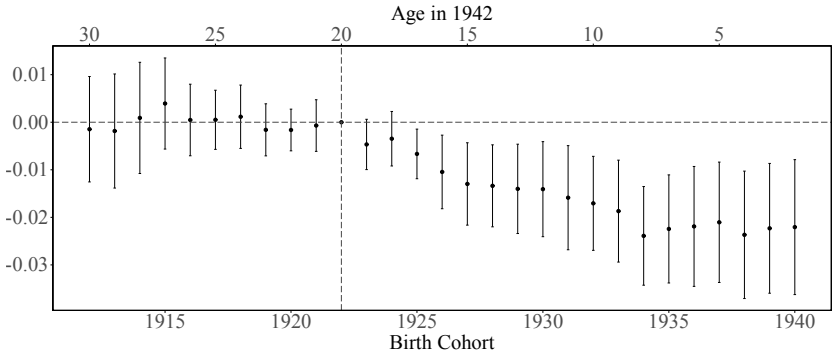
Figure 5. Relationship Between Missing Teachers and Overall Mobilization



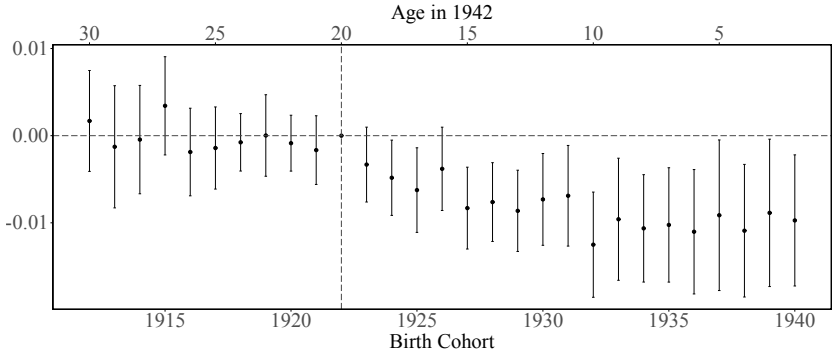
Notes: This figure shows the relationship between missing teachers per capita (x-axis) and the war mobilization rate of men 18-44 years old (y-axis). Missing teachers is defined in Equation 2 and standardized to have mean zero and standard deviation one. Mobilization rates are from Acemoglu et al. (2004).

Figure 6. Effects of Missing Teachers on Educational Attainment

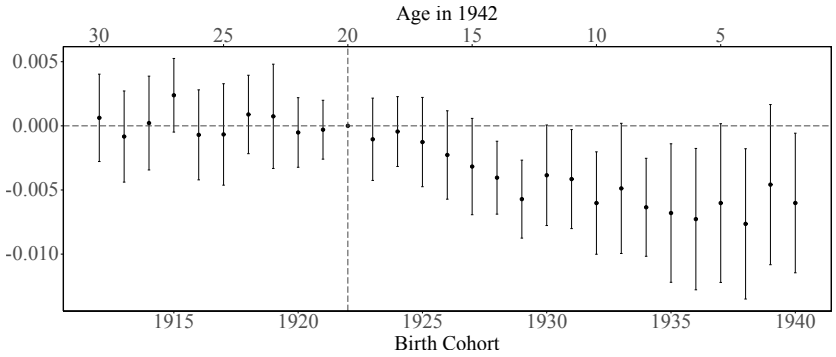
(a) High School Completion



(b) Some College



(c) College Completion



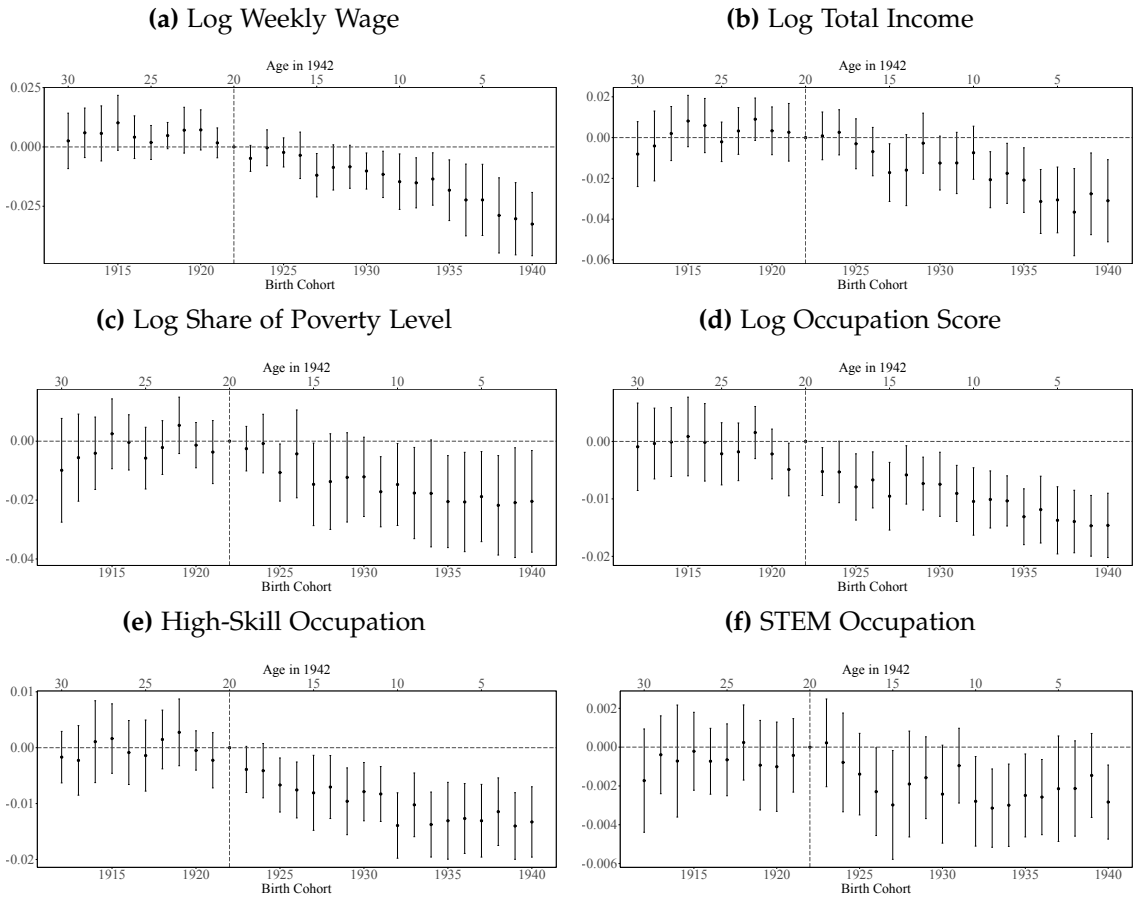
Notes: This figure shows the event study estimates from Equation 3 of the effect of a one standard deviation increase in missing teachers per capita on high school graduation, some college attendance, and four-year college graduation. The regression sample includes individuals aged 25-64 with non-missing education. All regressions are weighted by person weights. I pool census years 1940-2020. All regressions include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. The reference group is the 1922 birth cohort. Error bars represent 95% confidence intervals. Standard errors are clustered by birth state.

Table 1. Effects of Missing Teachers on Education

	High School Grad	Some College	College Grad
	(1)	(2)	(3)
Panel A: All			
Missing Teachers			
× (Birth Year ≥ 1923)	-0.016***	-0.008**	-0.004**
	(0.005)	(0.003)	(0.002)
Dep. Var. Mean	0.634	0.227	0.111
Observations	8,443,549	8,443,549	8,443,549
Panel B: Female			
Missing Teachers			
× (Birth Year ≥ 1923)	-0.017***	-0.009***	-0.006***
	(0.006)	(0.003)	(0.002)
Dep. Var. Mean	0.645	0.191	0.082
Observations	4,370,852	4,370,852	4,370,852
Panel C: Male			
Missing Teachers			
× (Birth Year ≥ 1923)	-0.014***	-0.007*	-0.003
	(0.005)	(0.004)	(0.003)
Dep. Var. Mean	0.620	0.269	0.145
Observations	4,072,697	4,072,697	4,072,697

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on high school completion, at least some college, and college completion. The regression sample includes individuals aged 25-64 with non-missing education. I pool census years 1940-2000. All regressions include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. Standard errors are clustered by birth state.

Figure 7. Effects of Missing Teachers on Labor Market Outcomes



Notes: This figure shows the event study estimates from Equation 3 of the effect of a one standard deviation increase in missing teachers per capita on income and occupation outcomes. The regression sample includes individuals aged 25-64 with non-missing outcomes. All regressions are weighted by person weights. For weekly wages, occupation score, and high-skill occupation, I restrict to employed workers who worked at least 40 weeks in the past year. For log weekly wages, individuals earning less than half the federal minimum wage are dropped and top-coded values are replaced with the top-coded value multiplied by 1.4. High-skill occupations are defined as those within the "Professional, Technical" and "Managers, Officials, and Proprietors" categories of 1950 occupation codes. I pool census years 1940-2020. All regressions include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. The reference group is the 1922 birth cohort. Error bars represent 95% confidence intervals. Standard errors are clustered by birth state.

Table 2. Effects of Missing Teachers on Income

	Log Weekly Wage	Log Total Income	Log Share of FPL
	(1)	(2)	(3)
Panel A: All			
Missing Teachers			
× (Birth Year ≥ 1923)	-0.019***	-0.018***	-0.012
	(0.004)	(0.006)	(0.008)
Observations	3,587,649	6,823,072	8,307,320
Panel B: Female			
Missing Teachers			
× (Birth Year ≥ 1923)	-0.019***	-0.022**	-0.011
	(0.005)	(0.009)	(0.008)
Observations	1,279,854	2,872,443	4,316,029
Panel C: Male			
Missing Teachers			
× (Birth Year ≥ 1923)	-0.018***	-0.014**	-0.013*
	(0.004)	(0.006)	(0.007)
Observations	2,307,795	3,950,629	3,991,291

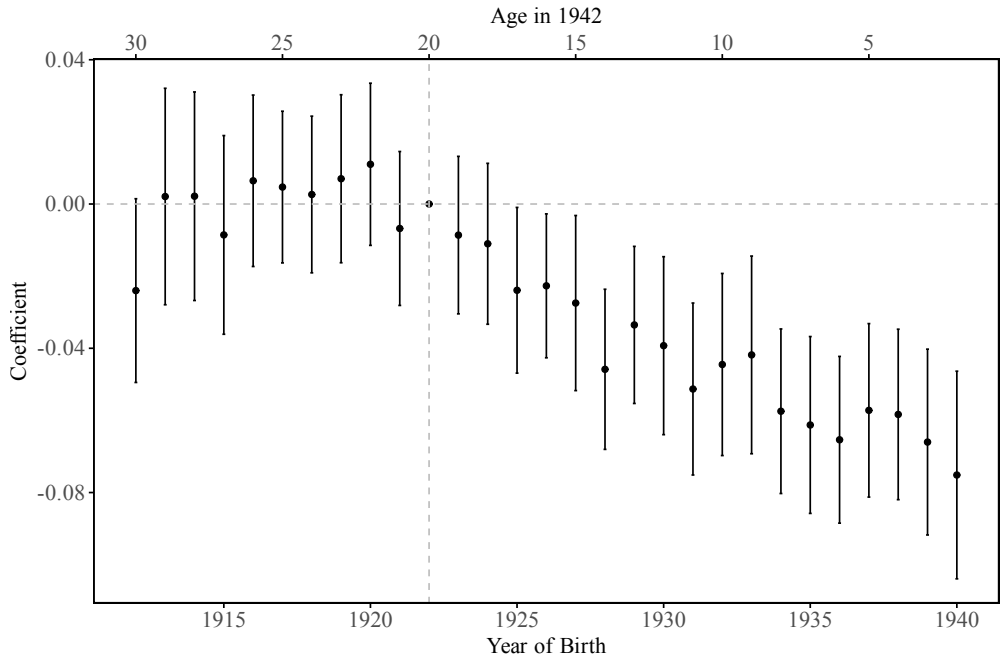
Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on various labor market outcomes. The regression sample includes individuals aged 25-64. For weekly wages and occupation score, I restrict to employed individuals who worked at least 40 weeks in the past year. For weekly wages, individuals earning less than half the federal minimum wage are dropped, and top-coded values are replaced with the top-coded value multiplied by 1.4. For total income, I restrict to those reporting any positive total income. Share of FPL refers to total family income as a percentage of the family's poverty threshold. I pool census years 1940-2020. Total income and poverty are only available starting in 1950. All regressions include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. Standard errors are clustered by birth state.

Table 3. Effects of Missing Teachers on Occupation

	Log Occ Score	High-Skill Occ	STEM Occ
	(1)	(2)	(3)
Panel A: All			
Missing Teachers			
× (Birth Year ≥ 1923)	-0.009***	-0.009***	-0.001***
	(0.002)	(0.002)	(0.000)
Dep. Var. Mean	3.306	0.272	0.036
Observations	4,614,460	4,614,460	4,614,460
Panel B: Female			
Missing Teachers			
× (Birth Year ≥ 1923)	-0.016***	-0.013***	-0.001**
	(0.004)	(0.002)	(0.000)
Dep. Var. Mean	3.124	0.223	0.011
Observations	1,539,699	1,539,699	1,539,699
Panel C: Male			
Missing Teachers			
× (Birth Year ≥ 1923)	-0.005***	-0.008***	-0.002***
	(0.002)	(0.002)	(0.001)
Dep. Var. Mean	3.349	0.284	0.042
Observations	3,074,761	3,074,761	3,074,761

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on occupation score and dummy variables for high-skill occupations or STEM occupations. See Appendix B for a list of STEM occupations. The regression sample includes individuals aged 25-64. All regressions are weighted by person weights. For occupation score, I restrict to employed individuals who worked at least 40 weeks in the past year. I pool census years 1940-2020. Poverty is only available starting in 1950. All regressions include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. Standard errors are clustered by birth state.

Figure 8. Effects of Missing Teachers on Age at Death



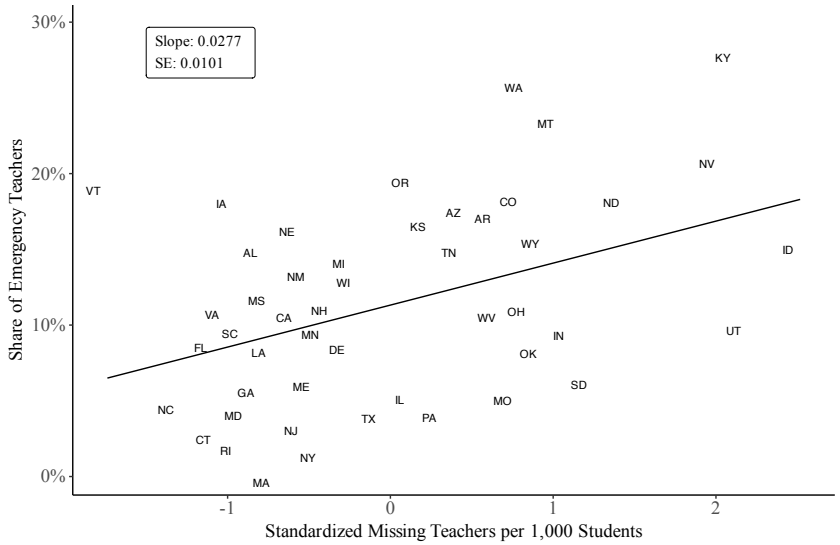
Notes: This figure shows the event study estimates from Equation 5 of the effect of a one standard deviation increase in missing teachers per capita on age at death. Missing teachers are defined at the birth county level. Death age and birth county come from individual-level Social Security death records in the BUNMD. Regressions are weighted by "complete case" weights. I include fixed effects for birth county and birth cohort, as well as controls for WWII government spending per capita interacted with birth cohort. The reference group is the 1922 birth cohort. Error bars represent 95% confidence intervals. Standard errors are clustered by birth county.

Table 4. Effect of Missing Teachers on Age at Death

	All		Men		Women	
	(1)	(2)	(3)	(4)	(5)	(6)
Standardized Missing Teachers						
$\times$ (Birth Year $\geq$ 1923)	-0.031***	-0.023***	-0.041***	-0.016**	-0.025***	-0.026***
	(0.008)	(0.006)	(0.012)	(0.007)	(0.007)	(0.006)
Observations	14,561,324	14,561,324	7,514,223	7,514,223	7,047,101	7,047,101
R^2	0.505	0.505	0.483	0.483	0.522	0.522
Dependent variable mean	76.0	76.0	75.3	75.3	76.7	76.7
Birth County FE	✓	✓	✓	✓	✓	✓
Birth Cohort FE	✓	✓	✓	✓	✓	✓
Birth State $\times$ Birth Cohort FE		✓		✓		✓

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on age at death. Missing teachers are defined at the birth county level. Death age and birth county come from individual-level Social Security death records in the BUNMD. All regressions are weighted by "complete case" weights. All regressions include fixed effects for birth county and birth cohort, as well as controls for WWII government spending per capita interacted with birth cohort. Standard errors are clustered by birth county.

Figure 9. Relationship Between Missing Teachers and Share of Emergency Teachers, 1944-45



Notes: This figure shows the relationship between missing teachers per capita and the share of teachers holding an emergency license during the 1944-45 school year. Source: (National Education Association, 1946b).

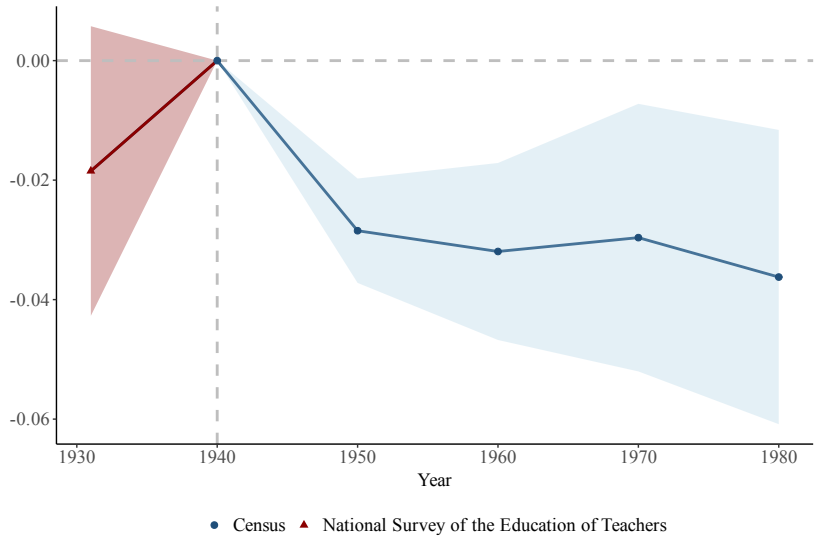
Table 5. Effects of Missing Teachers on Change in Teacher Composition
By State (1940-1950)

	Share Male		Share Married Women		2+ Years College		4+ Years College	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Missing Teachers	-0.015***	-0.015***	0.030***	0.030***	-0.024***	-0.025***	-0.022***	-0.023***
	(0.003)	(0.003)	(0.008)	(0.008)	(0.005)	(0.004)	(0.007)	(0.008)
Observations	48	48	48	48	48	48	48	48
R^2	0.443	0.477	0.338	0.363	0.291	0.341	0.171	0.226
Controls		✓		✓		✓		✓

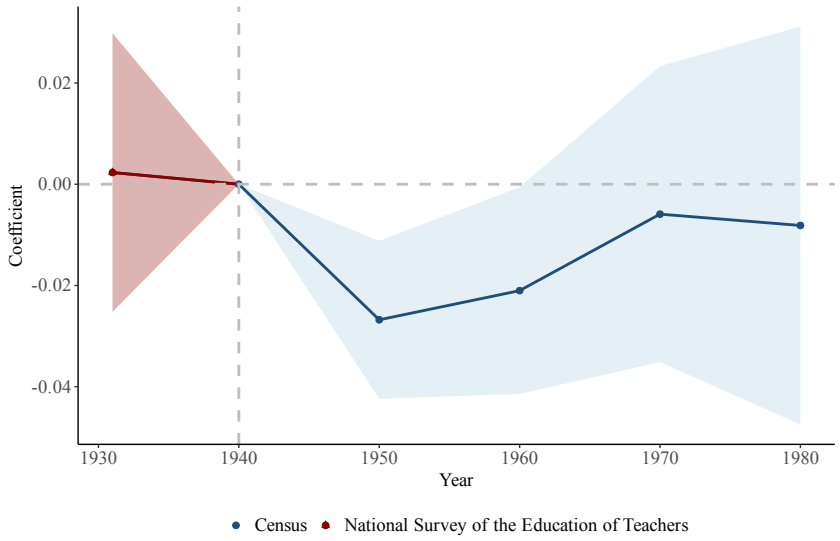
Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table shows the effect of a 1 SD increase in missing teachers per capita on changes in the characteristics of the teacher workforce from 1940 to 1950. Teacher characteristics are drawn from the complete count 1940 and 1950 census. Odd-numbered columns present bivariate relationships, and even-numbered columns add controls for the state's wartime mobilization rate of men and government wartime spending per capita.

Figure 10. Effects of Missing Teachers on Educational Attainment of Teachers

(a) 2+ Years of College

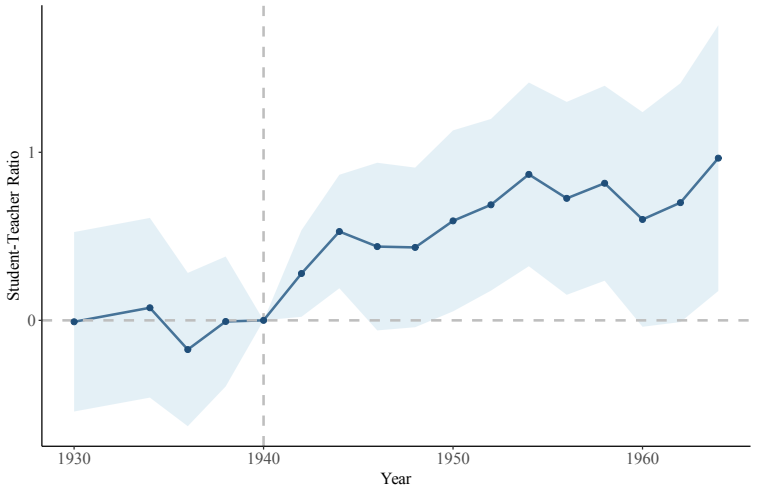


(b) 4+ Years of College



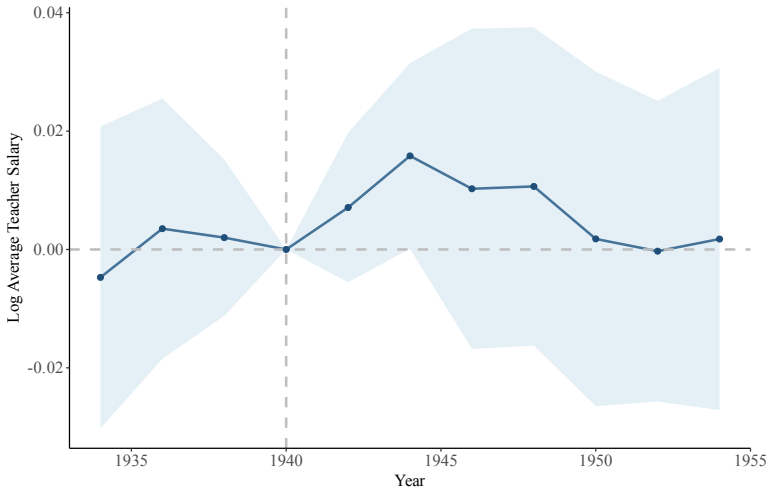
Notes: This figure shows the effect of a one standard deviation increase in missing teachers per capita during WWII on the share of teachers with at least two or four years of college education. Data from 1931 come from Evenden et al. (1935). The remaining data are from the 1940 and 1950 complete count census, and census samples in subsequent years. Error bars represent 95% confidence intervals.

Figure 11. Effect of Missing Teachers on Student-Teacher Ratio



Notes: This figure shows the event study estimates from Equation 6 of the effect of a one standard deviation increase in missing teachers per capita on the student-teacher in average daily attendance. I include state and year fixed effects, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. The reference year is 1940. The shaded area represents 95% confidence intervals. Standard errors are clustered by state.

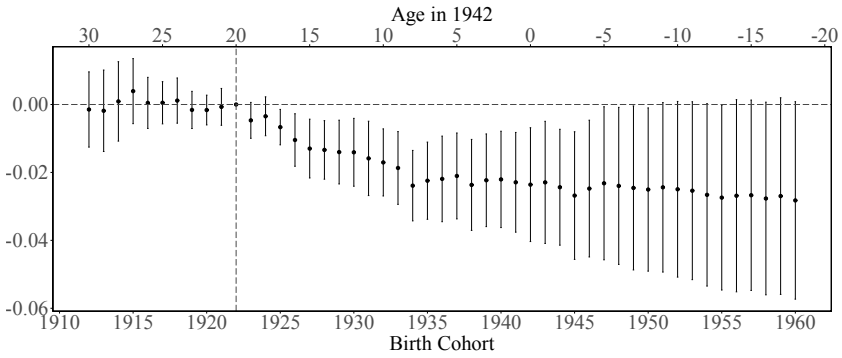
Figure 12. Effect of Missing Teachers on Log Average Teacher Salary



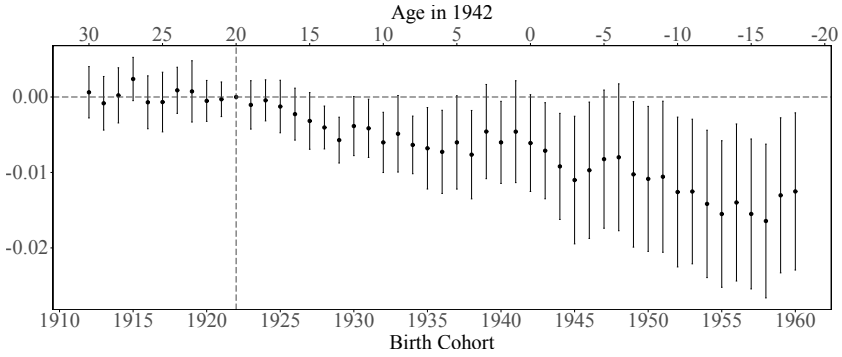
Notes: This figure shows the event study estimates from Equation 6 of the effect of a one standard deviation increase in missing teachers per capita on the log average teacher salaries. I include state and year fixed effects, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. The reference year is 1940. The shaded area represents 95% confidence intervals. Standard errors are clustered by state.

Figure 13. Effects of Missing Teachers on Education and Wages Through the 1960 Birth Cohort

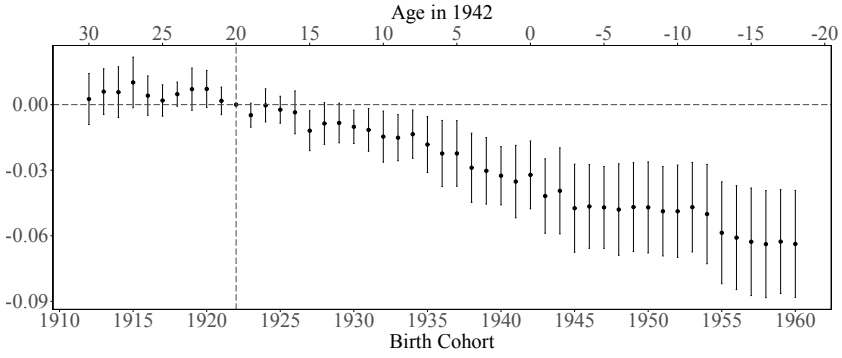
(a) High School Completion



(b) College Completion



(c) Log Weekly Wage



Notes: This figure shows the event study estimates from Equation 3 of the effect of a one standard deviation increase in missing teachers per capita on high school graduation, four-year college graduation, and log weekly wages through the 1960 birth cohort. The regression sample includes individuals aged 25-64 with non-missing education. All regressions are weighted by person weights. I pool census years 1940-2020. All regressions include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. The reference group is the 1922 birth cohort. Error bars represent 95% confidence intervals. Standard errors are clustered by birth state.

Table 6. Effects of Missing Teachers on Change in Teacher Composition
By State Economic Area (1940-1950)

	Share Male		Share Married Women		2+ Years College		4+ Years College	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Missing Teachers	-0.016***	-0.016***	0.014***	0.012***	-0.014***	-0.009***	-0.007**	-0.003
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Observations	462	462	462	462	462	462	462	462
R^2	0.209	0.390	0.065	0.504	0.050	0.483	0.009	0.440
State FE		✓		✓		✓		✓

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table shows the relationship between missing teachers per capita and changes in the characteristics of the teacher workforce from 1940 to 1950. Missing teachers are defined at the state economic area level. Teacher characteristics are drawn from the complete count 1940 and 1950 census. Even numbered columns add a state fixed effect.

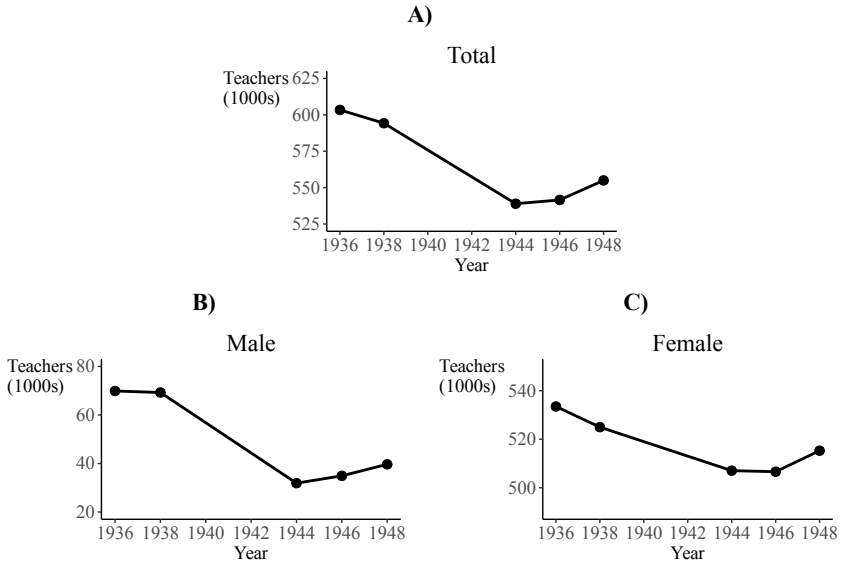
Table 7. Effects of Missing Teachers on State Growth in Education, Wages, Skills, and TFP (1940-2000)

	Δ Education (1)	Δ Log Wage (2)	Δ Skill (3)	Δ TFP (4)
Missing Teachers	-0.360***	-0.082***	-0.010*	-0.038**
	(0.105)	(0.026)	(0.005)	(0.018)
Observations	48	48	48	48
R^2	0.232	0.154	0.052	0.072

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. These figures show the relationship between a one standard deviation increase in missing teachers per capita and the growth in various state outcomes from 1940-2000. All outcomes are based on individual-level census data. I follow the approach in Lange and Topel (2006) to define skill (based on birth state and cohort) and TFP (based on a state-year fixed effect). See Lange and Topel (2006) for details. Education is defined as average years of education in the state. Skill and TFP can be interpreted in percentage terms.

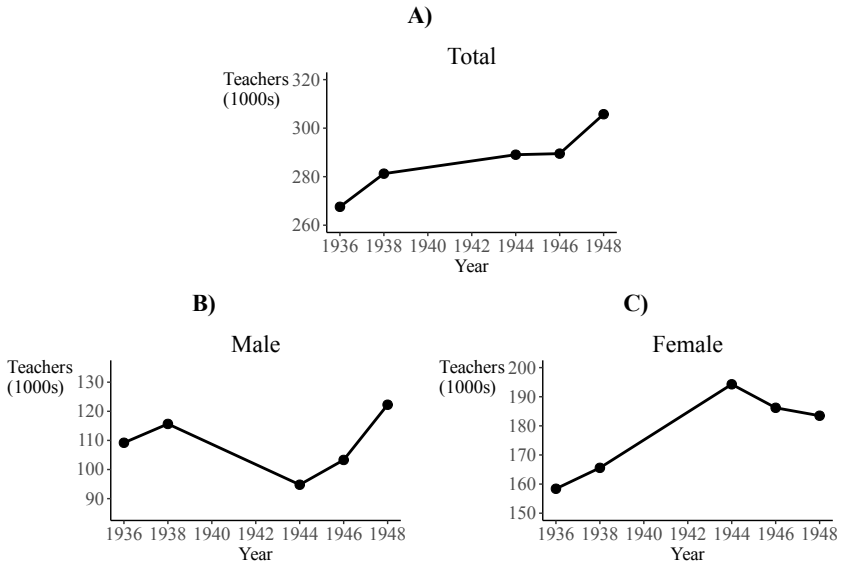
A Appendix Figures and Tables

Figure A1. Public Elementary School Teachers



Source: Biennial Survey of Education in the United States (U.S. Office of Education, n.d.)

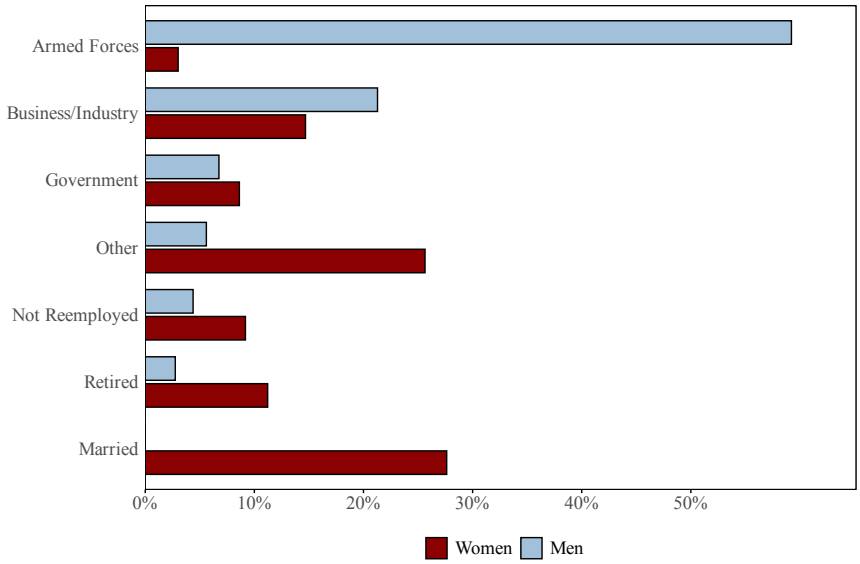
Figure A2. Public Secondary School Teachers



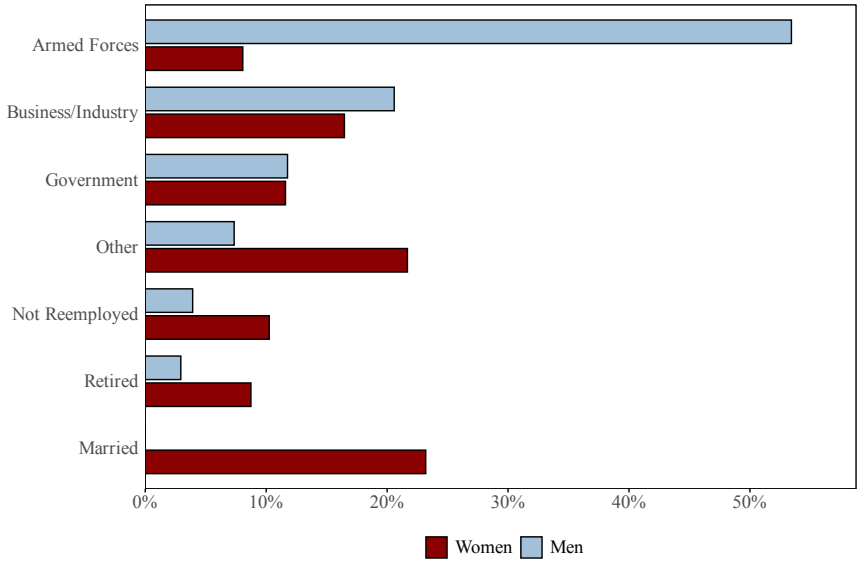
Source: Biennial Survey of Education in the United States (U.S. Office of Education, n.d.)

Figure A3. Reasons for Leaving Teaching

(a) End of 1941–42 School Year to Oct 15, 1942



(b) End of 1942–43 School Year to Oct 1, 1943

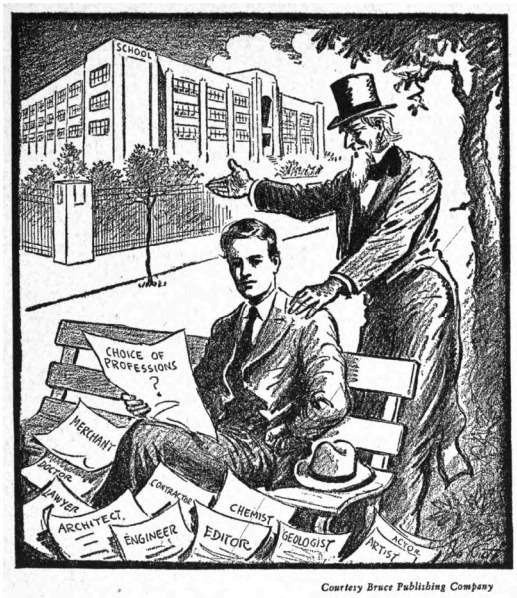


Notes: This figure shows the share of teachers who left the profession for various reasons in two different school years. Shares for men and women are calculated separately and each add up to one. Data for panel (a) come from an Office of Education survey of 448 school systems (US Office of Education, 1943b). Data for panel (b) come from an Office of Education survey of 1,390 school systems (Foster, 1944b).

Figure A4. Advertisements from Ohio Governor's Office to High School Students

Courtesy Bruce Publishing Company

A VACANT CHAIR THAT MUST BE FILLED



Courtesy Bruce Publishing Company

SEVERAL REASONS WHY YOU MAY WANT TO CONSIDER TEACHING AS A PROFESSION.

Teachers are in demand.
Teachers will be in demand after the war.
Teaching is an essential and patriotic service.
Teaching is an enjoyable service.
Teaching is becoming more highly regarded and better rewarded.
Opportunities to train for teaching were never better.
Opportunities in many fields may be limited after the war.

Source: Bowers (1944)

Figure A5. Advertisement from Pennsylvania Department of Instruction to High School Students

ENLIST IN THE FORCES OF EDUCATION

Shortage of Teachers

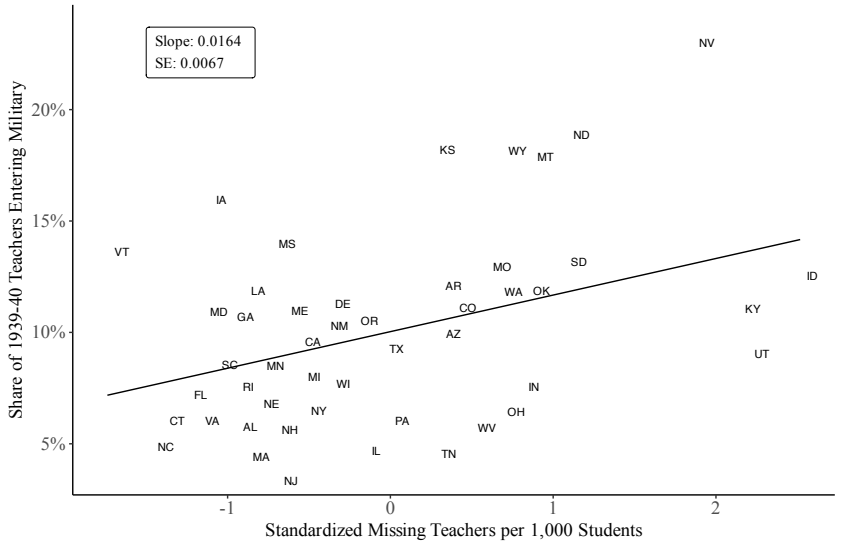
STUART CHASE, in the October, 1942, issue of *Harpers Magazine*, says we will need 400,000 more teachers if the schools are to play their proper part in the life of the nation. In Pennsylvania alone not less than 4,000 too few teachers for both the high and elementary schools is anticipated. The rapidly rising birthrate will result in a demand for additional teachers four years hence. Competent authorities view with alarm this situation. It is absolutely essential that an adequate number of able and intelligent young people with a desire to render a worthy social service should begin at once to prepare themselves for teaching.

Why Not Be a Teacher?

The teaching profession is everywhere recognized as essential to the preservation and development of our heritage of freedom and our destiny as a nation. Many college students and graduates will undoubtedly find a place in the armed forces and in the immediate war effort. On the other hand, the perpetuity of the nation demands that a reasonable percentage of college-trained people must be selected for service in the educational forces to lead and to teach the children and youth of America the American Way of Life. If you have the quality of mind and of heart for such leadership, why not enlist as a teacher in the educational branch of the national service?

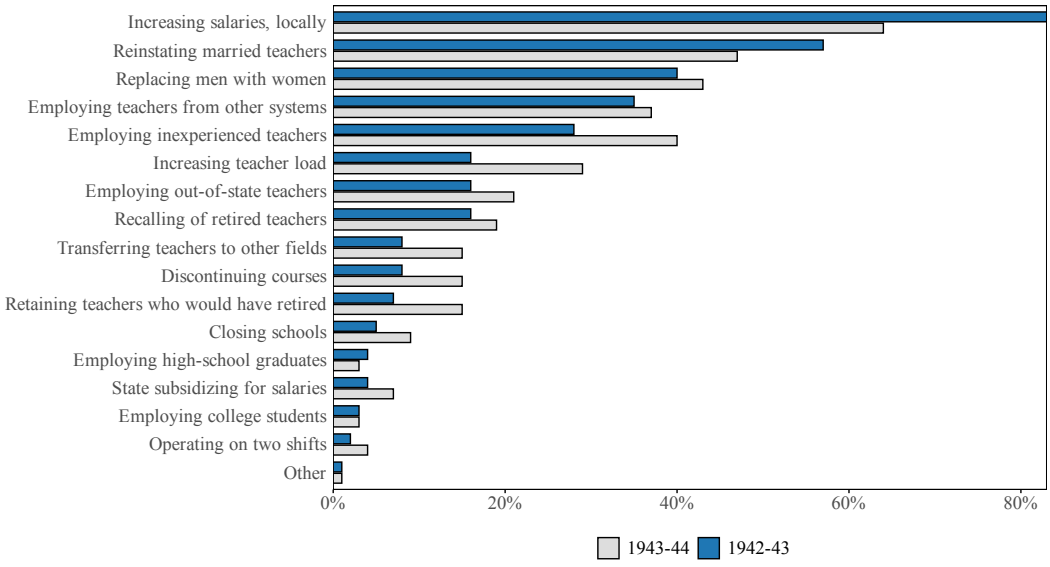
Source: Pennsylvania Department of Public Instruction (1943)

Figure A6. Correlation Between Missing Teachers and Teachers Leaving for Military



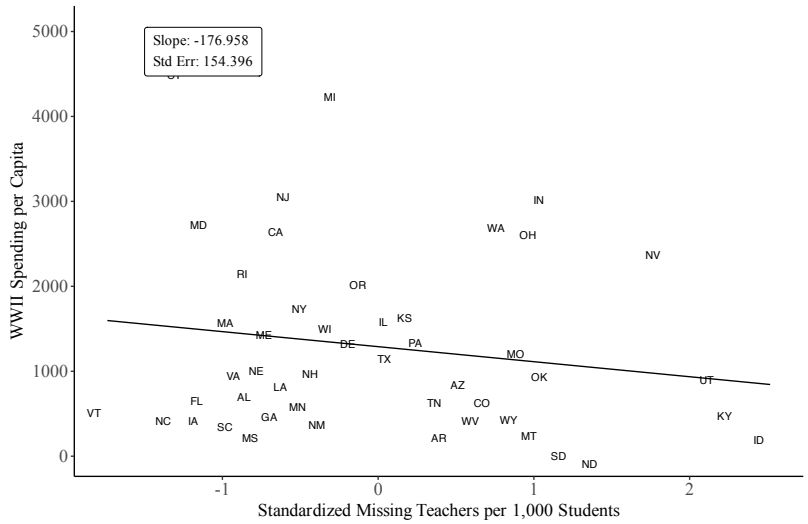
This figure shows the relationship between missing teachers and the share of 1939-40 teachers estimated to have left the profession for the military by the 1944-45 school year. National Education Association (1946b) reports estimates for the number of teachers in each state who have left for the military. I divide these counts by the total number of teachers in each state in 1939-40.

Figure A7. Methods Used by 1,389 Systems to Address Teacher Shortages



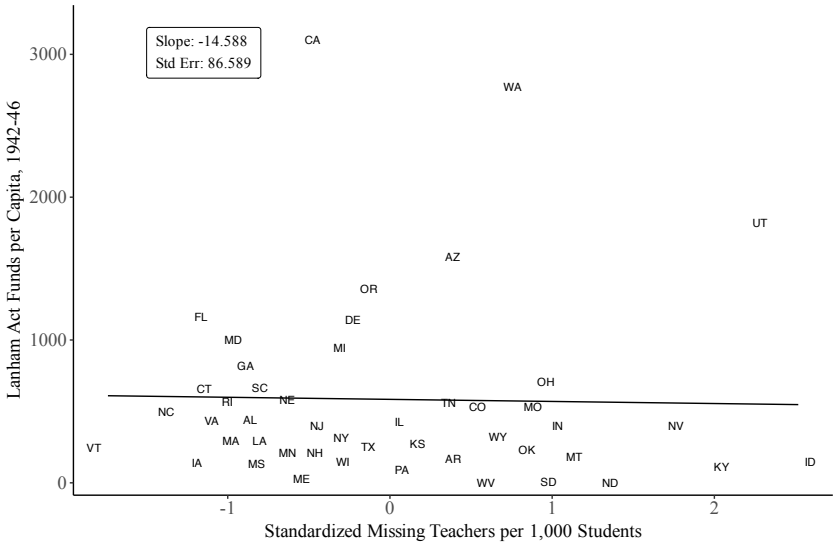
Notes: This figure shows the various methods used by school superintendents to address the teacher shortage crisis. Data come from an Office of Education survey (Foster, 1944b).

Figure A8. Correlation Between Missing Teachers and WWII Spending



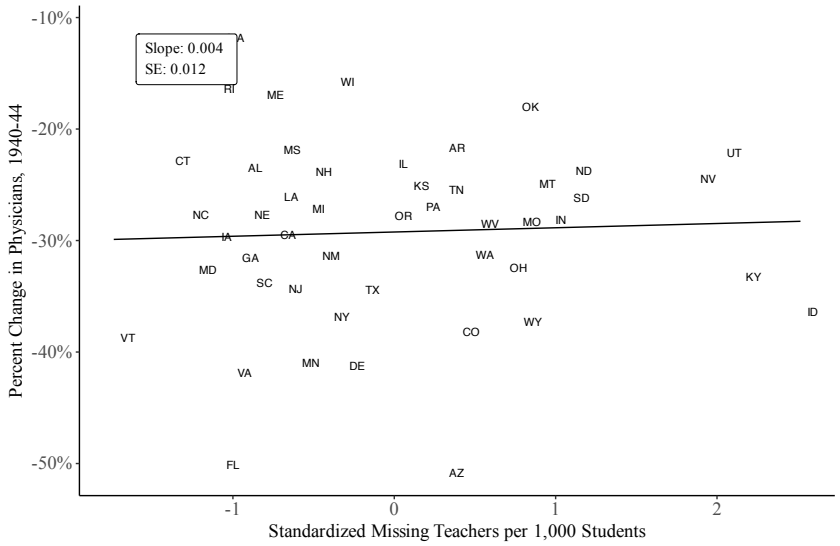
This figure shows the relationship between missing teachers per capita and WWII government spending per capita. I define spending as the sum of major war supply contracts and major war facilities projects as defined in the 1947 County Data Book and accessed through Haines (2005). I divide this spending by each state's 1940 population.

Figure A9. Correlation Between Missing Teachers and Lanham Act Spending



This figure shows the relationship between missing teachers per capita and funding for preschool programs through the Lanham Act (Goldin et al., 2025).

Figure A10. Correlation Between Missing Teachers and Percent Change in Physicians (1940-1944)



This figure shows the relationship between missing teachers per capita and the percent change in physicians from 1940 to 1944 (Lahey and Kaukonen, 1944).

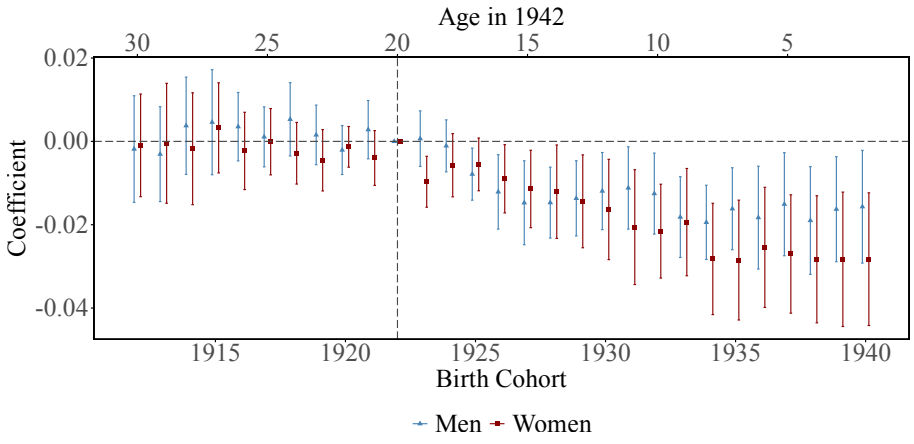
Table A1. Share of 17–20 Year Olds Enrolled in Secondary School (1940)

Age	Lower Bound	Upper Bound
(1)	(2)	(3)
17	53.8%	59.8%
18	23.1%	32.5%
19	7.8%	13.6%
20	2.6%	5.3%

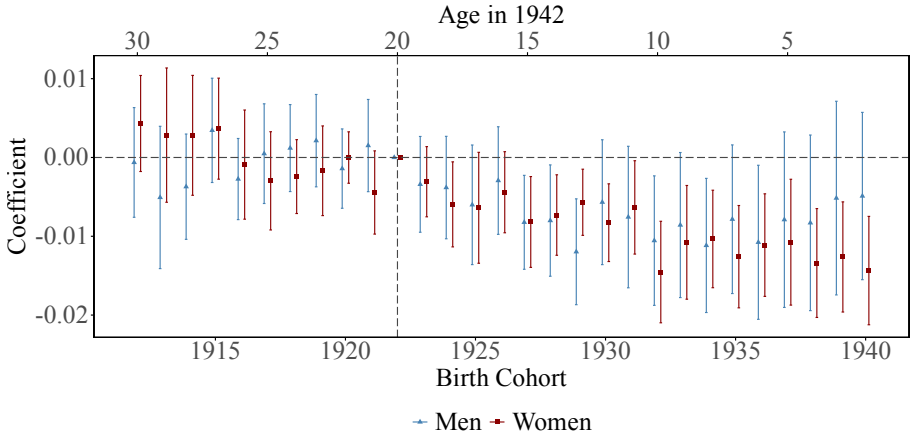
Notes: This table shows the share of 17–20 year olds enrolled in secondary school, according to the 1940 census. For each age, the census reports 1) the total number of individuals, 2) the total number attending school (including college), and 3) the highest level of education completed (U.S. Census Bureau, 1943). For an individual who is currently attending school and has completed four years of high school, it is unclear if they are currently attending college or if they are repeating a grade in high school. Column (2) assumes that all individuals attending school who have completed four years of high school are in college, thus reflecting a lower bound for the share still in secondary school. Column (3) assumes that all individuals attending school who have completed four years of high school are still in secondary school, representing an upper bound.

Figure A11. Effects of Missing Teachers on Educational Attainment

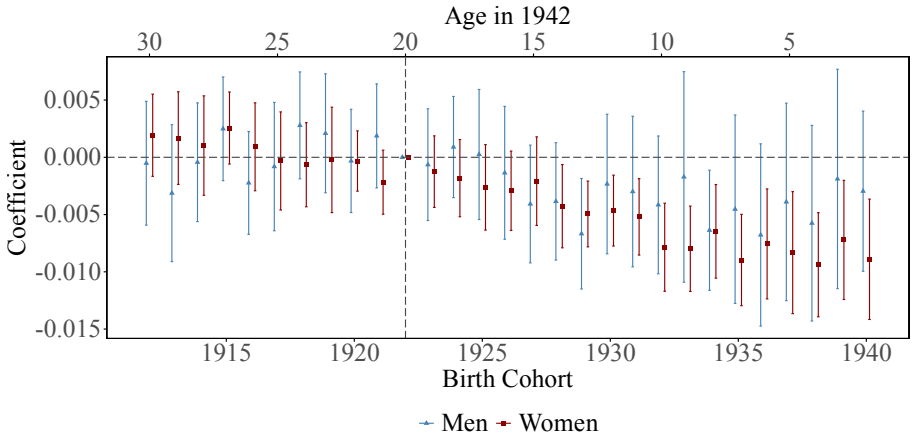
(a) High School Completion



(b) Some College



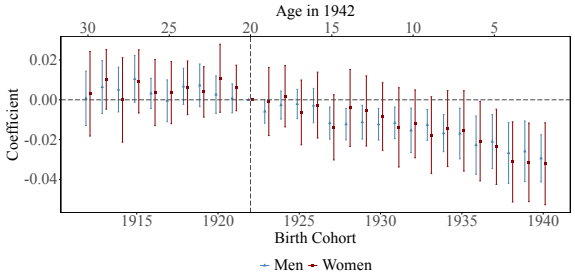
(c) College Completion



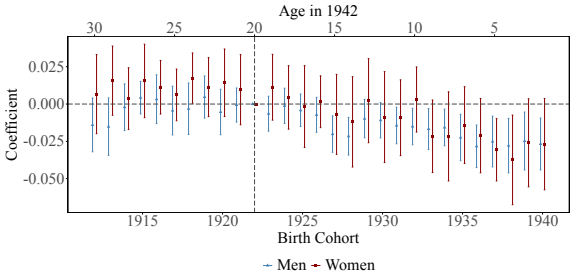
This figure shows the event study estimates from Equation 3 of the effect of a one standard deviation increase in missing teachers per capita on education outcomes, separately by sex. See the notes to Figure 6.

Figure A12. Effects of Missing Teachers on Labor Market Outcomes By Sex

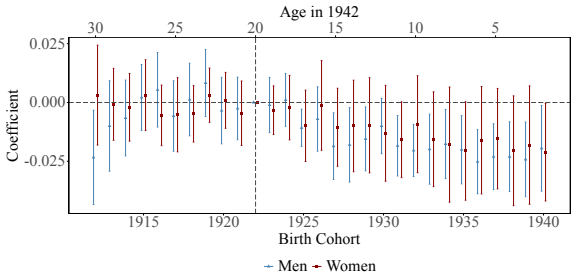
(a) Log Weekly Wage



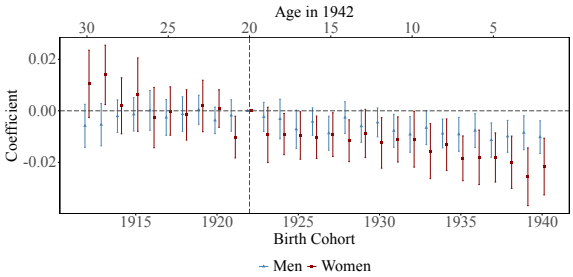
(b) Log Total Income



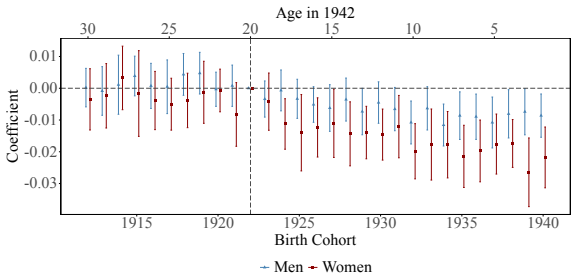
(c) Log Share of Poverty Level



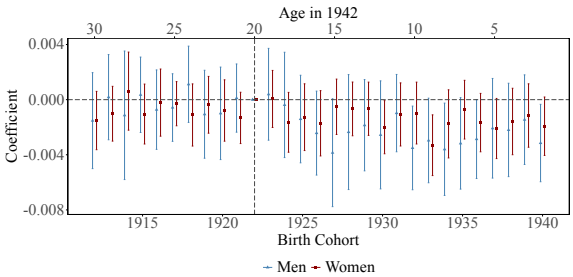
(d) Log Occupation Score



(e) High-Skill Occupation

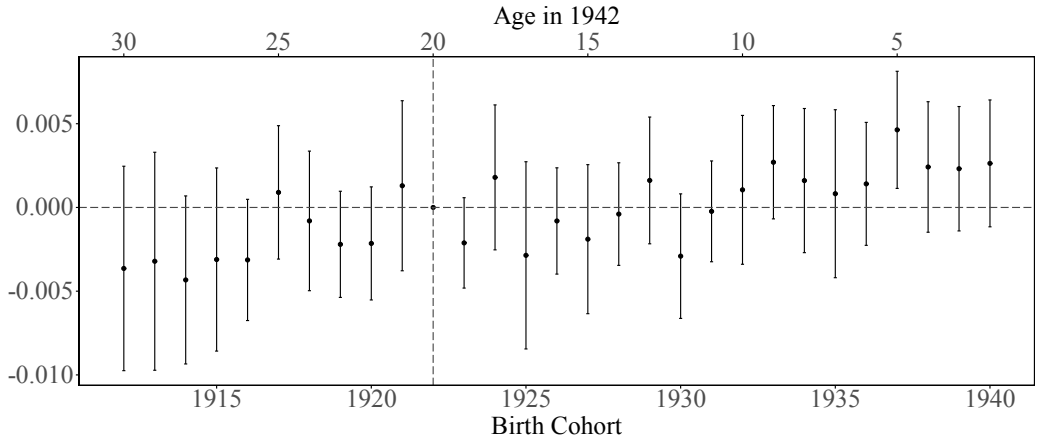


(f) STEM Occupation



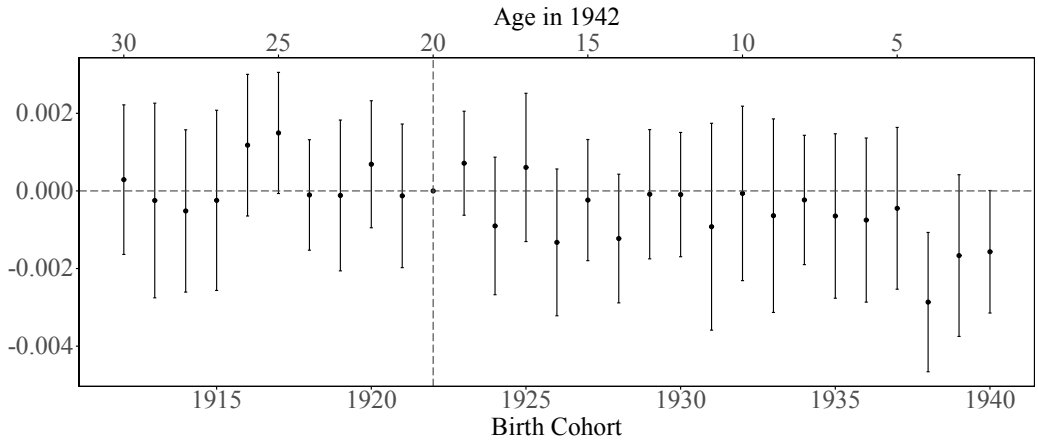
Notes: This figure shows the event study estimates from Equation 3 of the effect of a one standard deviation increase in missing teachers per capita on income and occupation outcomes, separately by sex. See the notes to Figure 7.

Figure A13. Effect of Teacher Shortages on Labor Force Participation



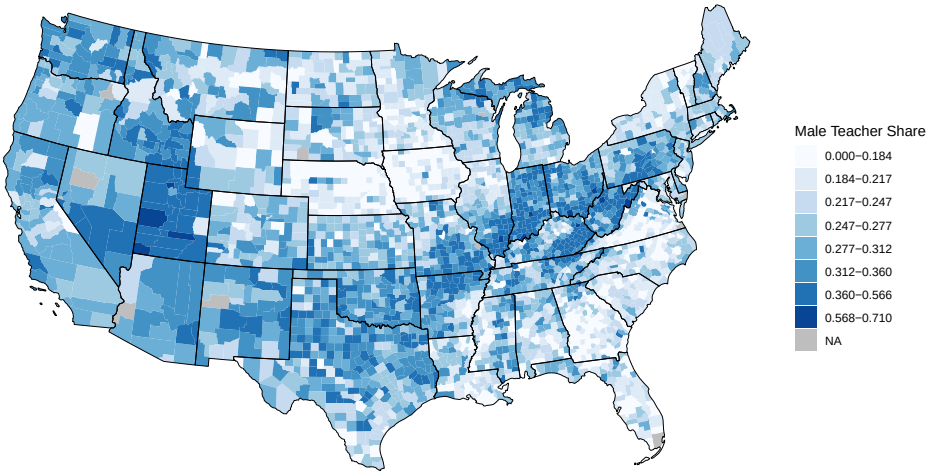
Notes: This figure shows the event study estimates from Equation 3 of the effect of a one standard deviation increase in missing teachers per capita on labor force participation for individuals aged 25-64. Regressions are weighted by person weights. I pool census years 1940-2020. I include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. The reference group is the 1922 birth cohort. Error bars represent 95% confidence intervals. Standard errors are clustered by birth state.

Figure A14. Effect of Teacher Shortages on Employment



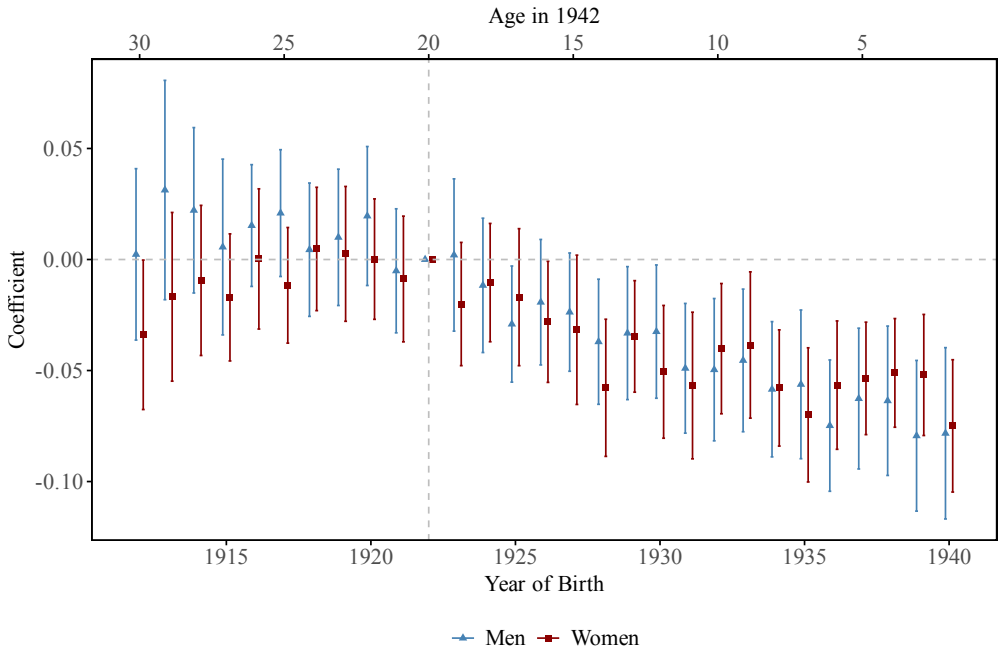
Notes: This figure shows the event study estimates from Equation 3 of the effect of a one standard deviation increase in missing teachers per capita on employment for individuals aged 25-64 in the labor force. Regressions are weighted by person weights. I pool census years 1940-2020. I include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. The reference group is the 1922 birth cohort. Error bars represent 95% confidence intervals. Standard errors are clustered by birth state.

Figure A15. Pre-War (1940) Variation in Male Teacher Shares



Notes: This figure shows the share of male teachers at the county level from the complete count 1940 census.

Figure A16. Effects of Missing Teachers on Lifespan



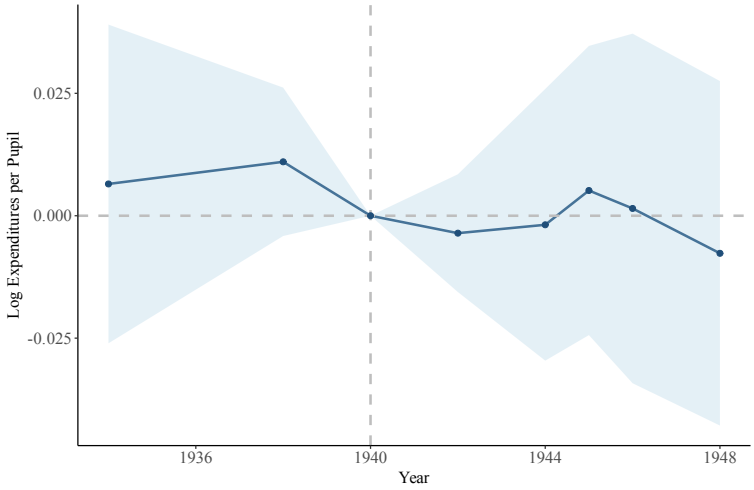
Notes: This figure shows the event study estimates from Equation 3 of the effect of a one standard deviation increase in missing teachers per capita on age at death. Missing teachers are defined at the birth county level. Death age and birth county come from individual-level Social Security death records in the BUNMD. Regressions are weighted by "complete case" weights. I include fixed effects for birth county and birth cohort, as well as controls for WWII government spending per capita interacted with birth cohort. The reference group is the 1922 birth cohort. Error bars represent 95% confidence intervals. Standard errors are clustered by birth county.

Table A2. Effect of 1 SD Increase in Missing Teachers per Capita on Age at Death

	All		Men		Women	
	(1)	(2)	(3)	(4)	(5)	(6)
Standardized Missing Teachers						
$\times$ (Birth Year $\geq$ 1923)	-0.036***	-0.019***	-0.044***	-0.012**	-0.033***	-0.021***
	(0.008)	(0.005)	(0.011)	(0.006)	(0.007)	(0.006)
Observations	14,561,324	14,561,324	7,514,223	7,514,223	7,047,101	7,047,101
R^2	0.553	0.553	0.535	0.535	0.565	0.565
Dependent variable mean	76.0	76.0	75.3	75.3	76.7	76.7
Birth County FE	✓	✓	✓	✓	✓	✓
Birth Cohort FE	✓	✓	✓	✓	✓	✓
Death Region FE	✓	✓	✓	✓	✓	✓
Birth State $\times$ Birth Cohort FE		✓		✓		✓

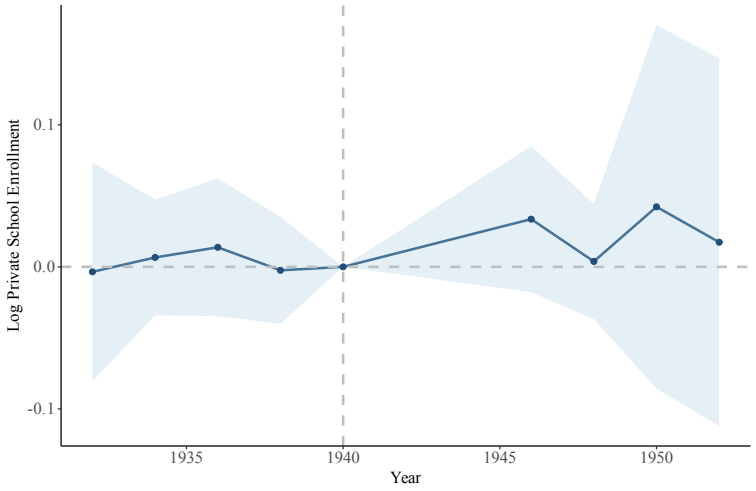
Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on age at death. Missing teachers are defined at the birth county level. Death age and birth county come from individual-level Social Security death records in the BUNMD. All regressions include fixed effects for birth county, birth cohort, and death region, as well as controls for WWII government spending per capita interacted with birth cohort. Standard errors are clustered by birth county.

Figure A17. Effect of Missing Teachers on Log Per-Pupil Expenditures



Notes: This figure shows the event study estimates from Equation 6 of the effect of a one standard deviation increase in missing teachers per capita on log expenditures per pupil in average daily attendance. I include state and year fixed effects, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. The reference year is 1940. Error bars represent 95% confidence intervals. Standard errors are clustered by state.

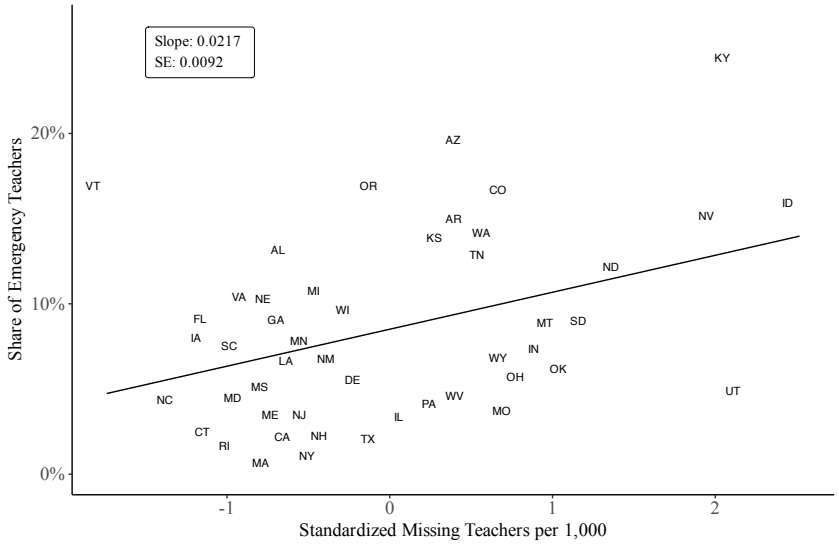
Figure A18. Effect of Missing Teachers on Private School Enrollment



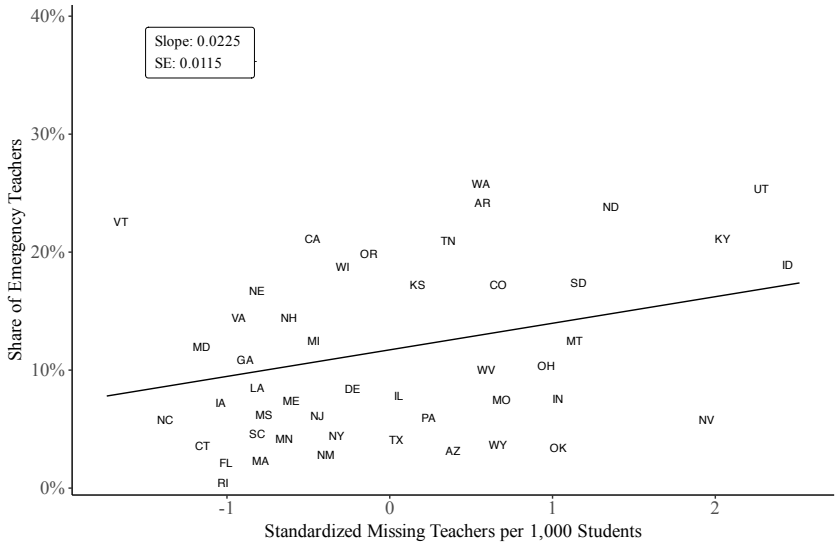
Notes: This figure shows the event study estimates from Equation 6 of the effect of a one standard deviation increase in missing teachers per capita on log private school enrollment. I include state and year fixed effects, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. The reference year is 1940. Error bars represent 95% confidence intervals. Standard errors are clustered by state.

Figure A19. Relationship Between Missing Teachers and Share of Emergency Teachers

(a) 1943-1944

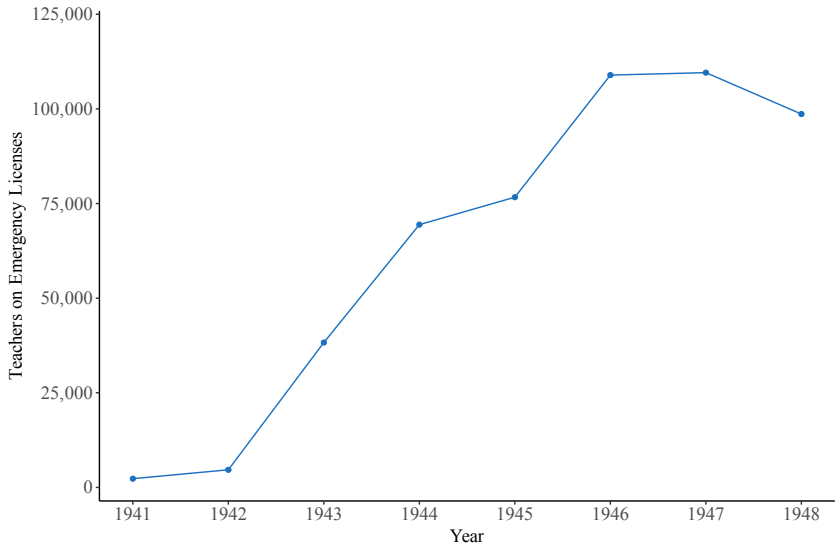


(b) 1948-1949



Notes: This figure shows the relationship between missing teachers per capita and the share of teachers holding an emergency license in each state. 1943-44 data are from United States Congress Senate Committee on Education and Labor (1945) and 1948-49 data are from National Education Association (1949).

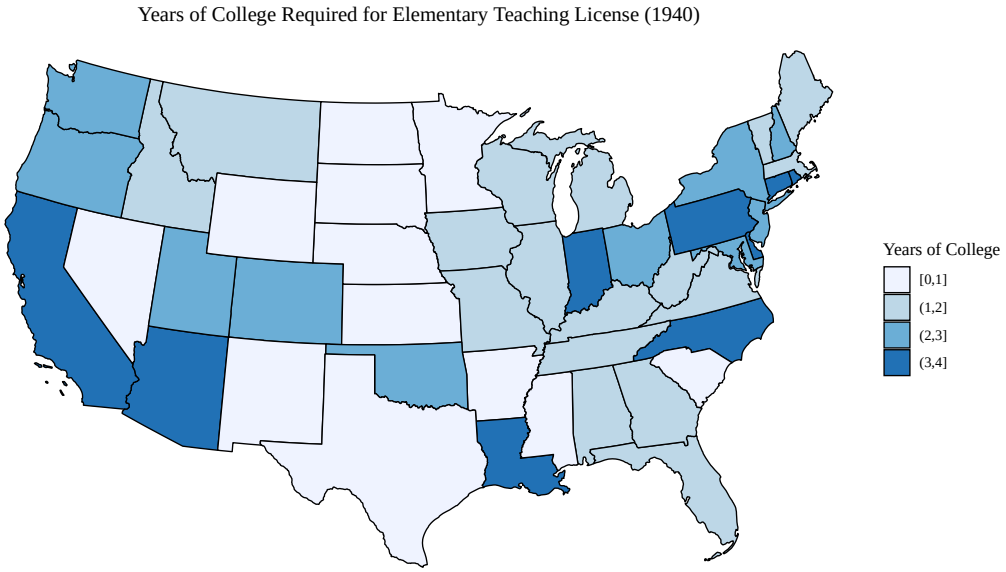
Figure A20. Teachers Holding Emergency Licenses by Year



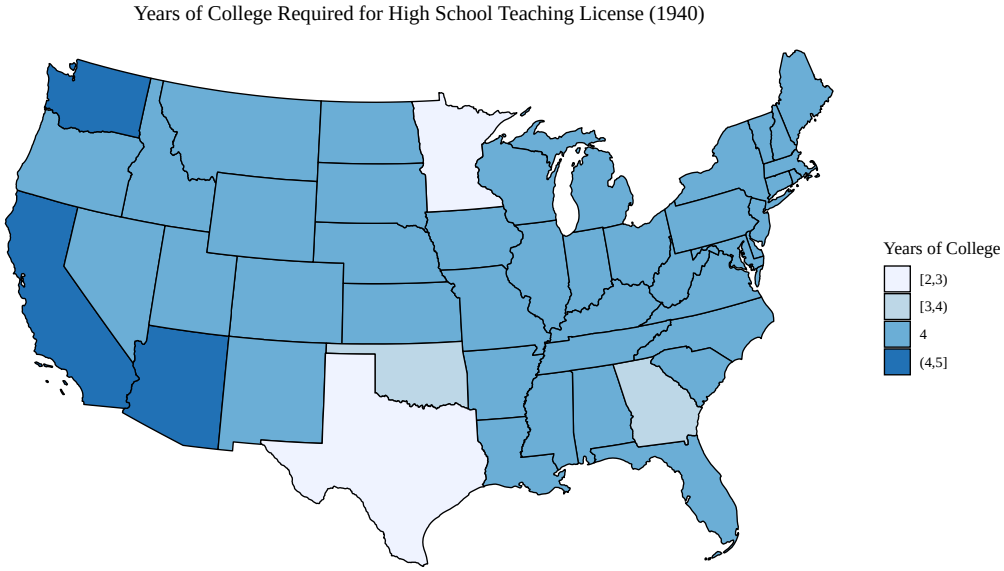
Notes: This figure shows the total number of emergency teachers across years. Source: Foster and United States (1949).

Figure A21. Minimum Requirements for Teaching Licenses (1940)

(a) Elementary School



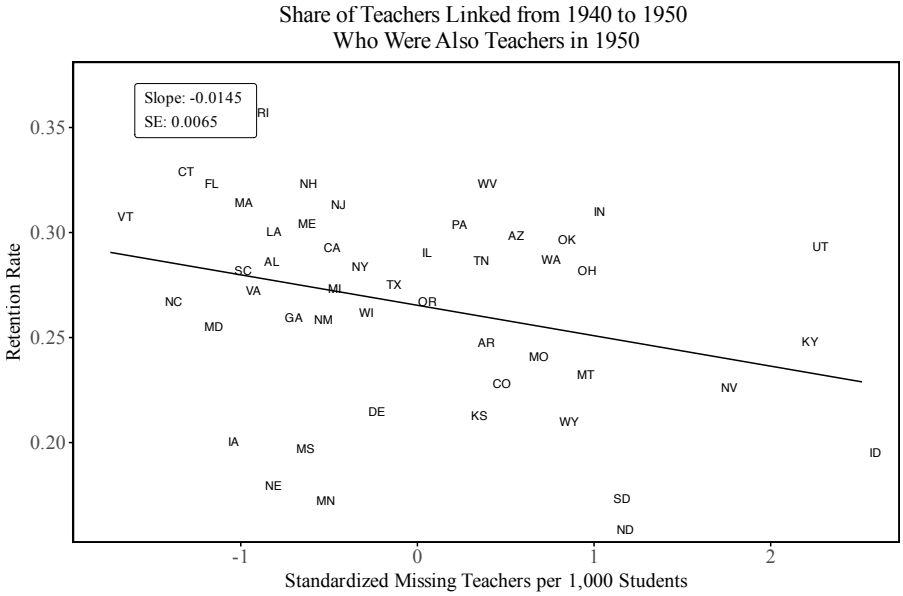
(b) High School



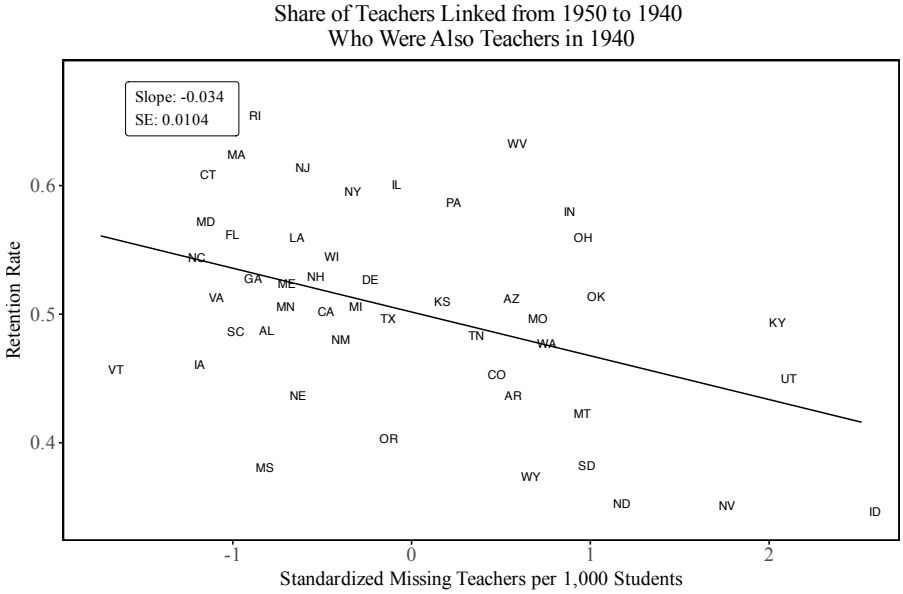
Notes: This figure shows the years of postsecondary education required for a standard elementary or high school teaching license in each state. Source: Frazier (1940).

Figure A22. Effect of Missing Teachers on Teacher Retention

(a) 1940–1950



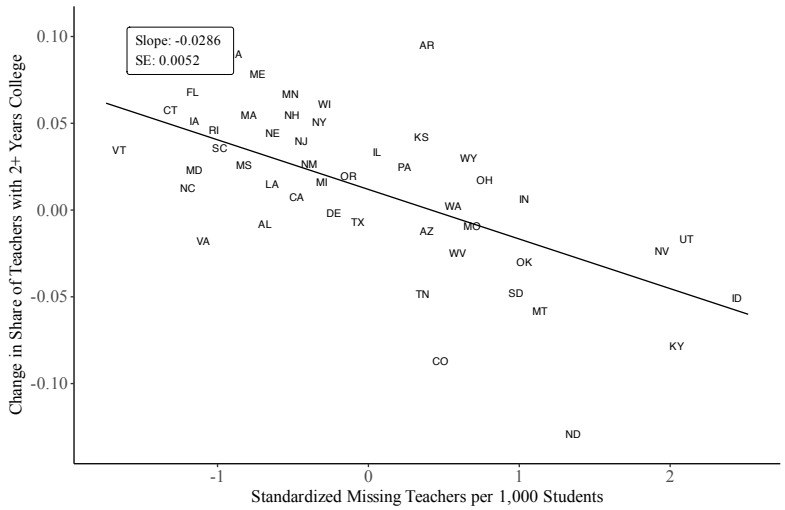
(b) 1950–1940



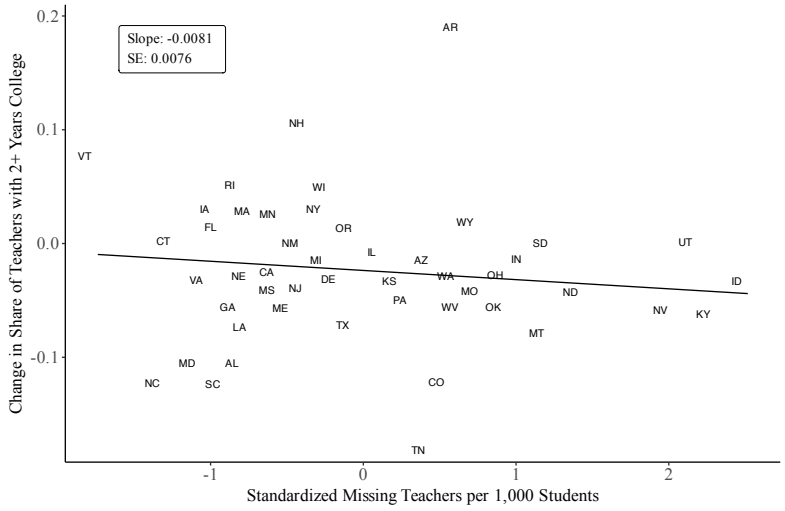
Notes: This figure shows the relationship between missing teachers per capita and the share of linked teachers from 1940 who remained teachers in 1950 (Panel (a)). Panel (b) shows the share of teachers linked from 1950 who were also teachers in 1940. I restrict to teachers aged 20–54 when linking 1940 teachers forward to 1950. I restrict to teachers aged 30-64 when linking 1950 teachers back to 1940. Links are based on IPUMS MLP links.

Figure A23. Relationship Between Missing Teachers and Change in Share of Teachers with at Least Two Years of College Education, 1940-1950

(a) Women



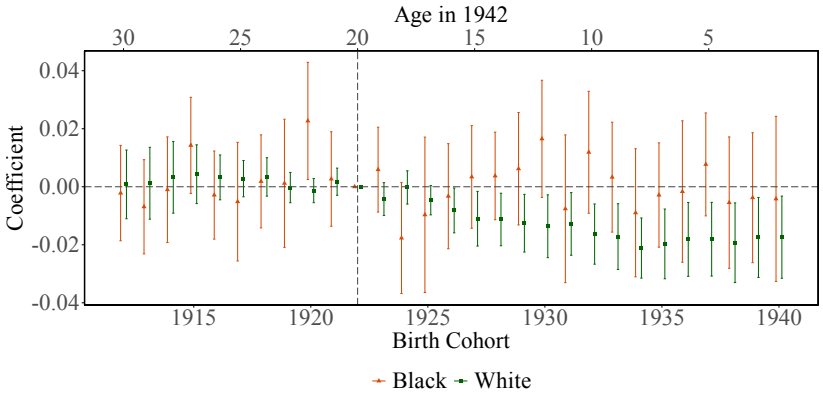
(b) Men



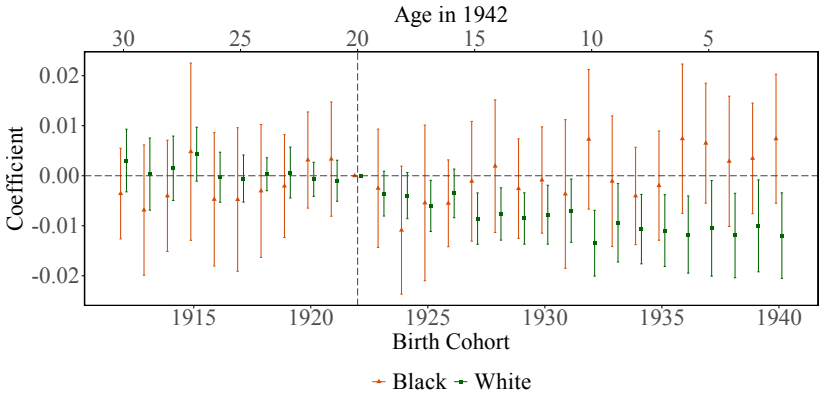
Notes: This figure shows the relationship between missing teachers during the war and the change in the share of teachers with at least two years of college education from 1940-1950, separately by sex. Data are from the complete count 1940 and 1950 census.

Figure A24. Effects of Missing Teachers on Educational Attainment By Race

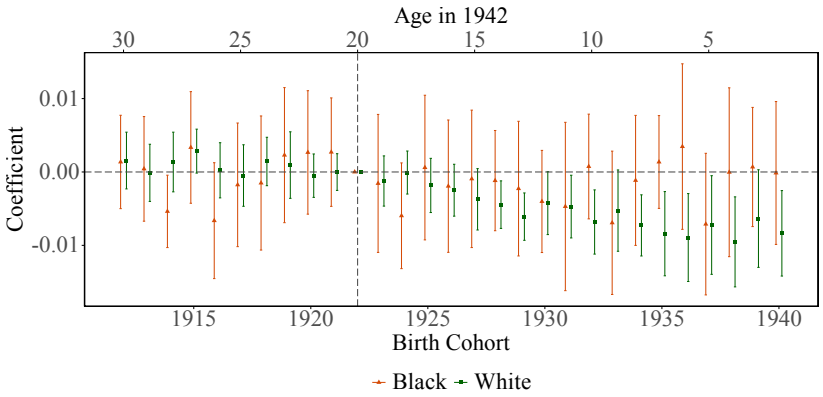
(a) High School Completion



(b) Some College

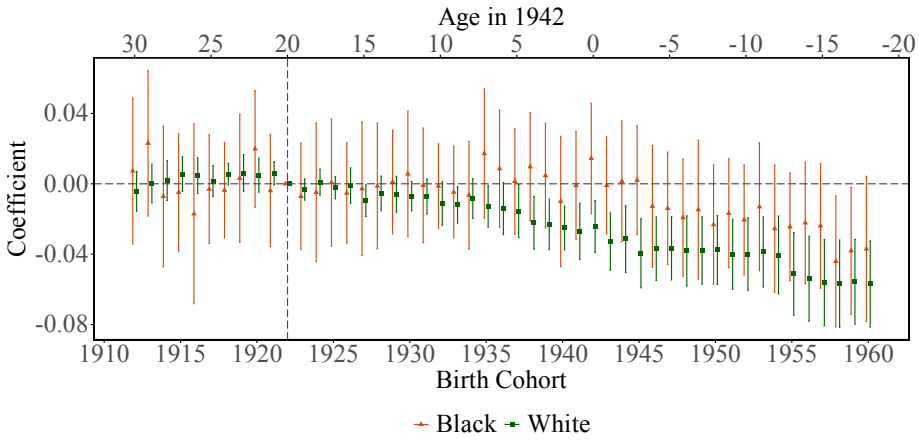


(c) College Completion



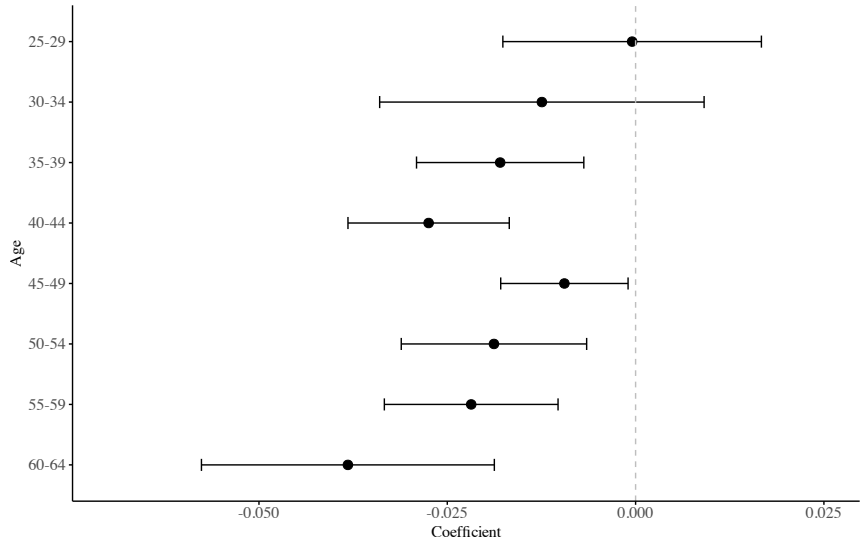
Notes: This figure shows the effect of a one standard deviation increase in missing teachers per capita on high school and college graduation, separately by race. See Notes to Figure 6 for details.

Figure A25. Effects of Missing Teachers on Log Weekly Wage By Race



Notes: This figure shows the effect of a one standard deviation increase in missing teachers per capita on log weekly wages, separately by race. See Notes to Figure 7 for details.

Figure A26. Effects of Missing Teachers on Log Weekly Wage Over the Life Cycle



Notes: This figure reports the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on log weekly wage, separately for various age bins. Error bars represent 95% confidence intervals. Standard errors are clustered by birth state. See Table 2 notes for details.

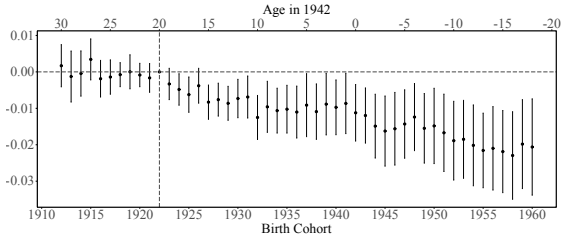
Table A3. Share of My Results Explained by Increase in Student-Teacher Ratio According To Estimates from Chetty et al. (2011)

	Linear (1)	Percentage (2)
Some College	29%	28%
Wages	33%	32%

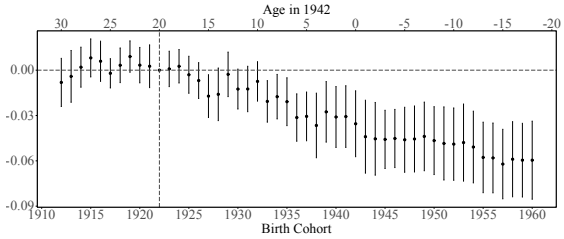
Notes: This table estimates the share of my overall DD results on college attendance and wages through the 1940 birth cohort that can plausibly be explained by larger class sizes. Relative to pre-war years, a one standard deviation in missing teachers increases class size by 0.62 students, or 2.6%, between 1942 and 1960 (and the 1940 cohort should have finished their education by 1960). I use parameters from Chetty et al (2011). to estimate how the increase in class size I find is predicted to affect long-run outcomes for students. Chetty et al. (2011) show the effects of the Tennessee STAR class size experiment on student outcomes, finding that find that being assigned to a small class (15.1 students on average) vs. regular class (22.6 students on average) is associated with a 1.57 pp increase in college attendance, relative to a baseline mean of 45.5%. These results show the effect of a 7.5 student or 33% decrease in class size. The effect is 1.57 / 45.5 = 3.45% of the baseline mean. Students assigned to a small class were in a small class for 2.14 years on average. Based on this study, how would we expect a 2.6% increase in class size for 7.08 years of exposure to affect college attendance? According to Chetty et al. (2011), a 33% increase in class size for 2.14 years reduces college attendance by 3.45%. I only find a 2.6% increase in class size, so I divide their 3.45% effect by 33 / 2.4 for an effect size of 0.27%. But I want to measure this effect over 7.08 years of exposure, not 2.14 years, so I scale the resulting number up by 7.08 / 2.14 years, resulting in an overall effect of a 0.89% decrease in college attendance. I find a negative effect of 3.21% on some college, so the 0.89% calculated here represents only about 28% of my overall effect. The calculation described in the paragraph above corresponds to the "Percentage" columns in table A3 which considers the percent change in class size. The "Linear" column performs a similar calculation but based on the actual number of students (e.g., the effects of a 7.5 student increase in class size in Chetty et al. (2011)).

Figure A27. Effects of Missing Teachers on Labor Market Outcomes Through the 1960 Birth Cohort

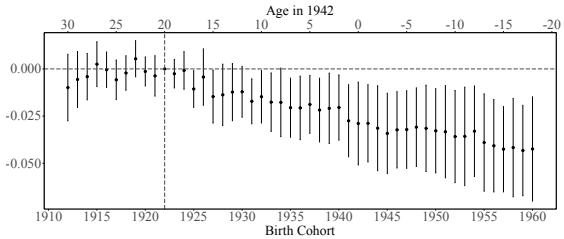
(a) Some College



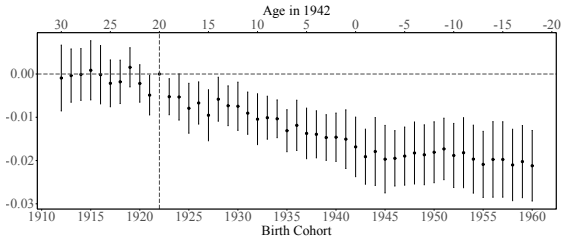
(b) Log Total Income



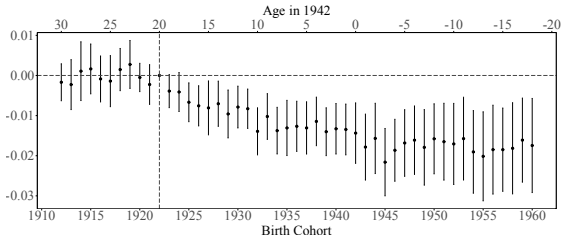
(c) Log Share of Poverty Level



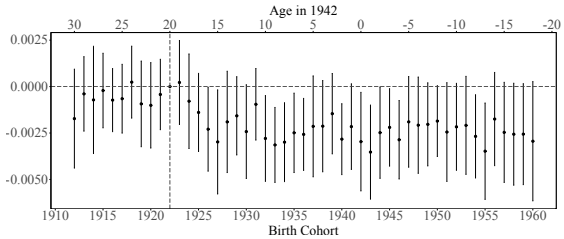
(d) Log Occupation Score



(e) High-Skill Occupation



(f) STEM Occupation



Notes: This figure shows the event study estimates from Equation 3 of the effect of a one standard deviation increase in missing teachers per capita on some college attendance, as well as income and occupation outcomes, through the 1960 birth cohort. The regression sample includes individuals aged 25-64 with non-missing outcomes. All regressions are weighted by person weights. For weekly wages, occupation score, and high-skill occupation, I restrict to employed workers who worked at least 40 weeks in the past year. For log weekly wages, individuals earning less than half the federal minimum wage are dropped and top-coded values are replaced with the top-coded value multiplied by 1.4. High-skill occupations are defined as those within the "Professional, Technical" and "Managers, Officials, and Proprietors" categories of 1950 occupation codes. I pool census years 1940-2020. All regressions include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. The reference group is the 1922 birth cohort. Error bars represent 95% confidence intervals. Standard errors are clustered by birth state.

Table A4. Effects of Missing Teachers on Education

	High School Grad			Some College			College Grad		
	$\leq$ 1940	$\leq$ 1960		$\leq$ 1940	$\leq$ 1960		$\leq$ 1940	$\leq$ 1960	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: All									
Missing Teachers									
× (Birth Year $\geq$ 1923)	-0.016***	-0.022***		-0.008**	-0.013***		-0.004**	-0.009**	
	(0.005)	(0.008)		(0.003)	(0.004)		(0.002)	(0.003)	
Missing Teachers									
× (Birth Year 1923–40)			-0.016***			-0.008***			-0.005**
			(0.005)			(0.003)			(0.002)
Missing Teachers									
× (Birth Year 1941–60)			-0.025**			-0.017***			-0.011**
			(0.011)			(0.005)			(0.004)
Dep. Var. Mean	0.634	0.812	0.812	0.227	0.400	0.400	0.111	0.197	0.197
Observations	8,443,549	21,660,043	21,660,007	8,443,549	21,660,043	21,660,007	8,443,549	21,660,043	21,660,007
Panel B: Female									
Missing Teachers									
× (Birth Year $\geq$ 1923)	-0.017***	-0.023**		-0.009***	-0.015***		-0.006***	-0.010***	
	(0.006)	(0.009)		(0.003)	(0.004)		(0.002)	(0.003)	
Missing Teachers									
× (Birth Year 1923–40)			-0.017***			-0.009***			-0.006***
			(0.006)			(0.003)			(0.002)
Missing Teachers									
× (Birth Year 1941–60)			-0.027**			-0.019***			-0.013***
			(0.012)			(0.005)			(0.005)
Dep. Var. Mean	0.645	0.816	0.816	0.191	0.375	0.375	0.082	0.175	0.175
Observations	4,370,852	11,146,792	11,146,792	4,370,852	11,146,792	11,146,792	4,370,852	11,146,792	11,146,792
Panel C: Male									
Missing Teachers									
× (Birth Year $\geq$ 1923)	-0.014***	-0.020***		-0.007*	-0.012***		-0.003	-0.007**	
	(0.005)	(0.007)		(0.004)	(0.004)		(0.003)	(0.003)	
Missing Teachers									
× (Birth Year 1923–40)			-0.015***			-0.007*			-0.004
			(0.005)			(0.004)			(0.003)
Missing Teachers									
× (Birth Year 1941–60)			-0.024**			-0.015***			-0.009**
			(0.010)			(0.005)			(0.004)
Dep. Var. Mean	0.620	0.807	0.807	0.269	0.427	0.427	0.145	0.220	0.220
Observations	4,072,697	10,513,251	10,513,251	4,072,697	10,513,251	10,513,251	4,072,697	10,513,251	10,513,251

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on high school completion, at least some college, and college completion. For each outcome, the first column restricts to birth cohorts 1912-1940, while the subsequent two columns restrict to cohorts 1912-1960. The regression sample includes individuals aged 25-64 with non-missing education. All regressions are weighted by person weights. I pool census years 1940-2020. All regressions include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. Standard errors are clustered by birth state.

Table A5. Effects of Missing Teachers on Income

	Log Weekly Wage			Log Total Income			Log Share of FPL		
	$\leq$ 1940	$\leq$ 1960		$\leq$ 1940	$\leq$ 1960		$\leq$ 1940	$\leq$ 1960	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: All									
Missing Teachers									
× (Birth Year $\geq$ 1923)	-0.019***	-0.042***		-0.018***	-0.039***		-0.012	-0.025**	
	(0.004)	(0.008)		(0.006)	(0.010)		(0.008)	(0.010)	
Missing Teachers									
× (Birth Year 1923–40)			-0.019***			-0.019***			-0.013
			(0.004)			(0.007)			(0.008)
Missing Teachers									
× (Birth Year 1941–60)			-0.055***			-0.052***			-0.033***
			(0.010)			(0.012)			(0.012)
Observations	3,587,649	10,738,554	10,103,209	6,823,072	18,855,538	18,855,505	8,307,320	21,403,679	21,403,643
Panel B: Female									
Missing Teachers									
× (Birth Year $\geq$ 1923)	-0.019***	-0.041***		-0.022**	-0.038***		-0.011	-0.025**	
	(0.005)	(0.007)		(0.009)	(0.007)		(0.008)	(0.011)	
Missing Teachers									
× (Birth Year 1923–40)			-0.020***			-0.023**			-0.011
			(0.005)			(0.009)			(0.009)
Missing Teachers									
× (Birth Year 1941–60)			-0.049***			-0.046***			-0.035**
			(0.008)			(0.007)			(0.013)
Observations	1,279,854	4,553,853	4,553,853	2,872,443	8,657,266	8,657,266	4,316,029	11,075,170	11,075,170
Panel C: Male									
Missing Teachers									
× (Birth Year $\geq$ 1923)	-0.018***	-0.036***		-0.014**	-0.029***		-0.013*	-0.024**	
	(0.004)	(0.008)		(0.006)	(0.010)		(0.007)	(0.010)	
Missing Teachers									
× (Birth Year 1923–40)			-0.018***			-0.014**			-0.014*
			(0.004)			(0.007)			(0.007)
Missing Teachers									
× (Birth Year 1941–60)			-0.048***			-0.040***			-0.031***
			(0.010)			(0.013)			(0.011)
Observations	2,307,795	6,184,701	6,184,701	3,950,629	10,198,272	10,198,272	3,991,291	10,328,509	10,328,509

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on various labor market outcomes. For each outcome, the first column restricts to birth cohorts 1912-1940, while the subsequent two columns restrict to cohorts 1912-1960. The regression sample includes individuals aged 25-64. For weekly wages and occupation score, I restrict to employed individuals who worked at least 40 weeks in the past year. For weekly wages, individuals earning less than half the federal minimum wage are dropped, and top-coded values are replaced with the top-coded value multiplied by 1.4. For total income, I restrict to those reporting any positive total income. Share of FPL refers to total family income as a percentage of the family's poverty threshold. I pool census years 1940-2020. Total income and poverty are only available starting in 1950. All regressions include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. Standard errors are clustered by birth state.

Table A6. Effects of Missing Teachers on Occupation

	Log Occ Score			High-Skill Occ			STEM Occ		
	$\leq$ 1940	$\leq$ 1960		$\leq$ 1940	$\leq$ 1960		$\leq$ 1940	$\leq$ 1960	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: All									
Missing Teachers									
× (Birth Year $\geq$ 1923)	-0.009***	-0.015***		-0.009***	-0.014***		-0.001***	-0.002***	
	(0.002)	(0.003)		(0.002)	(0.003)		(0.000)	(0.000)	
Missing Teachers									
× (Birth Year 1923–40)			-0.009***			-0.010***			-0.001***
			(0.002)			(0.002)			(0.000)
Missing Teachers									
× (Birth Year 1941–60)			-0.018***			-0.017***			-0.002***
			(0.004)			(0.004)			(0.001)
Dep. Var. Mean	3.306	3.321	3.321	0.272	0.355	0.355	0.036	0.040	0.040
Observations	4,614,460	13,175,846	13,173,841	4,614,460	13,175,846	13,175,831	4,614,460	13,175,846	13,175,831
Panel B: Female									
Missing Teachers									
× (Birth Year $\geq$ 1923)	-0.016***	-0.025***		-0.013***	-0.018***		-0.001**	-0.001*	
	(0.004)	(0.006)		(0.002)	(0.004)		(0.000)	(0.000)	
Missing Teachers									
× (Birth Year 1923–40)			-0.016***			-0.014***			-0.001***
			(0.004)			(0.002)			(0.000)
Missing Teachers									
× (Birth Year 1941–60)			-0.029***			-0.020***			-0.001
			(0.007)			(0.004)			(0.000)
Dep. Var. Mean	3.124	3.208	3.208	0.223	0.379	0.379	0.011	0.026	0.026
Observations	1,539,699	5,317,363	5,317,363	1,539,699	5,317,363	5,317,363	1,539,699	5,317,363	5,317,363
Panel C: Male									
Missing Teachers									
× (Birth Year $\geq$ 1923)	-0.005***	-0.008***		-0.008***	-0.012***		-0.002***	-0.002***	
	(0.002)	(0.002)		(0.002)	(0.002)		(0.001)	(0.001)	
Missing Teachers									
× (Birth Year 1923–40)			-0.005***			-0.008***			-0.002***
			(0.002)			(0.002)			(0.001)
Missing Teachers									
× (Birth Year 1941–60)			-0.010***			-0.015***			-0.002***
			(0.003)			(0.003)			(0.001)
Dep. Var. Mean	3.349	3.373	3.373	0.284	0.345	0.345	0.042	0.047	0.047
Observations	3,074,761	7,858,483	7,858,483	3,074,761	7,858,483	7,858,483	3,074,761	7,858,483	7,858,483

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on occupation score and dummy variables for high-skill occupations or STEM occupations. See Appendix B for a list of STEM occupations. For each outcome, the first column restricts to birth cohorts 1912-1940, while the subsequent two columns restrict to cohorts 1912-1960. The regression sample includes individuals aged 25-64. All regressions are weighted by person weights. For occupation score, I restrict to employed individuals who worked at least 40 weeks in the past year. I pool census years 1940-2020. Poverty is only available starting in 1950. All regressions include fixed effects for census year, birth state, and birth cohort, as well as controls for WWII government spending per capita and mobilization rate, both interacted with birth cohort. Standard errors are clustered by birth state.

B Data Appendix

B.1 Individual-Level Census Data

For individual-level educational and labor market outcomes used in Sections 5 and 5.3, I pool the following census samples from IPUMS (Ruggles et al., 2024):

- 1940: 1% sample
- 1950: 1% sample
- 1960: 5% sample
- 1970: 1% Form 1 state sample and 1% Form 2 state sample
- 1980: 5% state sample
- 1990: 5% state sample
- 2000: 5% sample
- 2010: ACS 5 year sample
- 2020: ACS 5 year sample

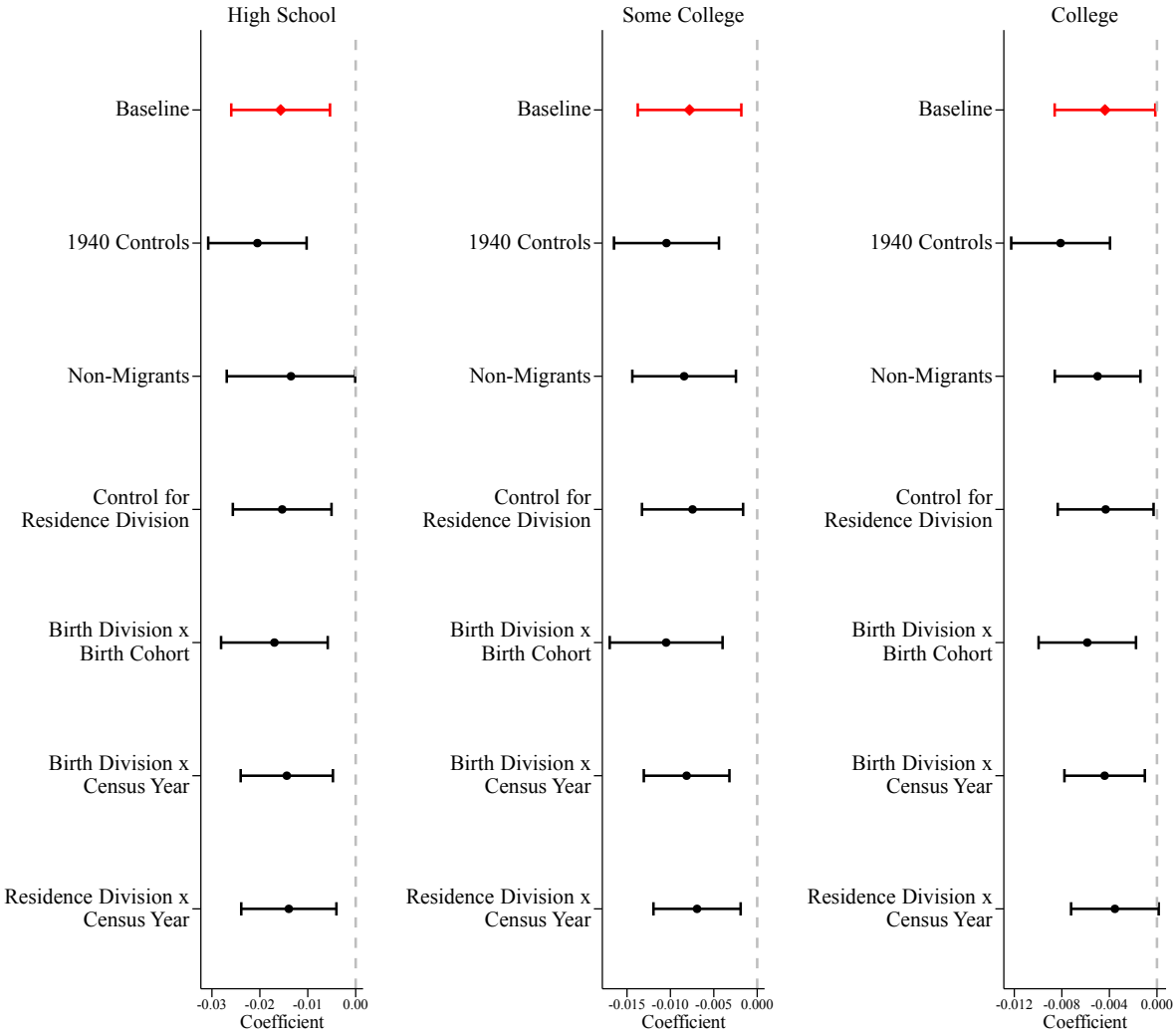
For more details on each sample, see https://usa.ipums.org/usa/sampdesc.shtml.

I use the `educ` variable to determine whether an individual has completed high school or college and whether a teacher has at least two years of college experience.

I consider a STEM occupation to be any of the following `occ1950` codes: chemists, agricultural scientists, biological scientists, geologists and geophysicists, mathematicians, physicists, miscellaneous natural scientists, statisticians and actuaries, aeronautical engineers, chemical engineers, civil engineers, electrical engineers, industrial engineers, mechanical engineers, metallurgical engineers, mining engineers, engineers (n.e.c.), medical and dental technicians, testing technicians, technicians (n.e.c.), chemistry professors, engineering professors, mathematics professors, physics professors, natural science professors (n.e.c.).

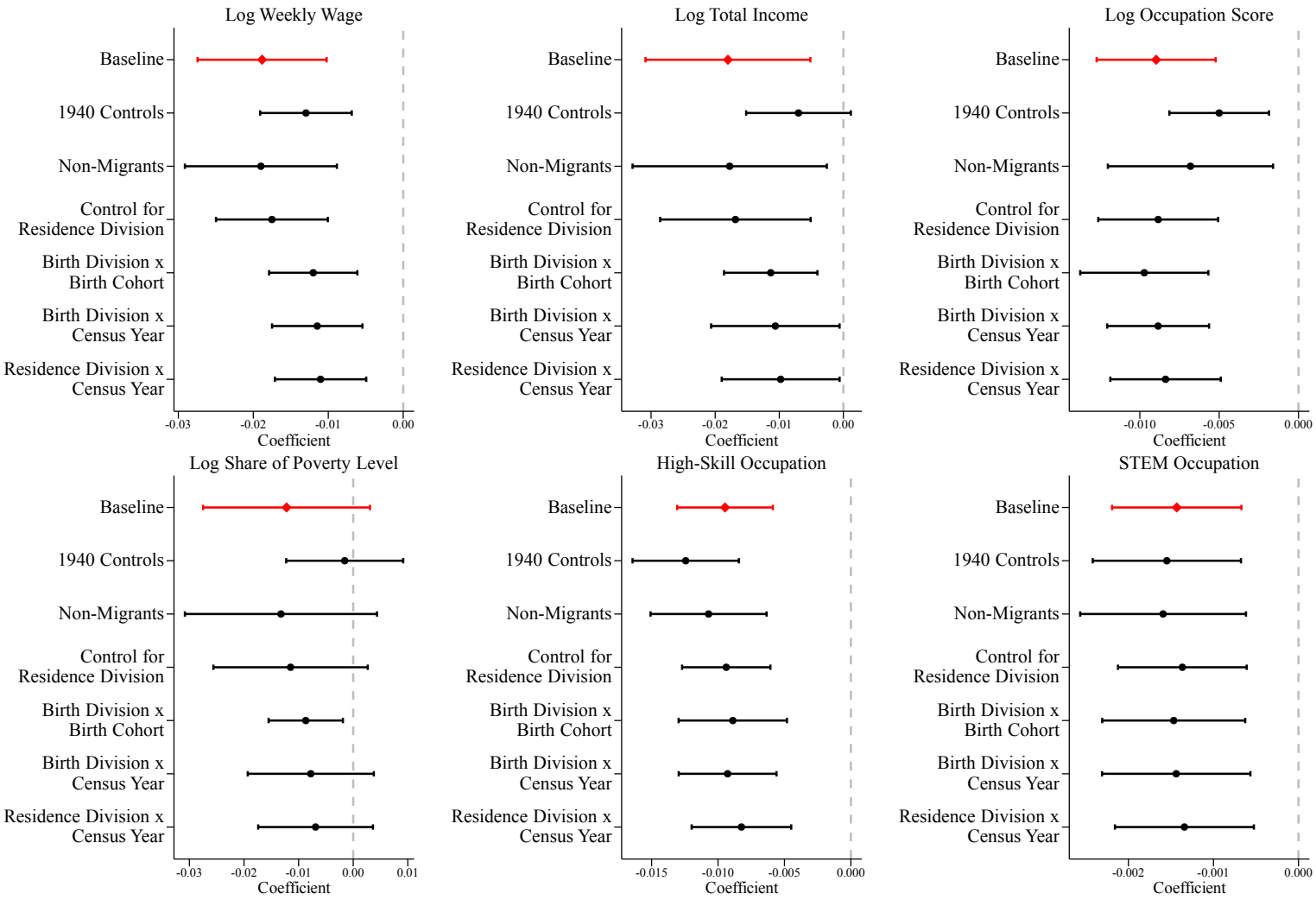
C Robustness of Main Results

Figure C1. Effects of Missing Teachers on Education
Additional Controls



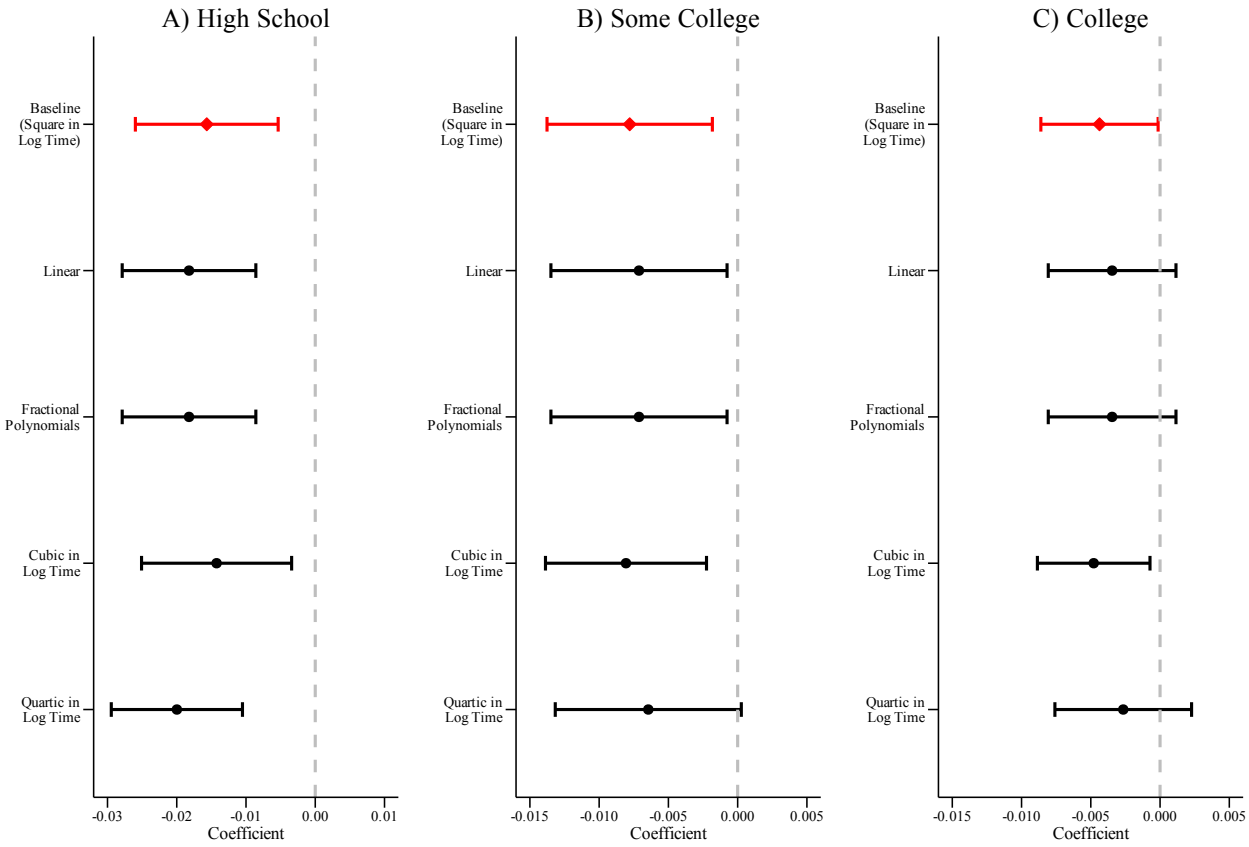
Notes: This figure shows the DD estimate of the effect of a one standard deviation increase in missing teachers per capita on high school graduation, some college attendance, and college graduation. The first row in each figure in red is the baseline specification. The remaining rows show results from different specifications that add additional controls. See notes in Table 1 for more details on the DD regression and sample, and see the description in section 6.1 for details on the alternative specifications.

Figure C2. Effects of Missing Teachers on Labor Market Outcomes
Additional Controls



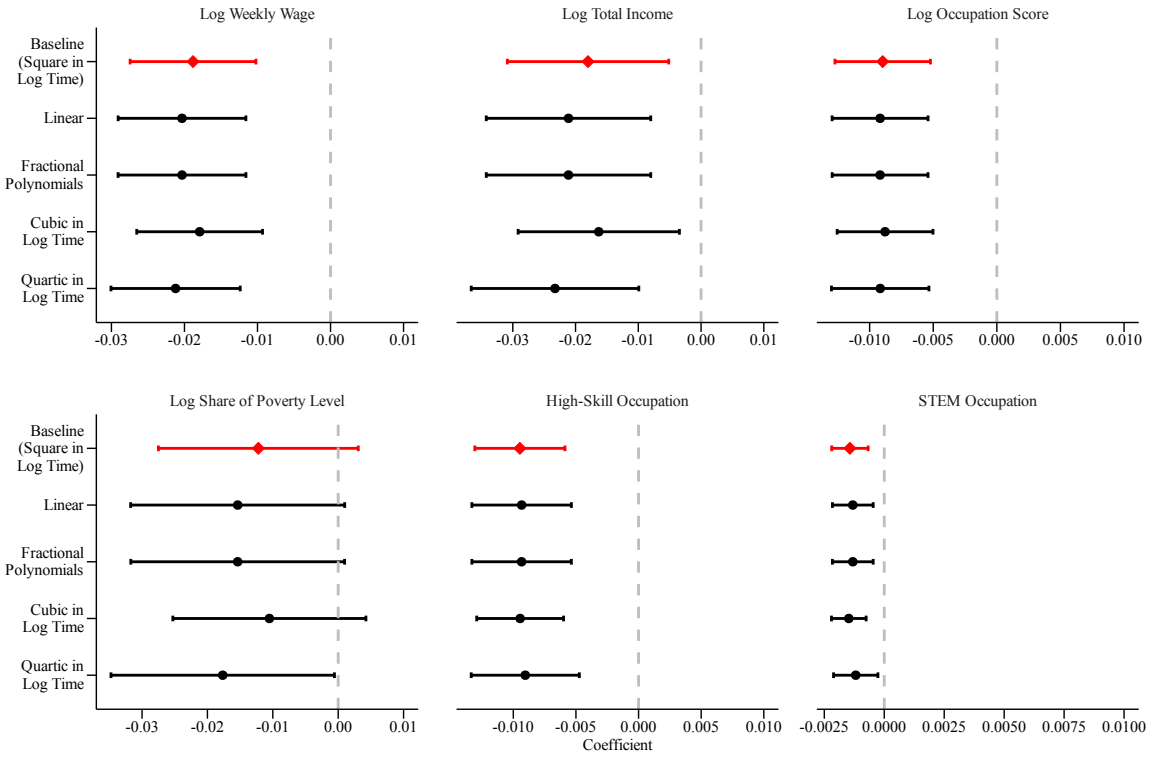
Notes: This figure shows the DD estimate of the effect of a one standard deviation increase in missing teachers per capita on several labor market outcomes. The first row in each figure in red is the baseline specification. The remaining rows show results from different specifications that add additional controls. See notes in Table 2 for more details on the DD regression and sample, and see the description in section 6.1 for details on the alternative specifications.

Figure C3. Alternative Ways to Predict Missing Teachers Effects on Education



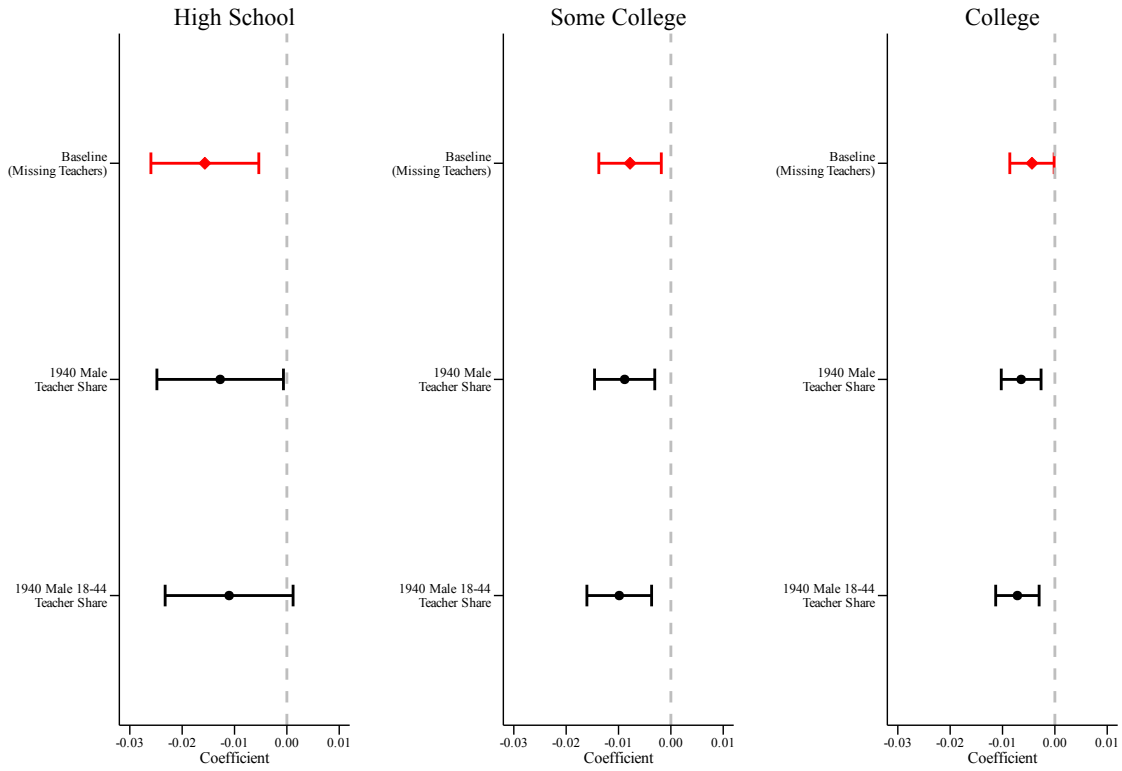
Notes: Panel A shows the DD estimate of the effect of a one standard deviation increase in missing teachers per capita on high school graduation. Panel B shows the estimates for some college and panel C for college graduation. The first row in each figure in red is the baseline specification. The remaining rows show results under different functional form assumptions for predicting missing teachers in Equation 1. See notes in Table 1 for more details.

Figure C4. Alternative Ways to Predict Missing Teachers
Effects on Labor Market Outcomes



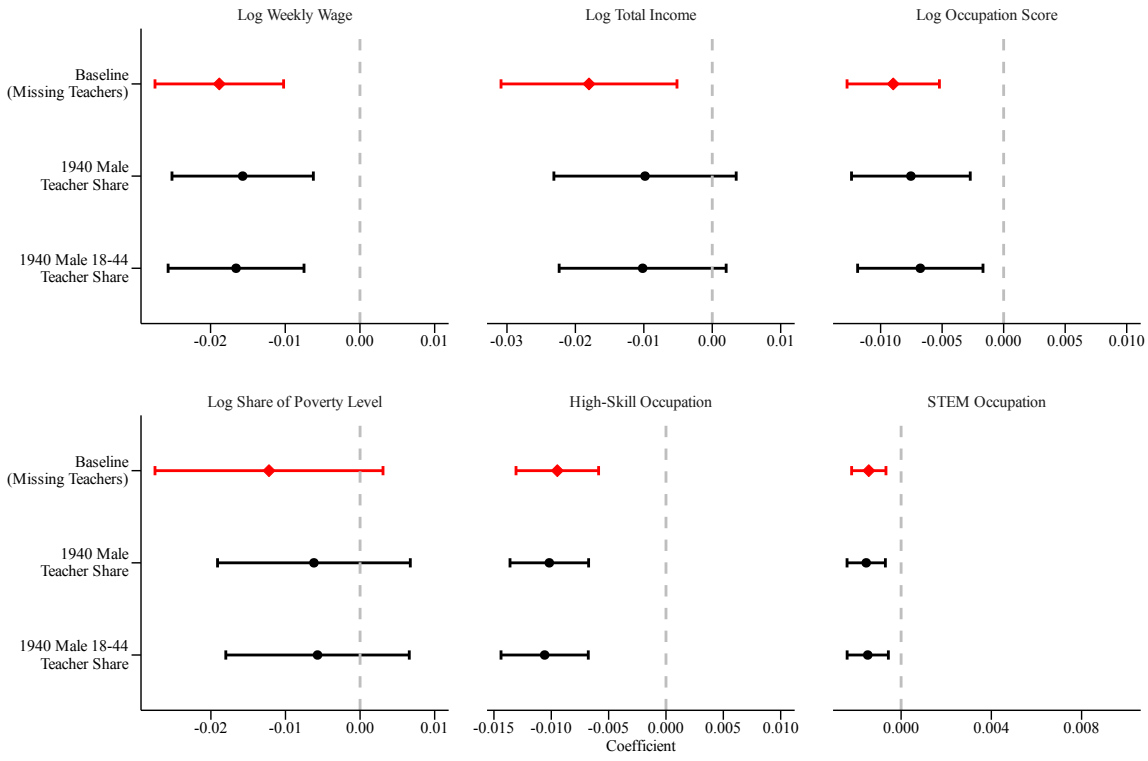
Notes: This figure shows the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on labor market outcomes. The first row in each figure in red is the baseline specification. The remaining rows show results under different functional form assumptions for predicting missing teachers in Equation 1. See notes in Table 2 for more details.

Figure C5. Alternative Sources of Variation
Effects on Education



Notes: Panel A shows the DD estimates on high school graduation with different treatment variables. The specification at the top in red is the baseline specification using missing teachers per capita as defined in Equation 2. The subsequent two estimates are based on the 1940 male share of the teacher workforce and the 1940 share of the teacher workforce who are males aged 18-44. Panel B shows the estimates for college graduation. See notes in Table 1 for more details.

Figure C6. Alternative Sources of Variation
Effects on Labor Market Outcomes



Notes: This figure shows the DD estimates on hvarious labor market outomes with different treatment variables. The specification at the top in red is the baseline specification using missing teachers per capita as defined in Equation 2. The subsequent two estimates are based on the 1940 male share of the teacher workforce and the 1940 share of the teacher workforce who are males aged 18-44. See notes in Table 2 for more details.

Table C1. Effect of Missing Teachers per 1,000 on Education
Logistic Regressions

	High School Grad			Some College			College Grad		
	All	Men	Women	All	Men	Women	All	Men	Women
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Standardized Missing Teachers									
× (Birth Year ≥ 1923)	-0.070***	-0.064***	-0.078***	-0.046***	-0.042***	-0.053***	-0.032***	-0.020	-0.057***
	(0.021)	(0.020)	(0.023)	(0.012)	(0.012)	(0.016)	(0.011)	(0.012)	(0.018)
Observations	8,443,300	4,072,581	4,370,719	8,443,300	4,072,581	4,370,719	8,443,300	4,072,581	4,370,719
Dependent variable mean	0.638	0.628	0.647	0.266	0.304	0.231	0.130	0.167	0.096
Census Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Birth State FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Birth Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. I restrict to the 1912-1940 cohorts. See Table 1 for details.

Table C2. Effects of Missing Teachers on Occupation
Logistic Regressions

	High-Skill Occ			STEM Occ		
	All	Men	Women	All	Men	Women
	(1)	(2)	(3)	(4)	(5)	(6)
Missing Teachers						
× (Birth Year ≥ 1923)	-0.075***	-0.060***	-0.101***	-0.073***	-0.070***	-0.034
	(0.015)	(0.012)	(0.021)	(0.021)	(0.020)	(0.027)
Observations	787,795	430,350	357,445	787,795	430,350	357,445
Census Year FE	✓	✓	✓	✓	✓	✓
Birth State FE	✓	✓	✓	✓	✓	✓
Birth Year FE	✓	✓	✓	✓	✓	✓

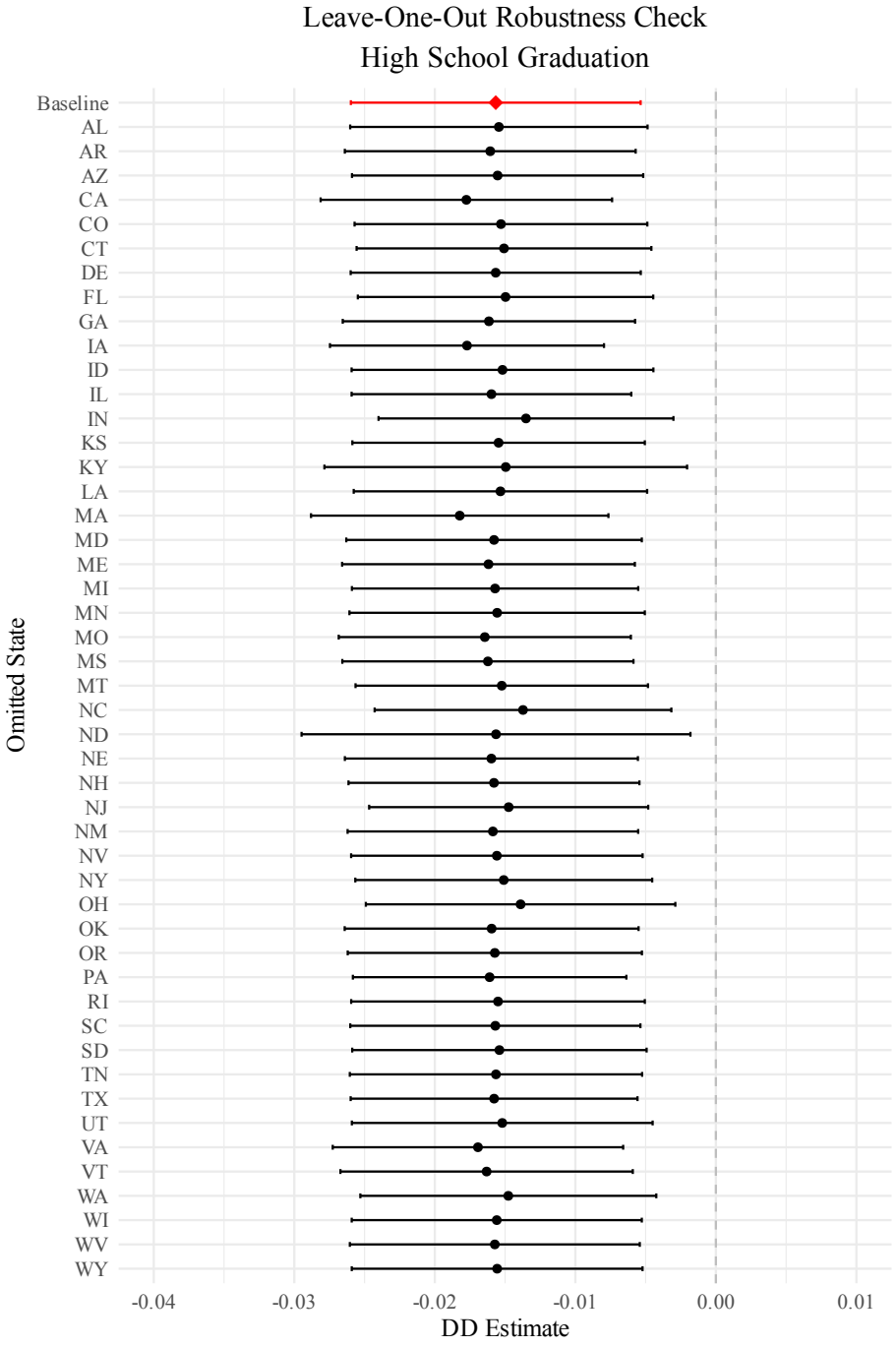
Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table reports the DD estimates of the effect of a one standard deviation increase in missing teachers per capita on the likelihood of holding a high-skill or STEM occupation. I restrict to the 1912-1940 cohorts. See Table 3 for details. See Appendix B for a list of STEM occupations.

Table C3. Effect of Missing Teachers per 1,000 on Earnings
Poisson Regressions

	Wage Income			Total Income		
	All	Men	Women	All	Men	Women
	(1)	(2)	(3)	(4)	(5)	(6)
Standardized Missing Teachers						
× (Birth Year ≥ 1923)	-0.029***	-0.026***	-0.031***	-0.006	-0.004	-0.008
	(0.006)	(0.006)	(0.007)	(0.004)	(0.007)	(0.005)
Observations	4,667,760	2,735,883	1,931,877	8,697,133	4,195,129	4,502,004
Census Year FE	✓	✓	✓	✓	✓	✓
Birth State FE	✓	✓	✓	✓	✓	✓
Birth Year FE	✓	✓	✓	✓	✓	✓

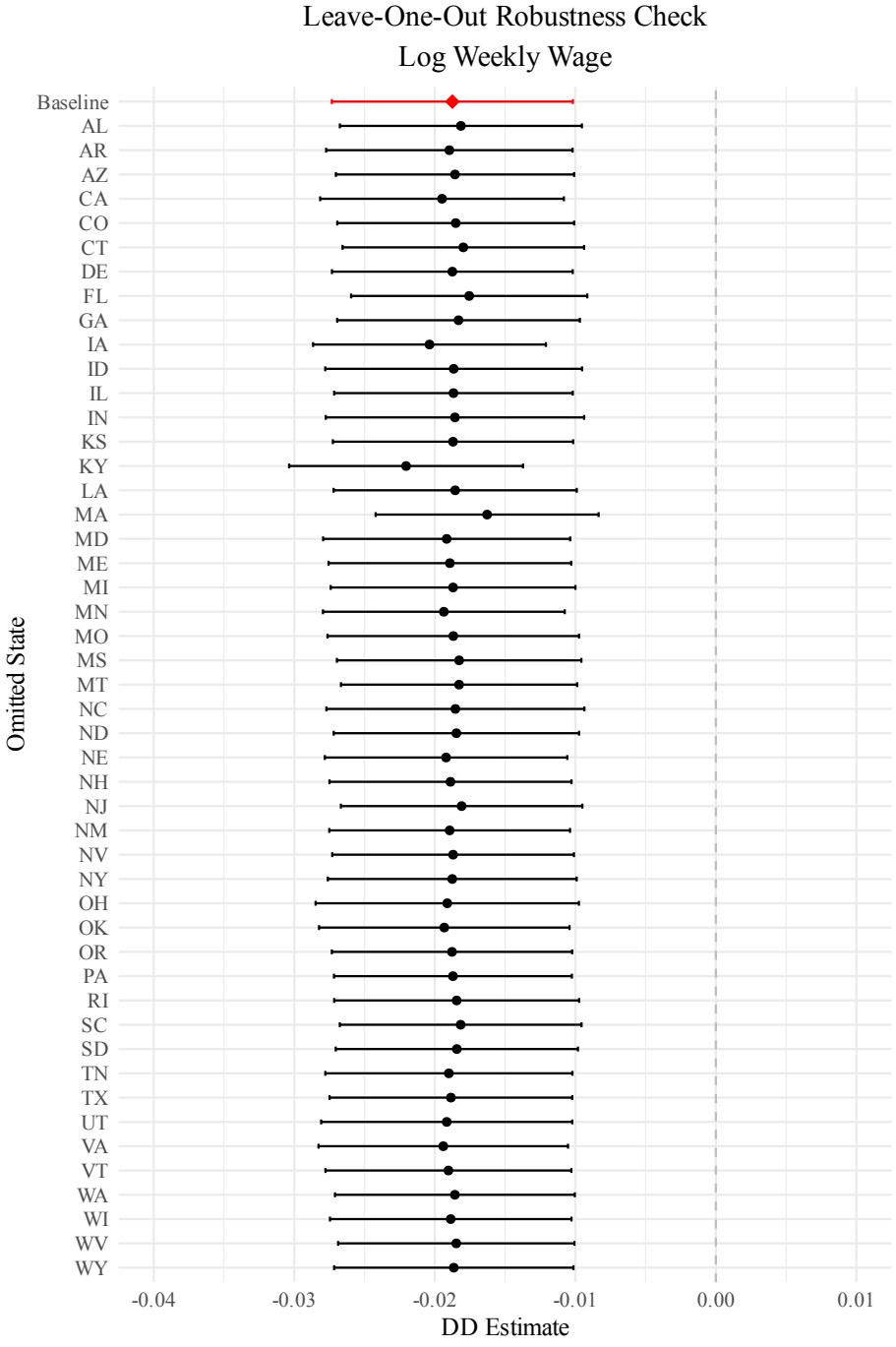
Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. See Table 2 for details.

Figure C7. Results on High School Graduation are Not Driven by any one State



Notes: This figure reports the DD effect of a one standard deviation increase in missing teachers per capita on high school graduation. The specification at the top in red is the baseline specification. All remaining specifications show the results when omitting a single state. See Table 1 for details.

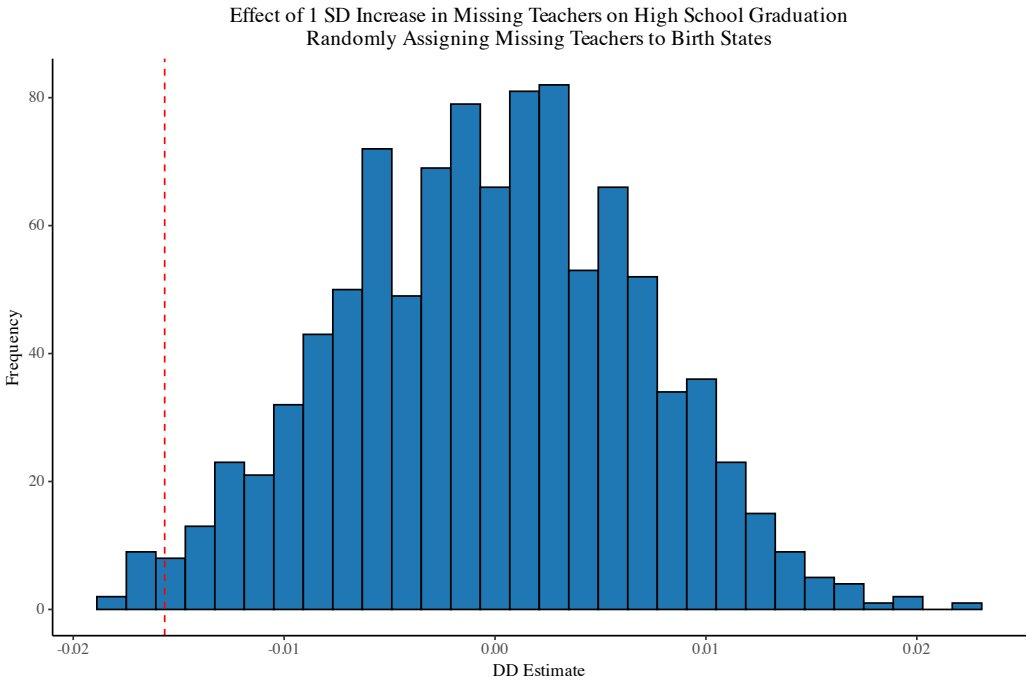
Figure C8. Results on Log Weekly Wage are Not Driven by any one State



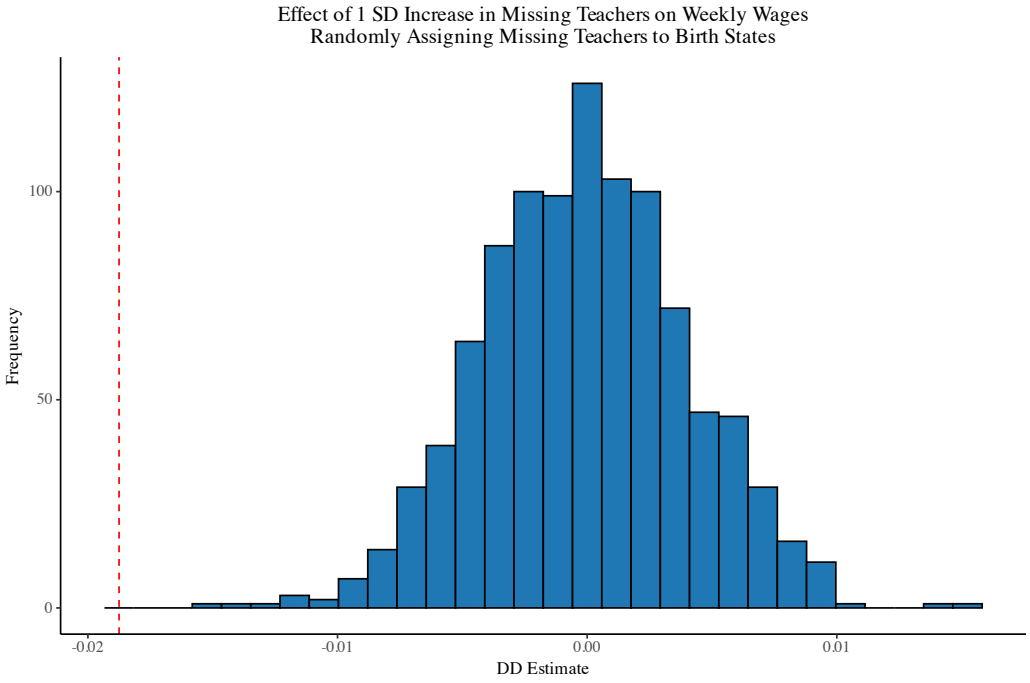
Notes: This figure reports the DD effect of a one standard deviation increase in log weekly wages. The specification at the top in red is the baseline specification. All remaining specifications show the results when omitting a single state. See Table 2 for details.

Figure C9. Randomization Test

(a)



(b)



Notes: This figure shows the distribution of coefficients from a randomization test. I randomly assign the missing teachers per capita measure defined in Equation 2 across states 1,000 times. The vertical red dashed line reports the baseline DD coefficient.