Engine of Upward Mobility: Typewriter Adoption and Women's Economic Outcomes*

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Abstract

Women's economic outcomes changed dramatically over the last century, but there is scarce evidence on the role of workplace technological advances in fueling these changes. This paper studies the effects of the adoption of the typewriter into US workplaces on women's economic outcomes in the 20^{th} century. Exploiting variation in the demand for typists across industries coupled with the geographic distribution of industries, I document that the adoption of the typewriter caused an increase in women's labor force participation. This entry into the labor force led to a decrease in their likelihood of being married and having children. I show that the mechanisms driving these developments operated through two main channels: there was a direct effect driving White women to leave the household and enter offices, and an indirect crowding-in effect that increased the participation of Black women, who substituted for White women by entering domestic service work. The typewriter also resulted in upward economic mobility for women through the channel of marriage. Using linked data following women over time, I show that typists were more likely to meet and consequently marry men of higher socioeconomic status compared to women working in alternative white-collar occupations.

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1 Introduction

Women in the United States experienced historical changes over the course of the nineteenth and twentieth centuries that led to their current status in the economy. One of the most notable changes occurred in their labor force participation, which nearly doubled between 1870 and 1940.[1] Factors such as increasing educational attainment, rising wages for white-collar work, reductions in fertility, and the introduction of technologies related to motherhood and the household have contributed to this rise in women's participation in the labor force (Goldin, 1986, 1990; Goldin and Katz, 2002; Greenwood et al., 2005). However, the role played by workplace technological changes in advancing women's participation in the labor force remains underexplored.

Workplace technological changes can lead to automation of work that displaces labor or result in creation of new work that "reinstates" demand for workers (Acemoglu and Restrepo, 2018). While the effects of technologies that automate tasks, especially those tasks that are performed by women (Feigenbaum and Gross, 2024; Ager et al., 2023), are well-documented, the consequences of new *task-creating* technological changes, especially for women, and their role in explaining the rising demand for female labor are not as well-understood.

Using arguably one of the largest task-creating workplace technological change for women, this paper studies the effects of the invention and diffusion of the typewriter on women's long-term outcomes. Unlike innovations in the household sector or ones that replaced production technology mainly operated by women, the typewriter was not an inherently *female-biased* technological change. In fact, early secretarial and clerical work was mainly performed by men. However, offices in the US adapted to the arrival of the commercial typewriter by shifting towards the available supply of educated women who provided cheaper labor: while women initially made-up only 12 percent of the typing and secretarial occupation in 1880, by 1900 they accounted for 75 percent of all typists. By 1940, the typewriter had become a large shock to women's employment, with over 1.2 million women working as typists, accounting for over 11 percent of all employed women at the time.

This paper shows that the introduction of the typewriter into US workplaces drew women into the labor force and new sectors of the economy, a shift that, in turn, led to unintended

[1] Calculated using data from historical US population censuses. See Appendix Figure 1.

changes in their marriage and fertility patterns and intergenerational mobility. However, the effects of the technological change varied greatly by race. As White women left the household to work in clerical occupations, Black women substituted for them in the household by entering domestic service work. Joining the labor force also led to reductions in fertility and marriage rates for White women. For Black women entering domestic service work, their marriage patterns did not change but living away from their spouse and working in an occupation where kids could not accompany them to work, meant reductions in their fertility rates. The typewriter not only affected women's labor market outcomes but it also served as a "meeting technology" for White women: it allowed them enter office spaces and marry men of higher income translating into upward economic mobility through the channel of marriage.

I rely on a number of data sources to conduct the analysis of this paper, including compiling novel data on early typing schools. Throughout the paper, to establish the main results, I use the historical US complete count censuses from 1870-1940. To study effects on women's intergenerational mobility, I rely on women linked from the 1920 to the 1940 census from Buckles et al. (2023). To shed light on the mechanisms and to complement the main empirical strategy, I assemble a new database of local women's organizations which offered early typing courses to train female typists. To complement the main empirical strategy, the paper also uses samples of the Canadian historical censuses of 1891 and 1911.

The main empirical strategy relies on the observation that before the invention of the typewriter, localities had varying industrial compositions that affected their likelihood of adopting the technological change. To address unobserved omitted factors that may codetermine increases in typists in a locality and improvements in women's outcomes, I construct plausibly exogenous predicted changes in the share of typists. To do this, I employ a shift-share instrumental variable approach that interacts local industry level employment shares before the introduction of the typewriter with the national growth in the typist occupation across industries to identify exogenous variation in the share of typists per locality. I also construct an alternative instrument that uses "as-good-as random shocks" in the form of national changes to the number of typists employed across industries in the Canadian census (Borusyak et al., 2022). I complement the main empirical strategy using a difference-in-differences approach to compare counties with and without women's organizations which later on went to offer typing courses. The localities which offered early typing courses had a greater supply of skilled

female typists as compared to localities that did not.

Using the main empirical strategy, I show that a 1 percentage point (pp) increase in the predicted change in typists between 1880 and 1920 led to a 2.9-3.3 pp increase in women's labor force participation. These estimates imply that without the shock of the typewriter, women's labor force participation rates in 1920 would have been 4.5 pp lower, equivalent to nearly 1.4 million fewer women in the labor force at the time. The labor market effects induced by the introduction of the typewriter further led to a 1.5-2 pp reduction in women's marriage rates and a 1.7-2.2 pp decrease in their likelihood of having children. These estimates imply that the share of married women and women with children would have been 2.1 and 5.2 pp higher in 1920, respectively, in the absence of women's entry into the labor force driven by the technological change.

The changes in women's labor outcomes were not limited to White women, who were more likely to be hired as typists, but also had a *crowding-in* effect on Black women's labor participation. Specifically, I show that Black women in counties that experienced a greater exposure to the typewriter were more likely to be in the labor force. In fact, as White women left *unpaid* housework to join the labor force and work in clerical occupations in response to the technological change, Black women substituted for them by entering the labor force to work in the domestic services industry. Part of the shift in Black women's labor supply to domestic service work also comprised of them substituting out of agricultural work.

The shifts in Black and White women's occupational opportunities also impacted their marriage and fertility patterns. By having better opportunities in the labor force as a result of the technological change, White women experienced reductions in their likelihood of being married and having children. The drop in marriage rates can be attributed to White women both delaying getting married, and in some cases, opting out of marriage entirely. The reductions in fertility mainly composed of White women forgoing having children rather than only delaying childbearing. On the other hand, entering the labor force to work in the domestic services sector did not significantly change Black women's likelihood of getting married. However, working as household service workers, which often meant living away from their spouses, resulted in a drop in Black women's fertility. Historically, compared to agricultural work where Black women could bring children with to work, the nature of domestic service work also meant that women could not bring their children with them to work. Though

arising from different channels, similar to the experience of White women, ultimately these reductions in fertility arose mainly from Black women remaining childless.

The typewriter not only changed White women's employment opportunities but also served as an engine of upward economic mobility for them. By following a sample of White women from the 1920 to the 1940 census, I am able to compare the economic standing of women's fathers to that of their future spouses. Because a majority of women at the time dropped out of the labor force upon marriage, married women's historical intergenerational mobility is best measured using a comparison between their father's and husband's economic statuses. I first descriptively illustrate that women who worked as typists in 1920, were more likely to have higher earning husbands in 1940 compared to women who worked in alternative non-typist occupations. I also rely on a within-household analysis to show that this result holds when comparing typists to non-typists *sisters*. I then turn to the instrument and causally show that locations with a greater predicted change in typewriter adoption offered women, who grew up in the bottom 25th percentile of the income distribution, a greater likelihood of marrying a spouse with higher income. This is consistent with a hypothesis that offices provided women a unique opportunity to work alongside and be connected to men of higher income as opposed to their alternative work options. I provide evidence in support of this mechanism by following the spouses of women back to the 1920 census and showing that the future husbands of typists were more likely to work in white collar occupations in the same county as their future wives when compared to the future husbands of women who worked in alternative occupations.

These findings point towards an important factor that is overlooked in the broad literature studying the historic increase in women's labor force participation in the US: the role of workplace technological changes. This paper provides a new, long run perspective of a workplace technological change and its effects on women's outcomes. Papers studying factors affecting the historic increase in women's labor force participation have so far considered factors such as household technological advances (Greenwood et al., 2005), expansion of educational opportunities (Goldin, 1990), innovation in contraception and reductions in fertility (Goldin and Katz, 2002; Bailey, 2006; Myers, 2017), rise in white-collar wages (Goldin, 1990), introduction of technologies related to motherhood (Albanesi and Olivetti, 2016), reduction in the cost of children (Attanasio et al., 2008) and access to electricity (Vidart, 2024).

This paper also contributes to an extensive literature focusing on the consequences of technological change for workers, which has largely focused on the impact of automation.[2] In comparison, there is relatively little empirical work documenting the consequences of technologies that result in creation of new work (Autor, 2022). Recent work studies the origins of new work and tasks, tracing it to technological change, and its effect on labor demand (Autor et al., 2024; Acemoglu and Restrepo, 2019, 2018; Lin, 2011). The results of this paper not only highlight the consequences of a task creating technological change for women's labor but also their marriage and fertility choices. By showing that the adoption of the typewriter led to changes in Black women's outcomes, my findings also emphasize the importance of considering indirect effects on groups of workers not directly exposed to the technological change.

Papers at the intersection of technological change and women's outcomes have considered the role of technologies that automate work done by women (Feigenbaum and Gross, 2024; Ager et al., 2023), technologies related to household production (Greenwood et al., 2005), general purpose technologies such as electrification (Vidart, 2024), and technologies related to motherhood (Albanesi and Olivetti, 2016). Relative to pre-existing work, this paper introduces workplace technological changes as a novel determinant for women's long term labor and family outcomes.

This paper also makes a contribution to an extensive literature studying intergenerational mobility generally and specifically to a more recent literature studying women's historical intergenerational mobility in the US (Olivetti and Paserman, 2015; Jácome et al., 2021; Buckles et al., 2023; Althoff et al., 2023; Eriksson et al., 2023), which has largely focused on documenting estimates of women's mobility and providing descriptive evidence of factors related to changes in women's mobility.[3] Instead, my results highlight the potential of technological changes in impacting mobility patterns. Specifically, the typewriter served as a "meeting" technology for marriage outcomes, which allowed women to gain upward economic mobility.[4]

[2]Papers studying the consequences of automation include Feigenbaum and Gross (2024); Adachi et al. (2024); Bessen et al. (2023); Acemoglu and Restrepo (2020); Chiacchio et al. (2018); Graetz and Michaels (2018); Dauth et al. (2018). In addition, this work also relates to empirical research on skill-biased technical change (Gray, 2013; Goldin and Katz, 2009; Acemoglu, 1998; Autor et al., 2003, 1998).

[3]The literature studying historical intergenerational mobility in the US is reviewed in Abramitzky et al. (2025). For a review of the literature studying intergenerational mobility more broadly, see Mogstad and Torsvik (2023).

[4]Papers studying the role of other "meeting opportunities" for marriage include Goldman et al. (2024); Belot

The availability of such opportunities is especially meaningful at a time when most married women did not participate in the labor force and women's long-term economic success was determined largely by their husband's socioeconomic standing.

Lastly, this research adds to the literature studying the introduction of women into occupations and the rise of white-collar work for women (Bald, 2025; Greenberg et al., 2024; Miller and Segal, 2019; Goldin, 2002, 1990).[5] This paper focuses on the creation of new white-collar work for women driven by a technological change. Compared to most examples of historical and modern white-collar work that primarily employ women, typing and secretarial work stands out as an occupation that rapidly transformed in terms of its gender composition and employed a large fraction of the female labor force across a variety of sectors.[6]

2 Background

The first commercial typewriter was not only a major nineteenth-century innovation, but was also a technological change that spurred the creation of new work for women. In this section, I first outline the historical background relevant to the typewriter as a technological innovation and its adoption. Next, I describe and provide evidence for the role of this technological change in generating new work for women. Then, I empirically and historically document the role of factors such as the presence of educated women in the adoption of female labor for typing and secretarial work. Lastly, I present descriptive patterns from US census data relevant to the background of the typing and secretarial occupation in this time period.

2.1 Invention and Adoption of the Typewriter

There had been several attempts over the nineteenth century to create a "writing-machine" (Hoke, 1979). Inventors across both the US and Europe had been experimenting with many versions of such machines which were intended for use at home (Boorstin, 2010). However, none of these machines were commercially promising until Christopher Sholes, a Milwaukee

and Francesconi (2013); Kalmijn and Flap (2001) and Ciscato (2024). Relatedly, these results also highlight that workplaces can serve as environments that can lead to relationship formation and changing marriage patterns. Using workplace level data, Macdonald et al. (2024) study relationship formation in the workplace.

[5] Aneja et al. (2024) study the expansion of female clerical workers in public service after WWI.

[6] The rise of typing as a predominantly female occupation is also related to a broad literature studying occupational gender segregation. See Blau and Winkler (2018) for a review of this literature.

based printer and editor, invented the "Type-Writer" in 1868 (Boorstin, 2010). Sholes, with the help of Carlos Glidden, improved this machine, and in 1873 convinced E. Remington & Sons to manufacture the machine.

The first commercially successful typewriter, known as the "Sholes and Glidden Machine", was sold to the public in 1874 (Hoke, 1979). Appendix Figure **??** presents an image of this early machine and the influence of Remington mechanics, who previously manufactured sewing machines, is evident in the design (Current, 1974). This early typewriter was mounted on a sewing machine base and used a foot treadle.

The early typewriter was marketed as a "literary machine" to writers and businesses were not thought of as its target consumers (Current, 1974; Hoke, 1979) .[7] In fact, "no one in business was striving to invent the typewriter. It was clearly *exogenous* to the business sector" (Hoke, 1979). This is evident in the slow adoption of the typewriter by businesses depicted in annual machine sales for the Remington typewriter. Nearly a decade since its introduction, by 1882, Remington had only sold 1,200 typewriter machines, however, in 1887 this trend began to change when 14,000 machines were sold, mainly to businesses (Davies, 1974). This marked the "commercial acceptance" of the typewriter and by 1900, Remington was selling over 500,000 typewriters (Hoke, 1979).[8]

The adoption of the typewriter by businesses can be attributed to both a demand for information collection and efficiency gains presented by the machine. Post-Civil War US, along with increasing complexity of firms, saw an increase in demand for information collected at different levels of a company's hierarchy. Additionally, businesses in the early twentieth century adopted "scientific management", a system which relied heavily on record keeping (Rotella, 1979). The typewriter also presented clear efficiency gains in writing speed and accuracy in comparison to handwritten memos that businesses had previously relied on. With the adoption of the typewriter, along with carbon paper and vertical filing, businesses could easily create and keep copies of different forms of communication (Yates, 1991; Boorstin, 2010).[9]

[7] The typewriter was even referred to as the "literary piano" for novelists and poets to "compose" at it (Hoke, 1979).

[8] The increased demand for typewriter machines brought by businesses is also evident by the arrival of competing typewriter machines in the mid-1880s such as the Caligraph, the Crandall, the Hammond and the Hall (Boorstin, 2010).

[9] This advantage of the typewriter over the pen is also highlighted in early advertisements of the machine. Appendix Figure **??**, Panel A shows an early advertisement for the typewriter that specifies that the typewriter can "write from thirty to sixty words per minute, more than twice as fast as the pen – in plain type, just like

And so, "once business realized all that the typewriter could do, the machine was adopted at an extremely rapid rate" (Hoke, 1979).

2.2 Creation of New Work for Women

As businesses began to rapidly adopt the typewriter, they also shifted to hiring a predominantly female workforce of typists and secretaries. While early secretarial and clerical work was mainly performed by men, after the invention of the typewriter, female typists and secretaries were hired at an unprecedented rate. Table 1 presents the number of men and women working in the "stenographers, typists, and secretaries" in each decade from 1880 to 1940.[10] In 1880, women initially made up only 12 percent of the occupation, however, in 1900 women accounted for over 75% of all typists. By 1940, over 1.1 million women were employed in this occupation, accounting for over 11 percent of all employed women at the time.

Table 1: Men and Women Working in Typing Occupation: 1880-1940

Census Year	Total	Men	Women	Percent Women
1880	1,866	1,634	232	12.43
1900	106,857	27,066	79,791	74.67
1910	340,392	74,487	265,905	78.12
1920	668,414	83,975	584,439	87.44
1930	984,493	79,246	905,247	91.95
1940	1,206,880	87,282	1,119,598	92.77

Notes: This table presents the number of men and women working in the stenographers, typists, and secretaries occupation as well as the percent of the occupation made up by women using the *occ1950* variable in the Census.

The typewriter led to creation of new work for women and drew women into the office space. In fact, it was a predominantly new task-creating technological change because it replaced very few or close to no men who performed secretarial work before its invention. Rather it created new jobs for female labor in the office space across new sectors of the economy. Specifically, "since opportunities in the business office were generally expanding, women were not competing with men for existing jobs, nor were they pushing men out of

print".

[10] Both the occupational strings and historical evidence suggest that women who were hired as typists or stenographers were also hired as typists. Occupation titles from occupational strings commonly combine secretary with typist or stenographer.

work. Women simply filled the newly created positions" (Hoke, 1979).

Importantly, pointing to the significance of the technological change in generating new work for women, such changes are not observed in the evolution of general clerical work, which existed before the invention of the typewriter.[11] Appendix Figure compares the number of men and women employed in clerical and kindred work (Panel A) over time to the typing and secretarial occupation (Panel B). While general clerical work continued to expand and employ more men than women, the growth of the typing occupation was driven predominantly by women. In fact, the importance of this technological change has been emphasized by Rotella (1981) who states that "there was no other single technological change that transformed the office so much as did the typewriter."[12]

2.3 The Supply of Qualified Female Typists

For women to enter this newly created work, businesses' growing demand for typists and secretaries required an available supply of qualified women. Because women in the late nineteenth century were paid one third to one half the wage of men (Goldin, 1990), and working as a typist paid more than women's other white collar alternatives such as teaching,[13] the main constraint was education and knowing how to operate the typewriter.

I first document the role of education, specifically high-school education, in shaping the supply of qualified women who could be hired as typists. Because "typists had to be able to read, write, and execute minimal mathematical skill" (Hoke, 1979), I rely on the expansion of secondary schooling in the late nineteenth century (Goldin and Katz, 2008) to document a relationship between secondary schooling and the supply of female typists.[14] Using variation in states that were early adopters of schooling laws, Appendix Table shows that states that were early adopters ("treated") had a greater supply of female typists in those states.

[11] General clerical jobs are classified as "Clerical and Kindred workers (n.e.c), *occ1950* code 290."

[12] Several historians further underscore this, including Hoke (1979) who posits that "the appearance of the female secretary was certainly hastened by the invention of the typewriter ... [the typewriter's invention was] the key event, the catalyst which sparked this rapid social change," and Boorstin (2010) who states that "by providing a socially acceptable employment for women in the commercial world, it [the typewriter] opened new office careers ... [and] helped bring women out of the kitchen into the world of affairs."

[13] For example, a female typist in New York City in 1888 could earn an average weekly wage of up to 20 dollars (Hubert, 1888), while a female teacher earned 17.70 dollars (Annual Report of the State Superintendent, 1892)

[14] Data for this exercise is obtained from (Goldin and Katz, 2008) along with data for the period 1900 to 1909. Details of this data construction can be found in Supplementary Appendix.

I next document the role of early typing schools in training female typists. Early typing training for women was provided by women's organizations such as the Young Women's Christian Association.[15] In fact, the New York City's YWCA first offered a typing course for women in 1881. Appendix Figure documents the role of early Women's Christian Association chapters at the county level in changing the supply of female typists. It shows that counties that had a WCA organization before 1880, had a greater supply of female typists after the invention of the typewriter.[16]

Together, these descriptive empirical analyses along with historical evidence, point to the crucial role played by secondary schooling expansion and early typing schools in training a supply of female secretaries and typists that businesses could employ after the invention of the typewriter.

2.4 The Resulting Typing Occupation and Female Typists

The typewriter became an unintended technological change for women and brought the very first women into office spaces, where they previously did not exist (Davies, 1974). In fact, by 1940 more women were working as typists than as teachers, which was the main white collar job that women worked in for decades before the typewriter was invented. Appendix Figure plots the share of white-collar women employed in 7 major white-collar occupations. The rise of typing and secretarial work as the main white-collar occupation for women is evident, especially when compared to other major white-collar occupations.

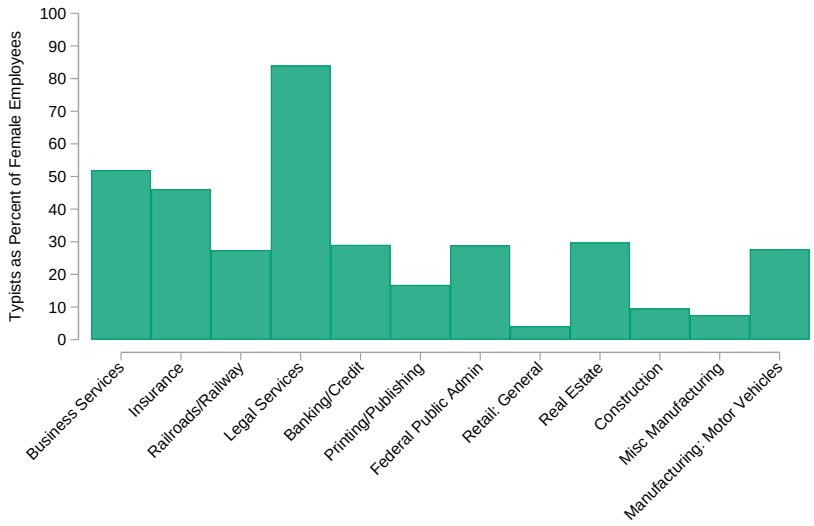
The resulting typing occupation, one which primarily employed women, was different from other female dominated white-collar occupations at the time in three ways: (1) It was driven largely by an exogenous technological change, (2) typists were needed across many different sectors, and (3) women co-existed in the same environment as men. There were certainly other occupations at the time that were affected by technological changes. Two such examples, which also employed a large number of women, are bookkeeping and telephone operation. Telephone operators came about as a result of the invention of the telephone in

[15] It was only later, in response to business demand for typists, that business colleges, typewriter agencies and independent businesses began offering typing courses. It was in fact the YWCA, along with Remington's agents, that offered the first typing courses (Hoke, 1979).

[16] The Data section along with Supplementary Appendix contains details of data collection for the WCA as well as details of this analysis.

1876 and the demand for bookkeepers increased following the invention of the tabulating machine in 1890. However, bookkeeping did not become a gendered occupation in the same manner. In fact, in 1940 there were close to as many men as women working as bookkeepers (Appendix Figure 5, Panel C). While telephone operation became a gendered occupation, the magnitude of female telephone operators was nowhere close to that of female typists, and telephone operators existed only within a single sector as opposed to typists who worked in many different sectors across the nation (Appendix Figure 6, Panel D).

Figure 1: Female Typist Employment Across Sectors, 1920



Notes: Figure 3 Panel A plots on the x-axis, in descending order, the top 12 industries that employ the highest number of female typists in 1920. Each of these industries employ at least 10,000 female typists. On the y-axis, Panel A plots the female typists as a share of the total industry female employment. Panel B plots on the x-axis the top 17 industries, in descending order, that employ the most female employees. The y-axis is the same as in Panel A.

Unlike other feminized white-collar occupations at the time, typists were needed across many different sectors. Figure 1 plots the major industries employing female typists that each employed at least 10,000 typists. Some of these industries included business services (where female typists made up over 50% of all female employees), insurance, railroads and railway services, legal services, banking, and printing & publishing. It is important to note that these industries were also major employers of women in general. For instance, industries such as business services, printing and railways are among the top 17 industries that employ women (Appendix Figure 3). Many of these industries, which by 1920 are major employers of female typists, did not hire women before the invention of the typewriter. Appendix Figure 7 shows that following the invention of the typewriter, the entry of women into industries such as legal

services and banking in 1900 is largely driven by the entry of typists.[17]

The typing occupation, by allowing women to enter the office space, gave them the unique opportunity to work alongside men of higher socio-economic status. Importantly, this was not an "amenity" that was offered by alternate white collar occupations at the time such as teaching, where most of women's coworkers were other women. The only occupation that could offer such an opportunity was nursing, however far fewer women worked as nurses at the time and female nurses most commonly worked as home nurses at the time. Women being able to interact with men of higher income in the office space provided these women a benefit on the marriage market whereby men in these offices began to "choose a wife amid the deft-fingered clerks in preference to society misses" (Waller, 1986). The presence of office relationships between typists and their bosses is also apparent through advertisements for typewriters. For example, Appendix Figure 2 Panel C shows an ad for the typewriter from 1939 where a female typist and her boss are together looking towards a typewriter. This is commonly seen in ads for typewriters by the 1930s.

As the typing occupation and industries that employed typists transformed over time, so did the typists. Figure 2 plots differences in characteristics of typists and the working age population in two decades: 1880 (black) and 1920 (green). Compared to the working age population, typists were more likely to be men in 1880. By 1920, the image of a typist completely changed and at that point women were more likely to be employed as typists. Typists in both decades are also more likely to be white, US-born, young, living in urban areas, single and without children. This especially holds true for female typists.[18]

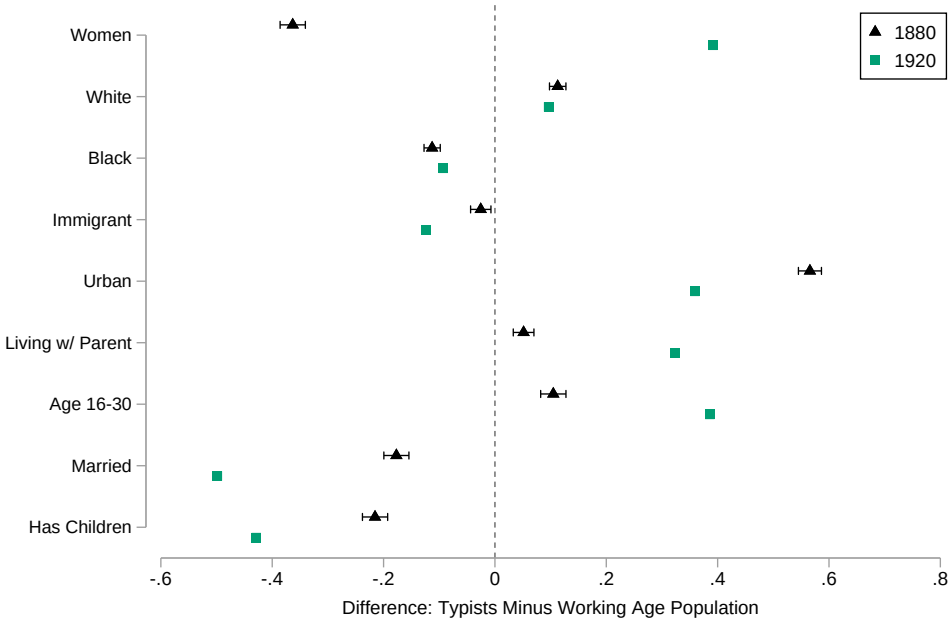
3 Data and Empirical Specification

To conduct the analysis of the paper, I mainly rely on US population decennial censuses from 1870 to 1940 (Ruggles et al., 2021). The analysis focuses on working-age individuals between

[17] Both these industries are also examples of industries which would involve women working in office spaces alongside men of higher socioeconomic status.

[18] Female typists, when compared to other working age women, were more likely to be white, US-born, living in urban areas, young, unmarried and without children (Appendix Figure 8). These differences still hold, though smaller in magnitude, when female typists are compared to women working in other white-collar occupations (Appendix Figure 9). Compared to male typists, female typists were more likely to be younger and unmarried (Appendix Figure 10).

Figure 2: Characteristics of Typists in 1880 vs 1920



Notes: This figure plots the differences in means of typists and working age population for each of the characteristics listed in 1880 (black triangles) and 1920 (green squares). The coefficients represent how much more likely a typist is than the working age non-typist to satisfy the particular characteristic.

the ages of 16 and 64. Women are defined as being in the labor force if they are employed in an occupation for pay.[19] They are classified as being married using the marital status variable [20] and as having children if they are recorded as having one or more own children residing in the same household.[21] The main geographic level use for the analysis is the county.[22]

To study women's intergenerational mobility, I rely on a sample of White women linked from the 1920 to the 1940 census using the Census Tree (Buckles et al., 2023). Because historical census data do not contain personal identifiers and women, who commonly changed their last names upon marriage, are especially difficult to link across the marriage decision, using genealogical data from FamilySearch Family Trees is one of the few ways to link such women across census decades.[23] Though the Census Tree data provide additional links using machine

[19]The main outcome is specifically defined using the *labforce* variable (*labforce* == 2).

[20]This includes options indicating married for the *marst* variable. For figures and tables that use the 1870 census, I rely on the *sploc* variable which specifies whether a spouse is present in the household. This is because the marital status variable was not recorded before 1880.

[21]This is coded using the number of children (*nchild*) variable. This will include biological children as well as step-children and adopted children.

[22]Because county boundaries changed over time, counties are harmonized using crosswalks and reweighted using population weights provided by Ferrara et al. (2022).

[23]Other methods include using marriage certificates (Eriksson et al., 2023) and administrative data sources

learning methods for women who changed their marital status, I mainly rely on the provided genealogical links.[24]

To shed light on the role of early typing schools and to use supply-side variation in a second empirical specification, I collected and digitized data on local Women's Christian Association (WCA) chapters in the late nineteenth century.[25] These local organizations provided early typing courses for women and led to an increased supply of female typists in those localities. These data include the locations and dates of founding of each chapter.[26]

To conduct the analysis of the paper, I rely on two primary data sources: (1) US Population census data from 1870 to 1940 (Ruggles et al., 2021) and (2) Census Tree data from Buckles et al. (2023). To study the effect of the diffusion of the typewriter on women's labor participation, and decisions of marriage and fertility, I rely entirely on decennial Census data. In order to study the effect on women's intergenerational mobility, I combine Census data with Census Tree Links to create longitudinal data that follows men and women over time. Historical censuses do not contain personal identifiers, like social security numbers, that allow individuals to be followed over time. Census Tree data rely on genealogical data from FamilySearch Family Trees to link individuals across census decades.[27].

The analysis focuses on working-age individuals between the ages of 16 and 64. Women are defined as being in the labor force if they are employed in an occupation for pay. They are classified as married if they are living with their spouse and as having children if they are recorded as having one or more own children residing in the same household.[28] To measure women's intergenerational mobility through marriage, I follow both the women and their spouses from the 1940 census back to the 1920 Census when women can be observed as living with their fathers. The resulting linked sample contains 1,218,336 married women and their

such as from the SSA (Althoff et al., 2023).

[24]I show robustness of main results to the inclusion of these additional links.

[25]The WCA is more commonly known as the YWCA.

[26]The analysis of this paper also makes use of the Canadian 1891 and 1911 census samples obtained from Ruggles et al. (2025). Further details can be found in the empirical specification section.

[27]Here the use of genealogically linked data from Buckles et al. (2023) is imperative in linking women from the earlier census (1920), where they can be observed living with their fathers and holding occupations as single women, to the later census (1940), where they can be observed living with their husbands. Linking single women to their future married selves without the use of genealogical links would be nearly impossible as women often changed last names upon marriage. Other methods that have successfully linked women across censuses include Eriksson et al. (2023), which uses marriage certificates and Althoff et al. (2023) which uses Social Security Administration data

[28]This will include biological children as well as step-children and adopted children.

spouses.[29]

In addition to US census data, for robustness of results to an alternate instrumental variable, this paper also makes use of components of the publicly available samples of Canadian censuses of 1891 and 1911. Construction of key variables using the Canadian census data is identical to that of main variables using the US census data.

3.1 Measure for Typewriter Adoption

To estimate the relationship between adoption of the typewriter from 1880-1920 and women's outcomes in 1920, I first define a measure for the rate of typewriter adoption at the State Economic Area (SEA) level.[30] This measure captures the 1880 to 1920 change in the number of people working as typists in a SEA as a share of the initial working population.

$$\Delta typ_c^{1880-1920} = \frac{typ_c^{1920} - typ_c^{1880}}{WorkPop_c^{1880}} \tag{1}$$

3.2 Baseline Estimating Equation

Using this measure for growth in typing jobs at the SEA level, the relationship between change in the number of typists and women's outcomes can be defined as follows:

$$Y_{ic}^{1920} = \alpha + \beta \Delta typ_c^{1880-1920} + \Gamma X_c^{1880} + \theta K_i^{1920} + \delta_s + \epsilon_c \tag{2}$$

where Y_{ic}^{1920} represents one of the outcome variables which include women's labor force participation, having children and being married for woman i in SEA c. X_c^{1880} includes a set of 1880 SEA level control variables such as the shares of women, white collar workers, young individuals, and white individuals. Because the data are at the individual level, I can also leverage 1920 individual level controls which include age, birthplace and race. Lastly, some

[29]The intergenerational mobility analysis only focuses on White women due to the much smaller sample size of Black women that can be linked and because it was White women who were more likely to be hired as typists and thus would have most to gain in terms of marriage through the mechanism of working as typists.

[30]SEAs were either single or groups of neighboring counties within a state that had similar economic characteristics. My sample contains a total of 452 SEAs in 1880 that can be matched to 1920.

of the specifications utilize only within state variation and in these cases state-fixed effects are included as δ_s.

The ordinary least square estimates of the relationship between the adoption of the typewriter and women's outcomes represented by β in equation (2) can be biased. An example of the case in which the estimates can be biased upwards is if areas with the greatest change in typists also have better norms for women. On the other hand, these estimates can be biased downwards if the areas with greatest change in typists are ones where more non-typist women stay at home. In order to overcome these challenges, I utilize a "shift-share" approach described below.

3.3 Shift-Share Instrumental Variable

The intuition behind this empirical strategy lies in the fact that by nature of their production processes, different industries have more or less use for typists and consequently adopt the typewriter at different rates, especially early on. Consequently, the first type of variation that the empirical strategy exploits is the variation in the number of typists being hired across industries. The second type of variation that is utilized is the fact that industries have varying geographic compositions before the invention. This implies that before the adoption of the typewriter, some localities have a mix of industries that rely more heavily on the typewriter while others have industries that hire fewer typists.

Utilizing these two sources of variation, I instrument for the 1880-1920 change in typists using a shift-share IV which captures the SEA level predicted change in typists as a share of the initial working population. I define it as follows:

$$\Delta\widehat{typ}_c^{1880-1920} = \frac{\sum_k \mu_{kc}^{1880} * \theta_k}{WorkPop_c^{1880}} \tag{3}$$

where, μ_{kc}^{1880} represents employment in each industry in the pre-period for each *SEA* and θ_k depicts the *national* industry-level 1880-1920 change in the number of typists relative to initial industry employment.

To depict the intuition behind each component of the IV, I consider a simple example consisting of two localities, New York and Albany, and two industries, agriculture and printing

(see Appendix Figure 11). As anticipated, Panel A shows that the share of workers employed in printing in New York is much higher than the share of agriculture workers and vice versa in Albany (representing μ_{kc}^{1880}). On the other hand, the national industry level change in typists between 1880-1920 (θ_k) experienced by the printing industry is 10 percent and 0.2 percent for the agricultural sector (Panel B). The interaction of the initial employment shares and national shifts in typists being hired across different industries then results in the numerator of equation (3). Then, based on the initial shares and shifts experienced by industries in each locality, New York has a higher 1880-1920 predicted change in typists while Albany has a much smaller one (Panel C) [31].

Estimating Equation with IV.—I estimate the relationship between the adoption of the typewriter and women's outcomes using the following framework:

$$\Delta typ_c^{1880-1920} = \alpha' + \gamma \Delta \widehat{typ}_c^{1880-1920} + \Gamma' X_c^{1880} + \theta' K_i^{1920} + \delta_s + \nu_c \tag{4}$$

$$Y_{ic}^{1920} = \alpha'' + \tilde{\beta} \Delta \widehat{typ}_c^{1880-1920} + \Gamma'' X_c^{1880} + \theta'' K_i^{1920} + \delta_s + \tilde{\epsilon}_c \tag{5}$$

where, equation (4) captures the first stage relationship between the instrument $\Delta \widehat{typ}_c^{1880-1920}$, the 1880-1920 predicted change in typists, and the actual change in typists $\Delta typ_c^{1880-1920}$. Equation (5) presents the reduced form estimating equation where $\tilde{\beta}$ captures the reduced form effect of the predicted change in typists on women's outcomes.

Identifying Assumption and Validity Checks.—To identify the causal effect of the adoption of the typewriter, conditional on baseline and 1920 individual level controls, on women's outcomes in 1920, the 1880-1920 predicted change in typists must orthogonal to omitted characteristics correlated with women's outcomes in 1920. This assumption is formally stated as:

$$\mathbb{E}[\Delta \widehat{typ}_c^{1880-1920} \times \tilde{\epsilon}_c | X_c^{1880}, K_i^{1920}] = 0 \tag{6}$$

[31] Panel C does not only use the two industries, printing and agriculture, used to depict μ_{kc}^{1880} and θ_k but rather sums over all industries in each SEA and divides by the 1880 working age population to obtain what the shift-share IV is for each SEA.

While I cannot directly test this assumption, in Table 2, I show that, conditional on baseline and individual level controls, the instrument is uncorrelated with women's labor participation in 1880, that is the period before the shock of typewriter is realized. In the third column, I check for the presence of any pre-trends, that is whether localities more exposed to the shock of the typewriter were already on an upward trend in terms of women's labor force participation. I show that this is not the case and that the instrument is uncorrelated with change in women's labor force participation from 1870 to 1880, the decade leading up to the invention and diffusion of the typewriter. To further rule out the possibility of unobservables being correlated with both the outcome and the shock of the typewriter, I construct an alternative shift-share IV which uses "as good as random" shifts (Borusyak et al., 2022). This alternative IV constructs the national change in typists for each industry using samples from Canadian historical censuses and interacts them with initial employment shares from the US. Importantly, results are robust to using this alternative instrument [32].

Table 2: Placebo Test of Identification Strategy —
Reduced-Form Effect on Pre-Period Women's Labor Force Participation

	1880 LFP	1880 LFP	$\Delta LFP^{1870-1880}$
$\widehat{\Delta typ}^{1880-1920}$	0.518	-0.185	0.215
	(0.652)	(0.359)	(1.053)
Outcome Mean	0.260	0.260	0.110
Observations	13,887,480	13,887,480	443
Baseline Controls	Y	Y	Y
Individual Controls	Y	Y	N
State Fixed Effects	N	Y	N

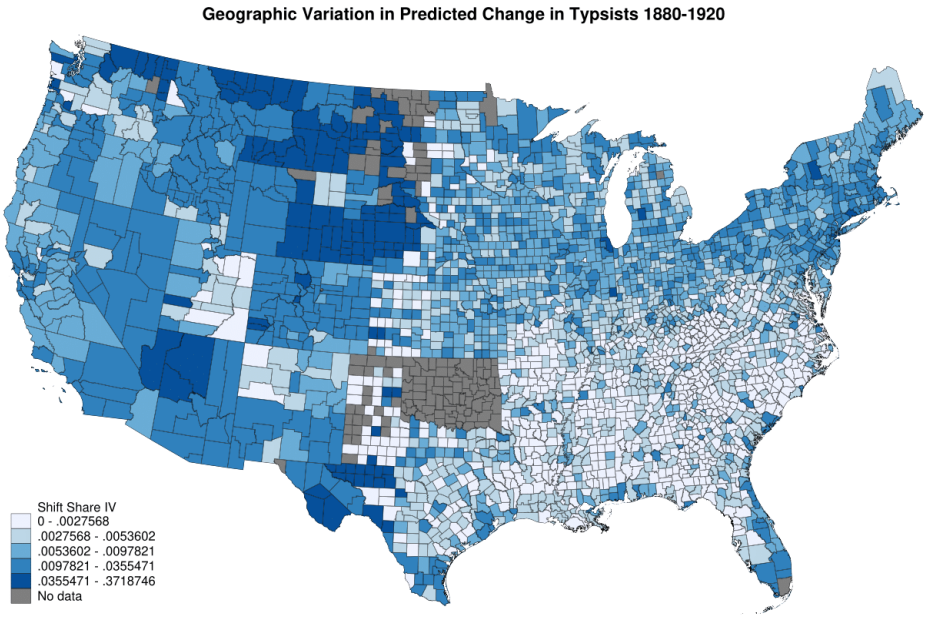
Notes: This table reports the effect of the instrument, the 1880-1920 predicted change in typists, on 1880 women's labor force participation. The regression sample is restricted to working age women. The outcome variable in first two columns is an indicator for participating in the labor force. Baseline controls include 1880 share of the SEA population that is woman, share of population that is white, share that is young, and share that works in white collar occupations. Individual controls include birthplace, birth year and race. Coefficients reported in the second column also include state fixed-effects. The third column uses the 1870 to 1880 change in women's labor force participation at the SEA level as the outcome and only includes baseline SEA characteristics as control.

Geographic Variation of IV.—Figure 3 plots a map of geographic variation in the shift-share IV. As one might expect, places that have the greatest change in predicted number of typists

[32]This alternative instrument is not used as the main specification because only samples of the 1891 and 1911 Canadian censuses record detailed industry and occupation information required for the construction of the instrument. In this case, the closest pre-period US census, the 1890 population census, no longer exists. Thus, the alternative IV still relies on 1880 for pre-period shares making it not an ideal instrument for the main specification.

are urban city centers such as Chicago and cities on the east coast which include the likes of New York and Boston. It is important to note that SEAs in the west, which aren't at that time defined as urban areas also see large changes in the predicted number of typists. This is because the railway and railroad industry is expanding west in these decades and they were one of the largest employers of typists.

Figure 3: Geographic Variation in 1880-1920 Predicted Change in Typists



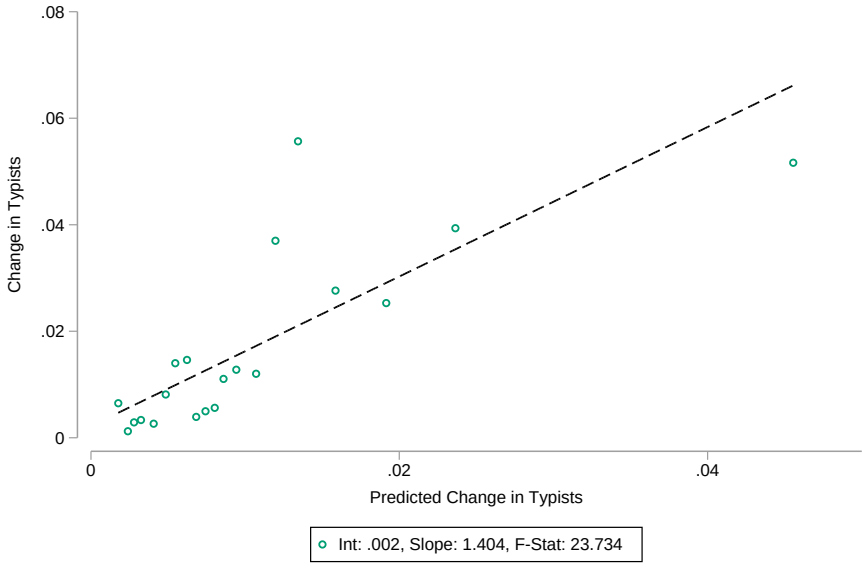
Notes: This map plots for each SEA the value of the instrument, the 1880-1920 predicted change in typists. Each of the colors correspond to ranges that correspond to different percentiles of the instrument. Starting from the lightest shade, the first range represents 0-25th percentile of values, second range represents 25th-50th, third 50th-75th, fourth 75th-90th, and fifth represents all values above the 90th percentile up until the maximum value of the change.

First Stage.— Figure 4 shows the relationship between the instrument $\Delta\widehat{typ}_c^{1880-1920}$, the 1880-1920 predicted change in typists, and the actual change in typists $\Delta typ_c^{1880-1920}$ in a binned scatterplot. There is a strong and positive relationship between $\Delta\widehat{typ}_c^{1880-1920}$, plotted on the x-axis, and $\Delta typ_c^{1880-1920}$, plotted on the y-axis. The F Statistic on the first stage is 23.7.

4 Effect of the Typewriter on Women's Outcomes

The invention and adoption of the typewriter in the US labor market represented a large scale change for women's employment. Did this change result in long term causal effects on women's outcomes such as their labor participation, marriage and fertility? While White

Figure 4: First Stage Relation between Real and Predicted Change in Typists



Notes: This figure plots a binned scatter plot of values of predicted change in typists against actual change in typists. The slope, intercept and joint test of significance (F-stat) are obtained from estimating the first stage representing equation (4).

women were more likely to be hired as typists, did the typewriter have any indirect effects on Black women's outcomes? This section outlines the first set of results on women's outcomes using complete-count Census data and sheds light on how a technological change such as the typewriter can have varying effects by race.

4.1 Women's Labor Force Participation, Marriage and Fertility

One of the contributions of this paper is to causally estimate the effect of a wide-spread female-biased workplace technological change, the typewriter, on women's outcomes. To that end, I first quantify the effect of being in a location with greater exposure to the typewriter, as captured by the predicted 1880-1920 change in typists, on women's outcomes in 1920. Figure 5 plots the effect of a 1 percentage point (pp) increase in the predicted change in typists on women's labor force participation and likelihoods of being married and having a child. Estimates including baseline and individual controls (in pink), show that the adoption of the typewriter led to a 3.3 pp increase in women's labor participation, a 2 pp decrease in women's likelihood of being married and an 1.9 pp decrease in their likelihood of having children (corresponding point estimates can be found in Table 3). Importantly, these estimates are

not sensitive to utilizing only within-state variation (coefficients in green). Table 3 presents the corresponding OLS, First Stage and 2SLS results for these outcomes.[33] Appendix Table 1 shows the reduced-form effect of the predicted change in typists on the 1880 to 1920 change in women's labor force participation at the SEA level. I find a significant and similar in effect in magnitude (4.7 pp) to the main specification at the individual level. Appendix Table 2 replicates the results for women's labor force participation in 1920 at the SEA level.

Taken together these results suggest that the adoption of the typewriter had lasting impacts on women's outcomes in the early twentieth century. Were these effects, especially on women's labor participation, a direct result of women entering occupations using the typewriter? Appendix Figure 12 shows that the effect is largely driven by typing and other occupations largely relying on the typewriter (e.g. non-classified clerical workers). In fact, there is a negative coefficient on teachers suggesting that women were substituting away from teaching in favor of office-work. This is notable because teaching employed the largest fraction of women in white-collar occupations before the invention of the typewriter.

To test for the validity of the main results, I use "as good as random" shocks to construct the shift share IV (Borusyak et al., 2022) by obtaining national changes in the share of typists employed for each industry from the Canadian censuses of 1891 and 1911. These shifts, θ_k, obtained from Canada are then interacted with initial 1880 employment shares for each industry to obtain an alternative IV. Appendix Figure 13 shows that results are robust to using this alternative IV.

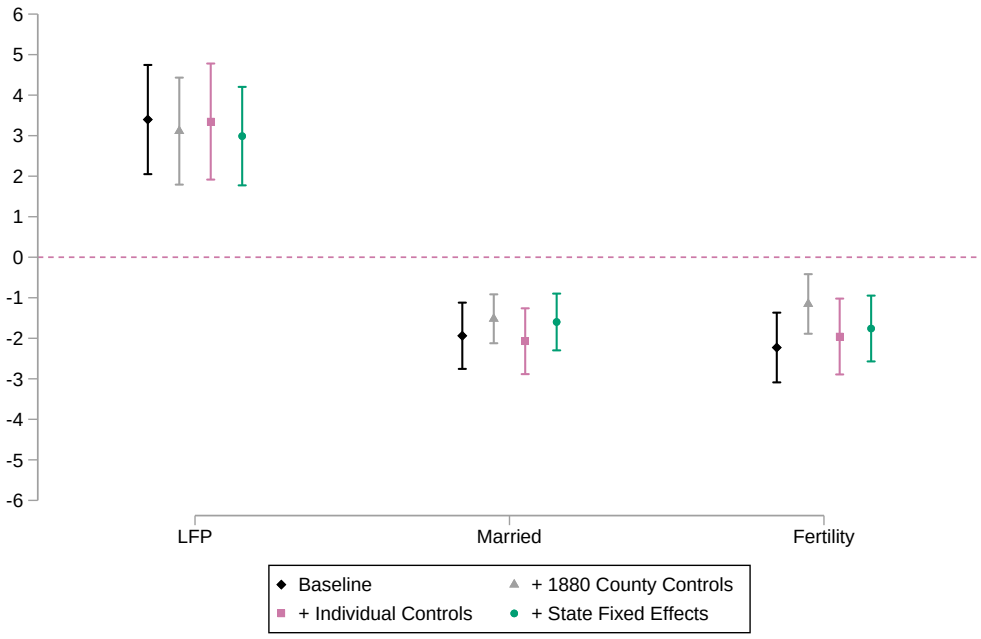
4.2 Women's Labor Force Participation in the Absence of Typewriter

To understand the magnitude of the changes brought about by the typewriter, I next ask what would have women's labor force participation rates in 1920 looked like without the shock of the typewriter? Using the reduced form estimates from Figure 5, I employ a back-of-the-envelope calculation to back out counterfactual women's labor force participation in the absence of the typewriter.

Table 4 depicts that women's labor force participation in 1920 would have been 2.4-6.5 pp lower in the absence of the typewriter. This implies that the invention and diffusion of the

[33] While the 2SLS results are similar in magnitude, they are noisier due to utilizing estimates from two steps.

Figure 5: Effect of Typewriter on Women's Labor Participation, Marriage and Fertility



Notes: This figure plots the reduced form effect of the instrument, the 1880-1920 predicted change in typists, on working-age women's likelihood of: (1) participating in the labor force, (2) marriage , and (3) having children in 1920. Coefficients in black represent reduced form effects that do not include any controls. Gray represent coefficients that control for baseline SEA characteristics including share of the SEA population that is woman, share of population that is white, share that is young, and share that works in white collar occupations. Pink represent coefficients that in addition to controlling for SEA characteristics also control for 1920 women's individual level characteristics which include birthplace, birth year and race. In addition to controlling for baseline SEA and individual characteristics, coefficients in green include state-fixed effects.

typewriter brought in an extra 760,000 - 2,000,000 women into the labor force at the turn of the twentieth century. Online Appendix outlines details of the steps employed in the back-of-the-envelope calculation.

4.3 Effect on Women's Outcomes by Race

I next ask whether the adoption of the typewriter had varying effects on women's outcomes by race? Figure 6 plots standardized coefficients[34] for women's outcomes by race after estimating equation (5) separately for each group – green for white women and pink for black women. Additionally, I plot separate coefficients in dashed lines for young women. Lastly, in gray I plot any general equilibrium effects on men as comparison.

[34]Note that though the coefficient in black for the overall effect on women corresponds to the green coefficient from Figure 5, the y-scale is different. This is because the coefficients and corresponding confidence intervals have been standardized.

Table 3: Effect of Typewriter on Women's LFP, Marriage and Fertility

	LFP	LFP	Married	Married	Fertility	Fertility
Panel A: First Stage						
$\widehat{\Delta typ}^{1880-1920}$	0.806	1.380	0.806	1.380	0.806	1.380
	(0.363)	(0.394)	(0.363)	(0.394)	(0.363)	(0.394)
F-Stat	10.85	11.44	10.85	11.44	10.85	11.44
Panel B: OLS						
$\Delta typ^{1880-1920}$	0.328	0.479	-0.144	-0.190	-0.249	-0.326
	(0.128)	(0.087)	(0.079)	(0.037)	(0.119)	(0.060)
Panel C: Reduced Form						
$\widehat{\Delta typ}^{1880-1920}$	3.348	2.988	-2.072	-1.598	-1.957	-1.759
	(0.729)	(0.618)	(0.413)	(0.356)	(0.476)	(0.413)
Panel D: 2SLS						
$\Delta typ^{1880-1920}$	4.156	2.166	-2.573	-1.158	-2.429	-1.275
	(2.453)	(0.799)	(1.453)	(0.442)	(1.431)	(0.503)
Outcome Mean	0.256	0.256	0.646	0.646	0.535	0.535
Observations	31,221,453	31,221,453	31,221,453	31,221,453	31,221,453	31,221,453
Baseline Controls	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
State FE	N	Y	N	Y	N	Y

Notes: This table reports coefficients corresponding to the main figure. Specifically it reports coefficients from the first stage regression of the predicted and real change in typists (Panel A), OLS regressions using real change in typists (Panel B), reduced form regression of the predicted change in typists on outcomes (Panel C) and corresponding 2SLS regression (Panel D). Panel C represents coefficients reported in Figure 6. All regressions include baseline SEA level controls and individual level controls corresponding to the main figure. Columns 2, 4 and 6 include state fixed effects.

Table 4: Contribution of Typewriter to Women's LFP in 1920 – Back-of-the-Envelope Calculation

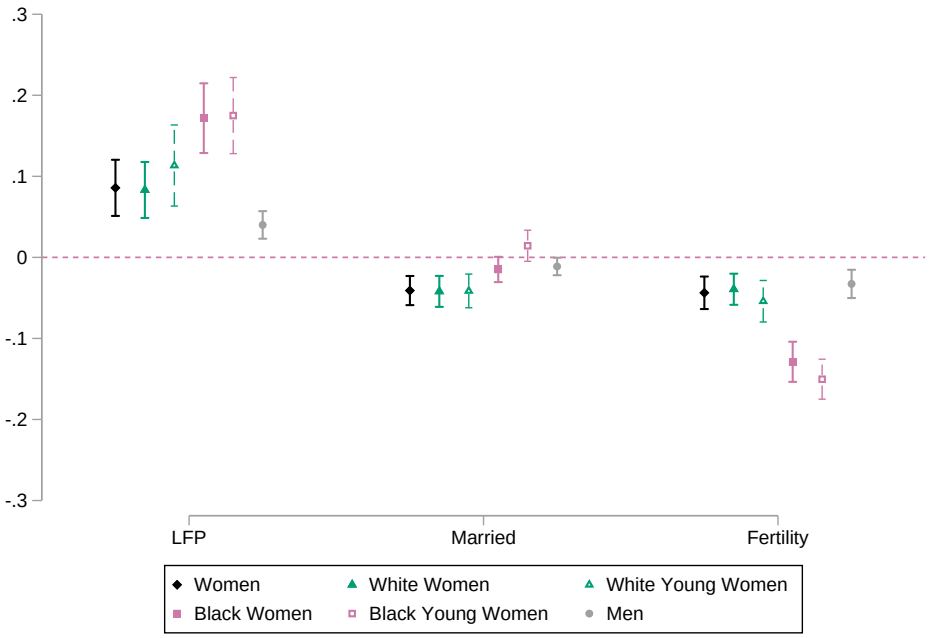
	Point Estimate	95% CI Low	95% CI High
Reduced-Form Effect	3.104	1.733	4.474
Women in Labor Force in 1920	8,092,995	8,092,995	8,092,995
Working-Age Women in 1920	31,822,316	31,822,316	31,822,316
WLFP 1920 Real	0.254	0.254	0.254
WLFP 1920 without Typewriter	0.209	0.230	0.189
Increase in WLFP due to Typewriter (pp)	4.505	2.443	6.566
Women in LF due to Typewriter	1,406,417	762,763	2,050,071

Notes: This tables presents results from the back-of-the-envelope calculation to obtain counterfactual women's labor force participation in 1920

I note that the adoption of the typewriter has a large and precise effect on Black women's labor participation – notably larger than that on White women's labor participation. However, higher labor participation rates for Black women do not translate into lower marriage rates for them as they do for White women. At the same time, Black women experience large decreases in fertility as a consequence of the typewriter. The effects are slightly larger when only young, aged 16-30, White women are considered in comparison to all working-age White women.

However, effects are not larger if only young Black women are looked at as the sample of interest in comparison to all Black women. Lastly, the effects on men's outcomes are closer to 0 and significantly smaller than the effect magnitudes for women. I interpret these small but significant effects on men's outcomes as general equilibrium effects

Figure 6: Heterogeneity of Main Results by Race and Gender



Notes: This figure plots standardized coefficients for each of the groups in the legend. Young captures women between the ages of 16-30 only. Coefficients control for baseline SEA characteristics, individual characteristics (not including race) and state fixed effects. Details of outcomes and control variables follow from notes of Figure 5

4.4 Mechanisms

Thus far, I have documented that typewriter adoption led to an increase in women's labor participation and a decrease in their fertility and marriage with an indirect and large effects on Black women's labor participation and fertility. Below, I outline the mechanisms driving these results.

Indirect Crowding-In Effect on Black Women's Outcomes.— To understand the driving forces behind the large increase in Black women's labor participation, I first turn to the industries that Black and White women are entering in response to the adoption of the typewriter.

Figure 7 Panel A plots the reduced-form effect of a predicted change in typists on the

likelihood of Black and White women entering each of the different industries. I find that as white women leave the household to join industries such as transportation (predominantly railways), trade, finance and business services, Black women enter manufacturing and largely domestic services in response. Panel B then focuses on categories of occupations and shows that the result for industries is corroborated by the fact that Black women are seeing the largest increase in employment in household services and white women in clerical work in response to the typewriter. This is consistent with a "crowding-in" effect, whereby as White women left housework to enter offices, this increased Black women's labor participation who substituted for White women by entering domestic services work.

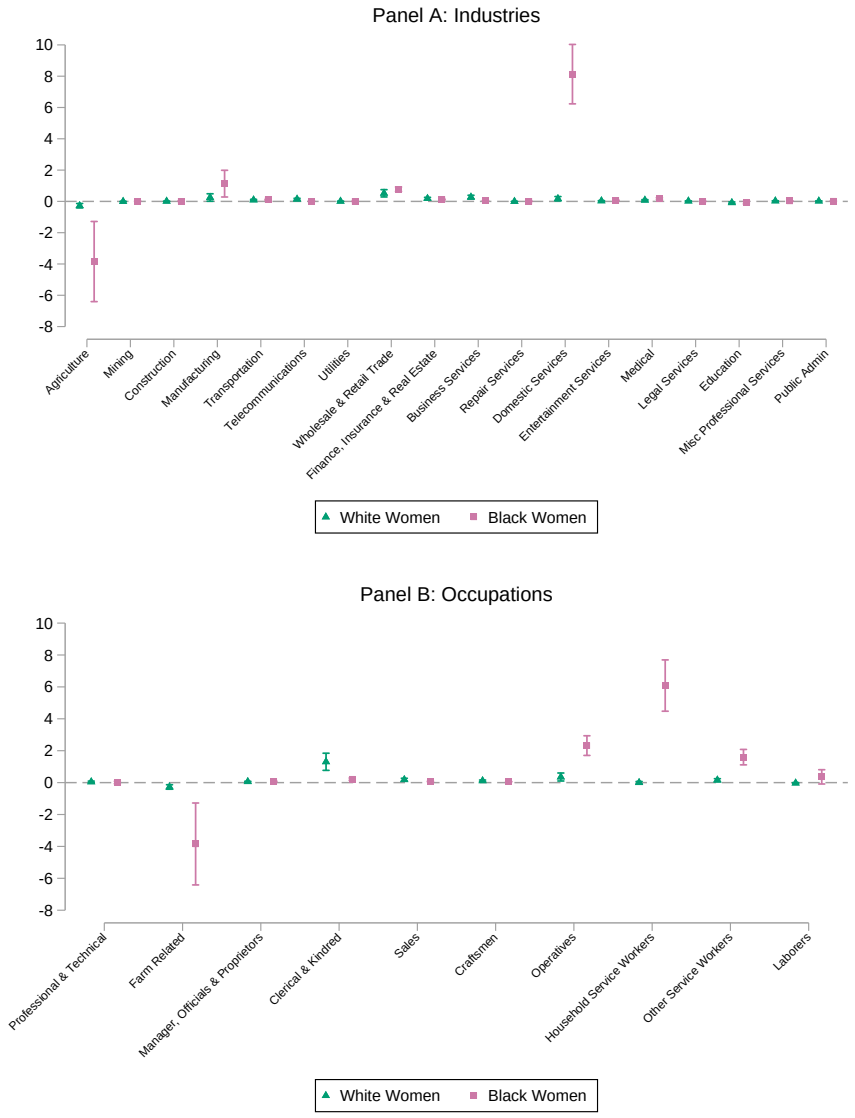
Marriage and Fertility Decisions.— Are women affected by the typewriter never getting married and never having kids or simply delaying these decisions and how does this vary by race?

Figure 8 Panel A plots the probability of White women being married at each age between 16 to 40 split by women who are more versus less exposed to the typewriter [35]. Exposure is captured as counties with an above or below median predicted change in typists. I find that at all ages, White women in SEAs with above median exposure to the typewriter have a lower probability of being married. However, there is a significant reduction in the gap in the late twenties implying that some while some of the women with greater exposure to the typewriter are never getting married, some are instead delaying and getting married at later ages. Panel B plots the probability of these women having children, conditional on being married, and we find a consistent gap at all ages between women in above median and below median exposure SEAs. Specifically, White women in above median exposure localities are significantly less likely to have children than women in below median areas.

Figure 8 Panels C and D plot these probabilities for Black women in 1920. In Panel C, we note that earlier in the age distribution, there is no significant difference in the probability of being married for Black women in above vs below median exposure counties. There is a small gap between the two in the late twenties and thirties which might arise from some Black women, who were more exposed to the shock, never getting married. Panel D shows a large and statistically significant gap in the probability of Black women having children for those

[35] See Appendix Figure 14 for these figures replicated for all working age women.

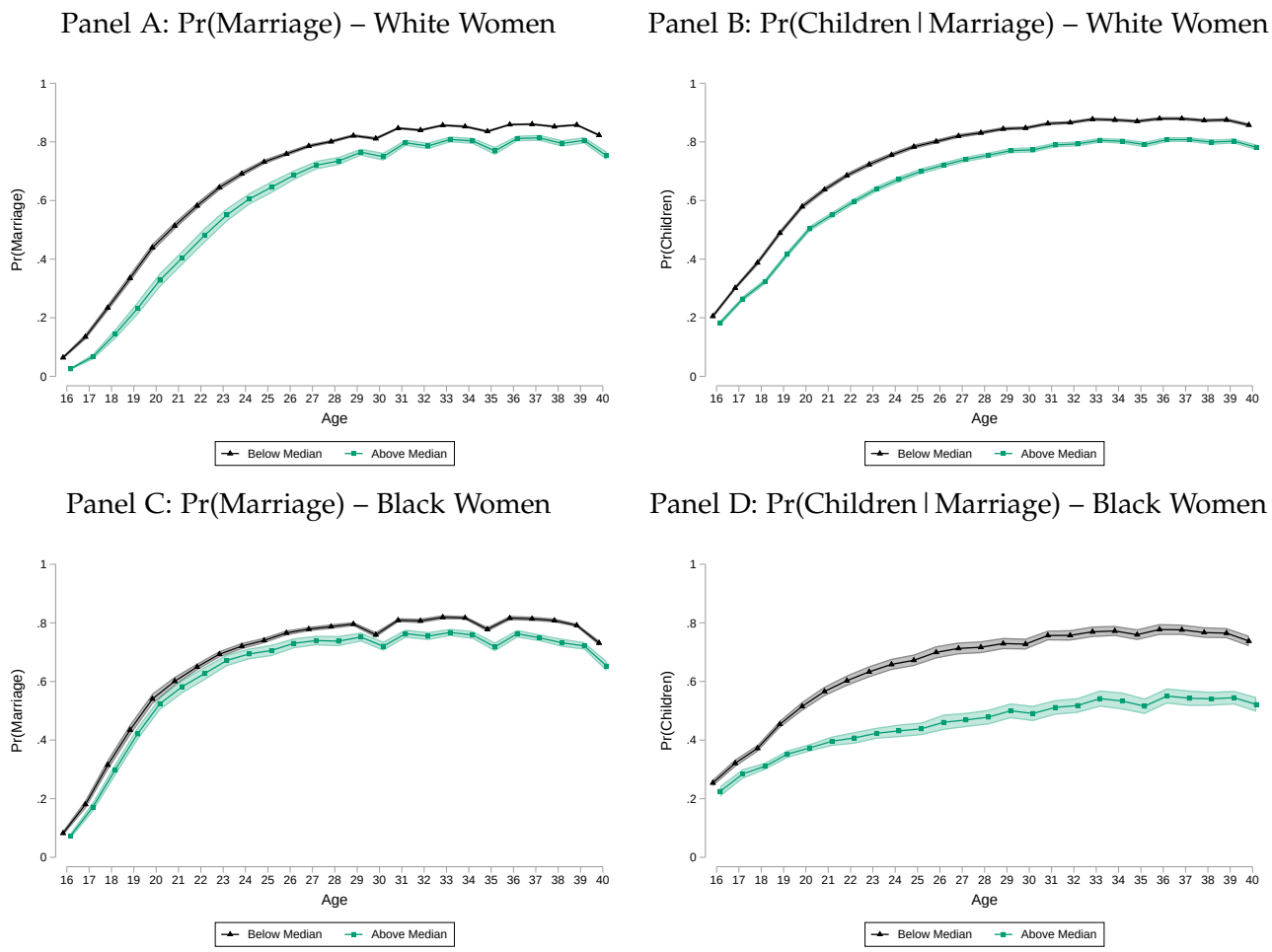
Figure 7: Effect of Typewriter on Employment in Industries and Occupations by Race



Notes: This figure plots the reduced-form effect of the instrument, the 1880-1920 predicted change in typists, on Black (pink) and White (green) women's likelihood of working in industry (Panel A) and occupation (Panel B) groups. All regressions include controls for baseline SEA characteristics, individual characteristics, and state fixed effects. Details of controls can be found in notes to Figure 6.

in above vs below median areas. Specifically, Black women in SEAs with an above median predicted change in typists are less likely than Black women in below median SEAs to have children at all ages. This finding is corroborated by the fact that in response to the shock of the typewriter, Black women were substituting away from agriculture, an occupation where their children could accompany them, to domestic services, where children could not be brought to work. Furthermore, in the data, Black women working in domestic services are 15 percent less

Figure 8: Probability of Marriage & Children by Age



Notes: This figure reports the probability of being married and having children, conditional on being married, for White and Black women at various ages who are residing in SEAs with above vs below median predicted change in typists in 1920. Panel A reports the probability of being married for White women in each age group and Panel B reports the probability of having children conditional on being married. Panels C and D report these probabilities for Black women.

likely to have children when compared to other Black employed women in the same locality.

5 Women's Intergenerational Mobility Through Marriage

The adoption of the typewriter created a unique opportunity for women to enter the office space which consequently allowed them to work alongside men, especially men of higher socioeconomic status. Did interacting with men in the office also help foster relationships between typists and their bosses and allow women to marry men of higher income than they would otherwise?

5.1 Descriptive Results

I begin by addressing this question descriptively and study whether typists marry men of higher income than comparable women who were not employed as typists. I follow women over time from 1920 to 1940 using linked Census data described in Section 3. In order to study women's intergenerational mobility through marriage, both the women's parents' income and her husband's income are needed. For this reason, I restrict the sample to women living in the same household as their fathers in 1920 and living with their spouse in 1940 Census. Because the 1920 Census did not ask for income, to obtain a measure for father's socioeconomic status I rely on a constructed income-score measure based on father's occupation, race, location, age and birthplace following Abramitzky et al. (2021).[36] Spousal income is obtained from the 1940 Census which recorded incomes at the individual level. Because in the long-run women frequently dropped out of the labor force upon marriage (Goldin, 1983) and only 13% of the 1.2 million married women in the linked sample of white women are recorded as having an occupation in 1940, [37] to measure intergenerational mobility of women through marriage, I compare a woman's father's economic status to that of her husband's. This approach to measuring women's historical intergenerational mobility has also been used in Eriksson et al. (2023) and Buckles et al. (2023).

Estimating Equation.—To estimate the relationship between working as a typist and future spousal income, I use the following regression:

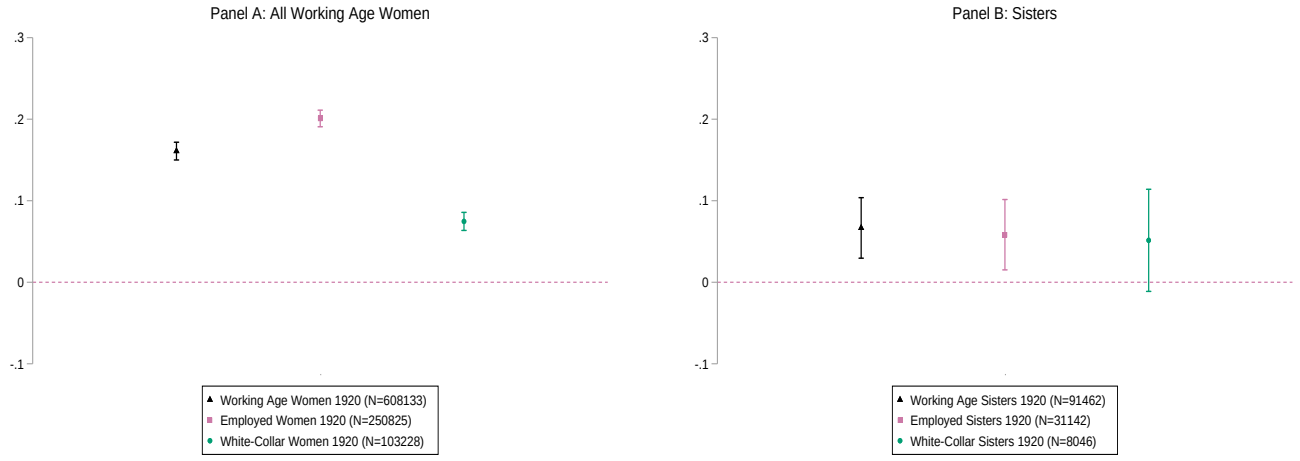
$$LogIncome^{1940}_{spouse} = \alpha + \beta \mathbb{1}(Typist^{1920}) + \gamma IncomeScore^{1920}_{father} + \Gamma X_i + \delta_c + \epsilon_i \tag{7}$$

where, the outcome variable is the logarithm of spousal income in 1940 and $\mathbb{1}(Typist^{1920})$ represents an indicator variable which is equal to 1 if the woman worked as typist in 1920. This specification controls for father's income score in 1920, the woman's birthplace, birth year and race. I also include 1920 county fixed-effects to only compare women living in the same county in 1920.

[36] A detailed description for the construction of this measure is described in the Online Appendix and can also be found in Abramitzky et al. (2021). I also test for robustness of results to alternative measures such as the occupation score provided by IPUMS in the Appendix.

[37] In comparison, 42% of the linked women are employed in 1920 when they were single.

Figure 9: Differences in Future Spousal Income of Typists and Non-Typists



Notes: This figure plots differences in spousal income of typists and non-typist working age women (Panel A) and only non-typist sisters (Panel B). Each plot uses three subsamples: (1) all working-age women (sisters) in 1920, (2) only employed women (sisters) in 1920, and (3) women (sisters) employed in white-collar occupations in 1920. Spousal income is obtained from the 1940 Census. All regressions include controls for father's income score in 1920, birth year, birthplace, and race. In addition, Panel A includes county fixed effects and Panel B includes household fixed effects.

Relationship Between Working as a Typist and Future Spousal Income.— Figure 9 Panel A plots the β coefficients obtained from equation (7) for three different samples. The first sample includes all working-age women in 1920 (coefficient plotted in black), the second only includes women who were employed in 1920 (gray) and the third further restricts to women working in white-collar occupations in 1920 (green). I find that compared to working-age women living in the same county in 1920, controlling for differences in fathers' economic status in 1920, birthplace, birth cohort and race, women working as typists were more likely to marry a spouse of higher socio-economic status. This relationship holds in comparison to employed women and women working in other white collar occupations. I next turn to only comparing sisters using a within-household analysis.

Within-Household Analysis.— Figure 9 Panel B plots coefficients that include 1920 household fixed effects. This allows for a comparison between sisters which eliminates unobservable differences across childhood households and families that might bias the results above.

I find that typists marry men of higher socio-economic status compared to their sisters who were also of working age in 1920 (in black). Comparing only to sisters who were employed in 1920 (gray) and working in white-collar occupations (green), the positive relationship still holds. However, for the last two comparisons, due to a smaller sample of sisters, coefficients

are less precise.

Relationship Between Working as a Typist and Intergenerational Mobility.— Lastly, to estimate the relationship between working as a typist in 1920 and women's intergenerational mobility, I rely on the following rank-rank specification:

$$Rank\ Husband = \alpha + \beta_0 \mathbb{1}(Typist^{1920}) + \beta_1 Rank\ Father + \beta_2 \mathbb{1}(Typist^{1920}) \times Rank\ Father + \epsilon \quad (8)$$

where, $\mathbb{1}(Typist^{1920})$ is an indicator variable that equals one when a woman is recorded as working as a typist in 1920. *Rank Husband* is measured based on 1940 income of the husband of the woman linked from the 1920-1940 census. *Rank Father* is her father's rank in 1920 based on an occupational income score measure (Abramitzky et al., 2021). Husbands and fathers are ranked in the national income distribution of their respective cohorts following Chetty et al. (2014, 2020). The constant term, α, then represents the absolute rank mobility, based on husband's income, for women not working as typists. β_0 measures the difference in this expected husband rank for women who worked as typists in 1920. β_1 captures relative mobility through marriage of women who were not employed as typists, that is the association between women's fathers' ranks and their husbands' ranks. Lastly, β_2 measures how this relative mobility differs for women who were employed as typists, or how the intergenerational mobility through marriage differs for women who worked and did not work as typists.

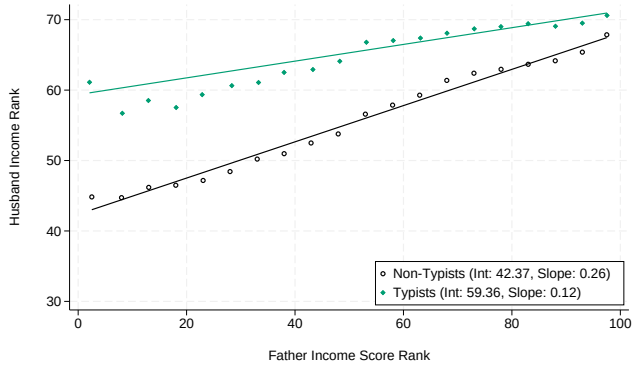
Figure 10, Panel A plots regression lines corresponding to equation (8) and a binned scatterplot showing husband's mean income rank by father's income ventile for women who worked and did not work as typists in 1920. Panel A shows that future husbands of typists out-earned husbands of non-typists for every ventile of father's income distribution, with gaps being the greatest for women born to fathers at the bottom of the distribution. In fact, women born to fathers at the 25th percentile who worked as typists married men with an average income rank that was 13.5 percentiles above the average rank of husbands of non-typists.

Figure 10, Panel B replaces the indicator for working as a typist in equation (8) with an indicator measure for working as a teacher in 1920 and plots corresponding regression lines and a binned scatterplot showing husband's mean income rank by father's income ventile for women working as teachers and non-teachers in 1920. Compared to Panel A, teachers depicted in Panel B, do not enjoy the same economic mobility advantages. Teachers with fathers at the 25th percentile of the income distribution are able to marry men with an average income

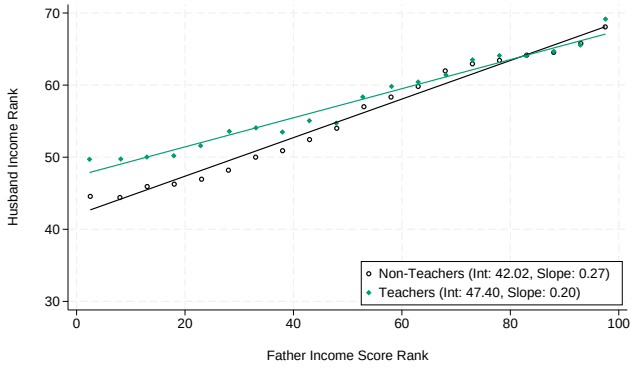
rank only 3.7 percentiles higher than the average income rank of non-teachers (compared to 13.5 percentiles for typists). This slight gap in mobility between teachers and non-teachers disappears at the upper tail of the fathers income distribution. While teachers and non-teachers with fathers at the 75th percentile have no significant difference in average rank of husband, typists with fathers at the 75th percentile are married to men with an average income rank that is 6.7 percentiles higher than non-typists.

Figure 10: Typewriter and the Intergenerational Mobility of Women

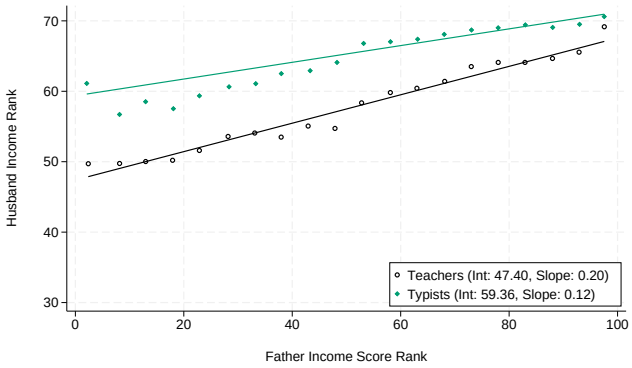
Panel A: Typists and Non-Typists in 1920



Panel B: Teachers and Non-Teachers in 1920



Panel C: Typists vs Teachers in 1920



Notes: Panel A plots the mean income rank of husband by father's income rank, for typists and non-typists. Panel B uses an indicator for working as a teacher in 1920 instead in equation 8. Panel C restricts the sample only to typists and teachers so that non-typists from equation 8 are in fact teachers. Husbands are assigned percentile ranks relative to all other husbands born in the same birth year. Fathers are ranked relative to all fathers with children born in the same birth year.

Lastly, Panel C restricts the sample only to typists and teachers and re-runs the regression specified in equation (8) to depict gaps in upward mobility when comparing typists and teachers. I find that for typists and teachers with fathers at the 25th percentile, typists marry men with average income ranks that are 10 percentiles higher than the husbands of teachers. This mobility gap between typists and teachers persists regardless of fathers income score

rank. Additionally Appendix Figure 15, Panels A-C, use the occupation score measure provided by IPUMS for father's socio-economic status and show that the results of Figure 10 are not sensitive to using constructed father's income scores.

5.2 Causal Effect of Typewriter Adoption on Women's Economic Mobility

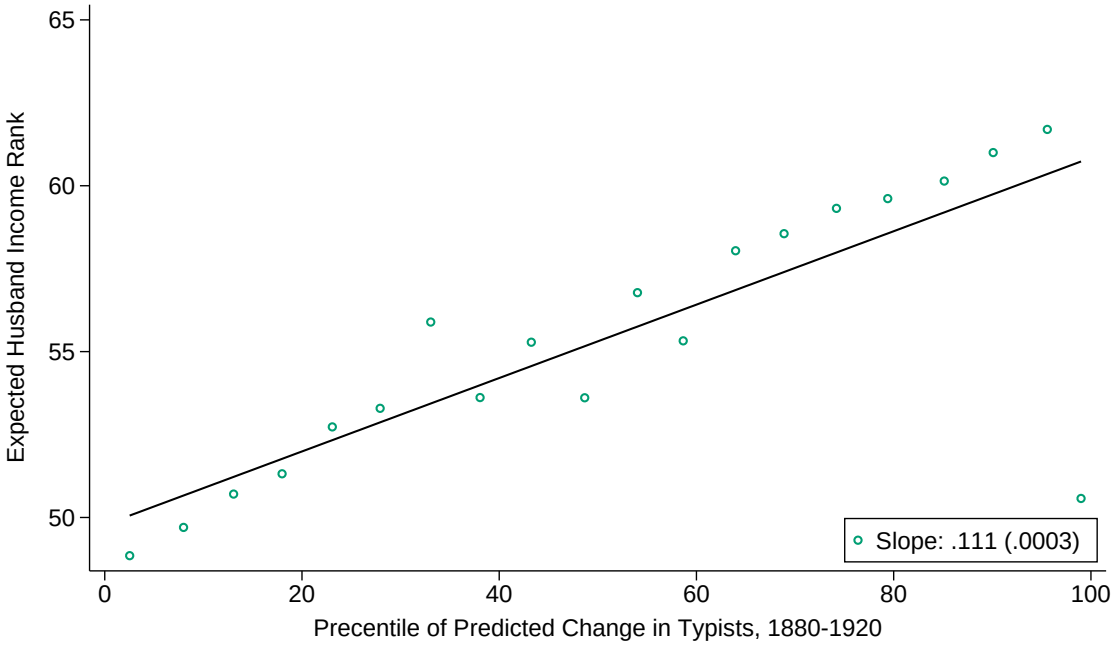
A key contribution of this paper is to study the causal impact of a technological change on women's intergenerational mobility. To estimate a causal relationship between typewriter adoption and women's intergenerational mobility, I instrument for typewriter adoption using the 1880-1920 predicted change in typists.

Figure 11 plots a binned scatterplot to show the relationship between ventiles of the instrument, the predicted change in typists, and expected spousal income rank. Specifically, husband's mean *expected* income rank conditional on father's socio-economic status is obtained by regressing observed husband income rank on father's income score rank as well as the woman and her husband's birthplaces and ages. It shows a striking positive relationship between increasing exposure to the typewriter as captured by the instrument and the expected income rank of women's future husbands. Specifically a 1-percentile increase in exposure to the typewriter leads to a 0.11 percentile increase in future husband's income. This key result implies that greater to exposure typewriter allowed women to marry men of higher income rank. Appendix Figure 16 does not rely on an income score measure for fathers and instead directly uses father's occupation, age, and birthplace to obtain husband's expected income rank and shows that results are not sensitive to the usage of constructed father's income score.

Appendix Figure 18 restricts attention to women growing up with fathers at or below the 25^{th} percentile of the income distribution and plots the relationship between the expected logarithm of husband's income and exposure to the typewriter as measured by the instrument.[38] Again, a positive relationship is observed and I find that locations with a greater change in typewriter adoption offer the chance for women, who grew up in the bottom 25^{th} percentile of the income distribution, to find a spouse with higher income.

[38] Appendix Figure 17 shows using bins of OccScore in the complete count census of 1920 that a significant number of female typists can be expected to be drawn from the bottom of distribution of father's socioeconomic status.

Figure 11: Typewriter Exposure and Husband's Expected Income



Notes: This figure plots a binned scatterplot depicting the relation between ventiles of the instrument, the 1880-1920 predicted change in typists, and husband's expected income rank. Father's 1920 income is based on an occupational income score measure. Husband's income is recorded from the 1940 census. The sample is restricted to white women who are linked from the 1920 to 1940 census and are recorded as being single in 1920 and married in 1940. Controls include spouse's year of birth, spouse's birthplace, spouse's race, own birth year, own birthplace, own race, and father's age.

Key Mechanism.— Combining the descriptive and causal results, I argue that greater exposure to the typewriter allowed women to marry men of higher income because pre-existing alternative occupations at the time, such as teaching, did not allow women to work alongside and interact with men of higher socio-economic status. While I cannot directly test this hypothesis in the data as individual workplaces are not recorded in the census, I provide suggestive evidence in support of this hypothesis by following the husbands, that the women are recorded as being married to in the 1940 census, back to the 1920 census. Using this approach I document two relationships: (1) husbands of typists are 0.5 pp more likely to be living in the same county as their future wives in 1920 than husbands of non-typists, and (2) husbands of typists are 0.4 pp more likely to be working in white collar occupations in the same county as their future wives as compared to husbands of non-typists.

Evidence for this mechanism can also be found in works of historians such as Kwolek-Folland (1998) and Waller (1986) who document the existence of relationships between women working in offices and their male colleagues, especially their bosses, at the time and their

resulting marriage. In fact, popular magazine short stories at the time often featured "the 'typewriter' or stenographer who 'married the boss'" and emphasized that "marriage was the ultimate goal of office women" (Kwolek-Folland, 1998). These themes are also found in other forms of print media such as advertisements (Appendix Figure 2, Panel C) and postcards (Library of Congress, 1909)[39]. Combining the evidence found in the data, from narratives at the time, and accounts of historians, I conclude that the typewriter became a channel of upward mobility by allowing women to work alongside men of higher socioeconomic status at a time when other occupations for women did not provide them with such an opportunity.

6 Conclusion

The 19th and 20th centuries saw dramatic changes for women's status in the US economy. The invention and adoption of the typewriter in this time period presents a unique episode of a large female-biased technological change that had many unintended long-term consequences on women's changing roles in the economy.

By creating millions of jobs for women, adoption of the typewriter led to an increase in women's labor participation and a decrease in their marriage and fertility rates. I find that the typewriter not only changed White women's outcomes by allowing them to enter offices but also affected Black women's outcomes. In fact, as White women left the household to join office-work, Black women substituted for them by gaining employment in domestic services. Thus, typewriter adoption led to a crowding in effect for Black women and increased their labor participation.

Through entry into the office, for the first time women were able to work alongside men of higher socioeconomic status in a unique environment. This allowed many women to marry men of higher socioeconomic status than they would otherwise. I show that women who worked as typists married men of higher socioeconomic status in comparison to their sisters who worked in comparable occupations. By allowing women to marry higher earning men, the adoption of the typewriter became an engine of intergenerational mobility for hundreds of thousands of women in the 20th century.

[39] A popular postcard image from 1909, titled "I love my wife but oh! you kid," depicts a relationship between a secretary and her boss.

In a world of rapid technical change, the findings of this paper have important implications for understanding unintended consequences of such changes. They highlight that technological changes can have varying effects on different types of workers who might not be directly affected by the technical change. In the case of the technological change offered by the invention of the typewriter, it had large unanticipated effects on Black women's outcomes. In light of these results, a case is to be made for the consideration of both direct and indirect effects of new technology adoption.

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Appendix Tables and Figures

Appendix Table 1: Effect on 1880-1920 Change in Women's Labor Force Participation

	First Stage	OLS	Reduced Form	2SLS
$\widehat{\Delta typ}^{1880-1920}$	1.404		4.709	
	(0.145)		(0.635)	
$\Delta typ^{1880-1920}$		1.565		3.355
		(0.310)		(0.374)
Observations	452	452	452	452
Baseline Controls	Y	Y	Y	Y
First Stage F-Stat	29.649	29.649	29.649	29.649

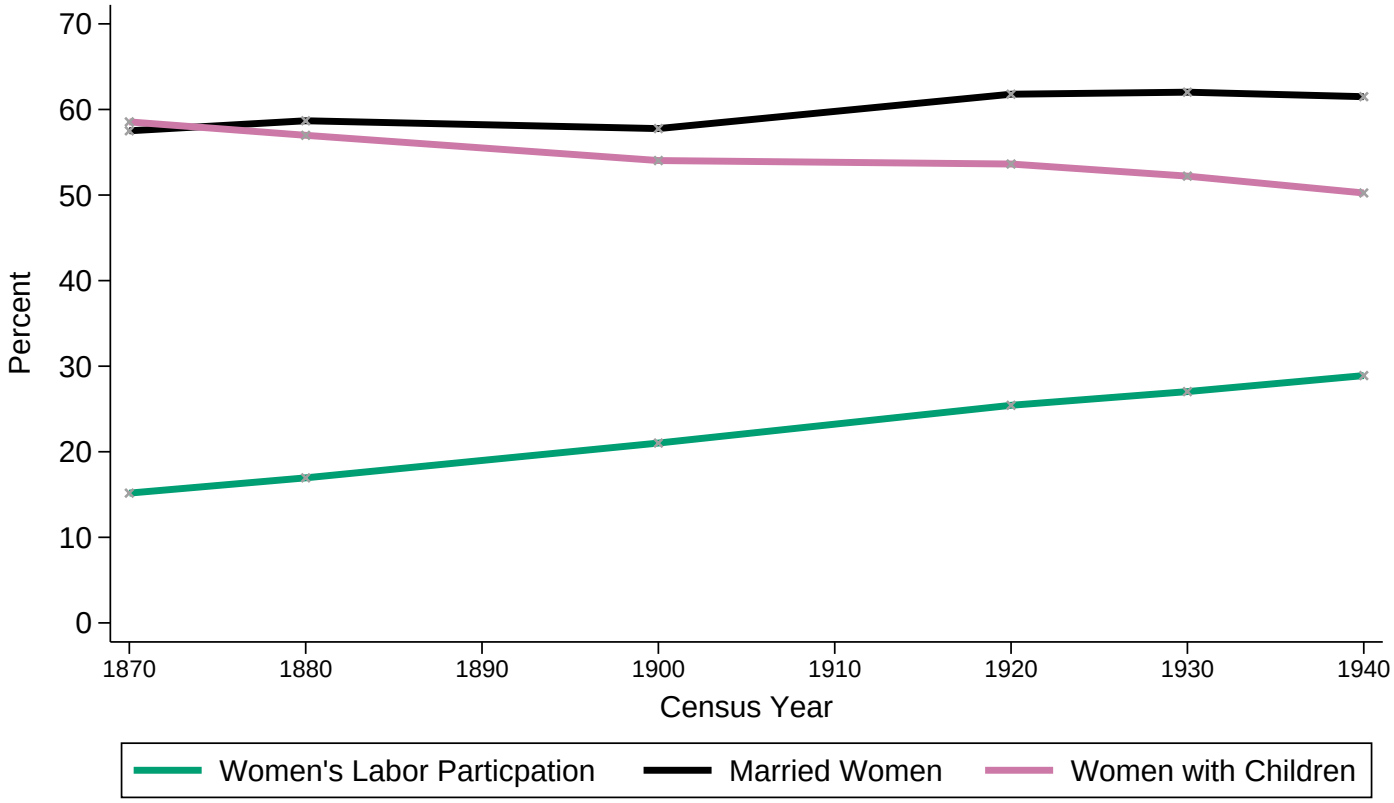
Notes: This table reports the coefficients from the first stage regression of the predicted and real change in typists (column 1), OLS regression of real change in typists on the 1880-1920 change in women's labor force participation (column 2), reduced form regression of the predicted change in typists on change in women's labor participation (column 3) and corresponding 2SLS regression (column 4). All variables are constructed at the SEA level and regressions are weighted by the share of working age women in an SEA in 1880. All regressions include baseline SEA level controls.

Appendix Table 2: Main Results at SEA Level

	LFP	Married	Fertility
Panel A: First Stage			
$\widehat{\Delta typ}^{1880-1920}$	0.765	0.765	0.765
	(0.389)	(0.389)	(0.389)
F-Stat	17.73	17.73	17.73
Panel B: OLS			
$\Delta typ^{1880-1920}$	0.330	-0.110	-0.203
	(0.116)	(0.057)	(0.090)
Panel C: Reduced Form			
$\widehat{\Delta typ}^{1880-1920}$	3.104	-1.509	-1.132
	(0.697)	(0.316)	(0.378)
Panel D: 2SLS			
$\Delta typ^{1880-1920}$	4.059	-1.973	-1.480
	(2.659)	(1.225)	(1.015)
Outcome Mean	0.256	0.646	0.535
Observations	452	452	452
Baseline Controls	Y	Y	Y

Notes: This table reports coefficients corresponding to the main figure but at the SEA level. These only include baseline SEA level controls. Specifically it reports coefficients from the first stage regression of the predicted and real change in typists (Panel A), OLS regressions using real change in typists (Panel B), reduced form regression of the predicted change in typists on outcomes (Panel C) and corresponding 2SLS regression (Panel D). Outcome variables include women's labor force participation in 1920, share of women who are married in 1920, and share of women with children in 1920. Working age women are used in the denominator for shares. All variables are constructed at the SEA level and regressions are weighted by the share of working age women in an SEA in 1920. All regressions include baseline SEA level controls corresponding to the main figure.

Appendix Figure 1: Women's Labor Force Participation, Marriage and Fertility Rates, 1870-1940



Notes: This figure plots women's labor force participation rate (green), share of married women (black) and share of women with children (pink) from 1870-1940. The denominator includes working age women (aged 16-64). Numbers for each decade are calculated from the US population decennial censuses.

Appendix Figure 2: Typewriter Advertisements

Panel A: 1875



Panel B: 1905

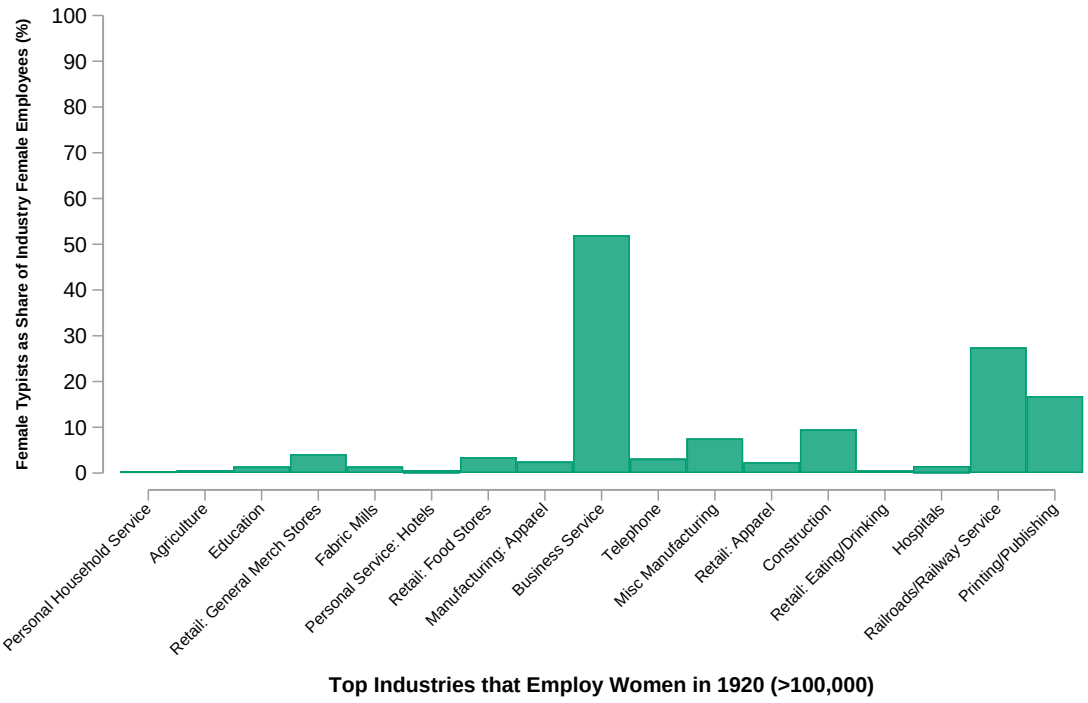


Panel C: 1939



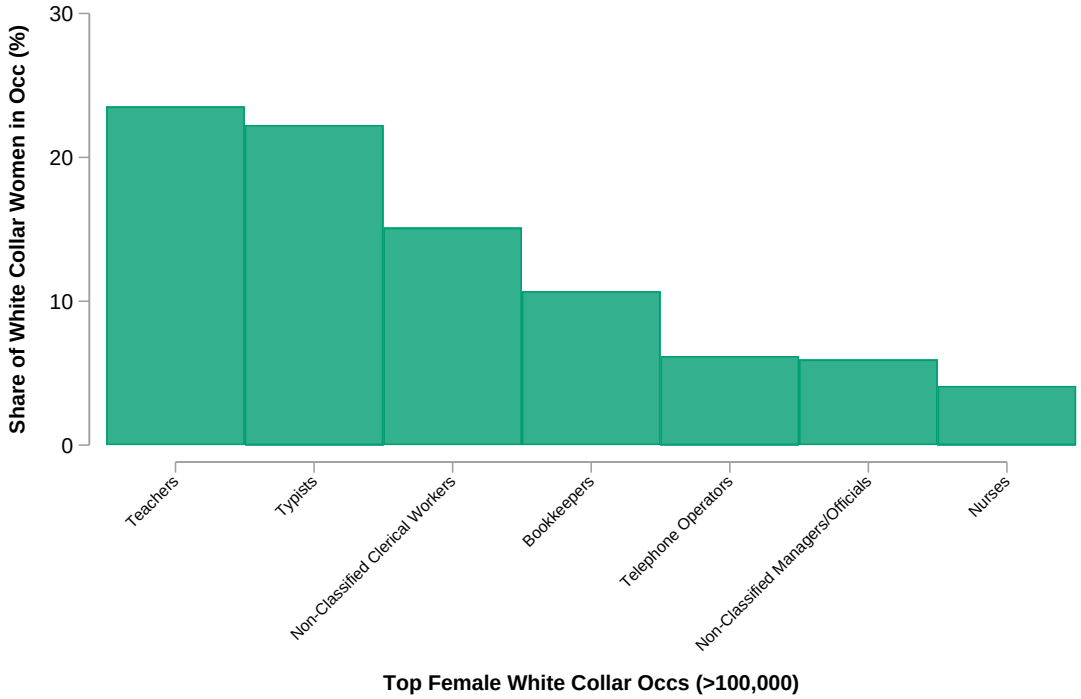
Notes: This figure plots three different historical advertisements for the typewriter: (1) Panel A is an ad from 1875, (2) Panel B from 1905, and (3) Panel C from 1939.

Appendix Figure 3: Share of Typists in Top Industries Employing Women, 1920



Notes: This figure plots women's labor force participation rate (green), share of married women (black) and share of women with children (pink) from 1870-1940. The denominator includes working age women (aged 16-64). Numbers for each decade are calculated from the US population decennial censuses.

Appendix Figure 4: Outside Option of Female Typists, 1920

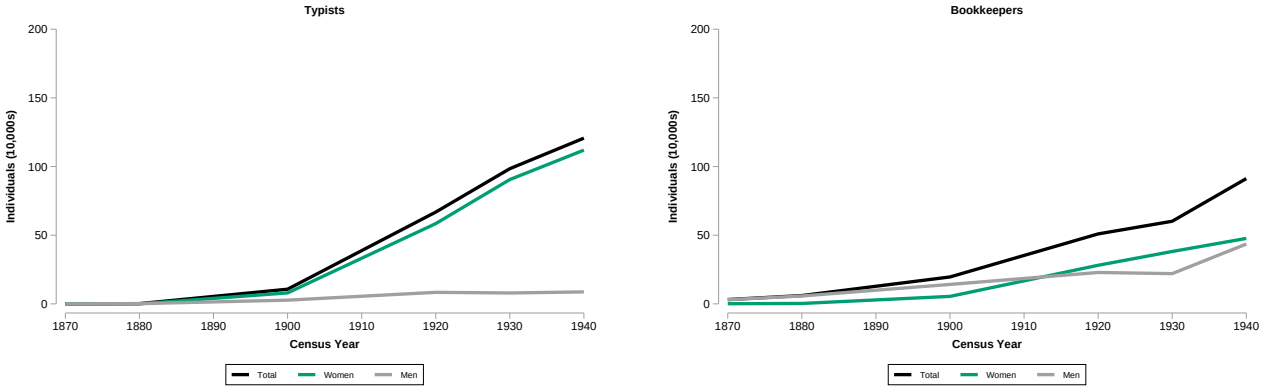


Notes: This figure plots women working in each of the listed occupations on x-axis as a share of the total working-aged women employed in white-collar occupations in 1920.

Appendix Figure 5: Evolution of Typing vs Bookkeeping

Panel A: Typing

Panel B: Bookkeeping

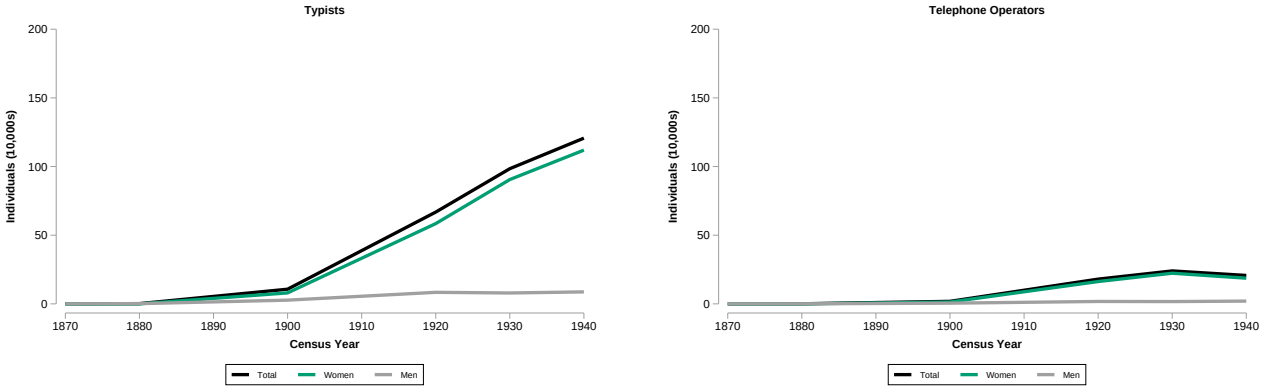


Notes: This figure plots the numbers of men and women working in the typing (Panel A) and bookkeeping (Panel B) occupations from 1870-1940. The y-axis represents numbers of individuals in 10,000s. Green line plots number of women, gray plots men and black plots the total number of employees.

Appendix Figure 6: Evolution of Typing vs Telephone Operation

Panel A: Typing

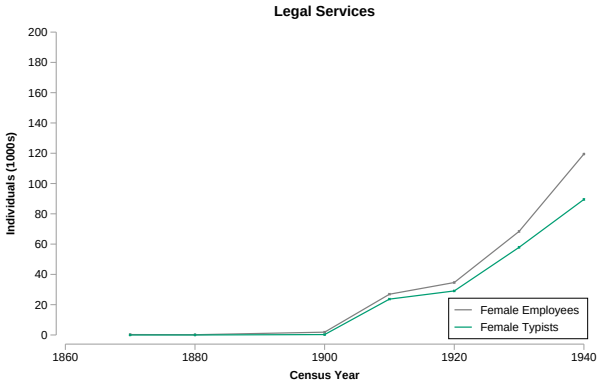
Panel B: Telephone Operation



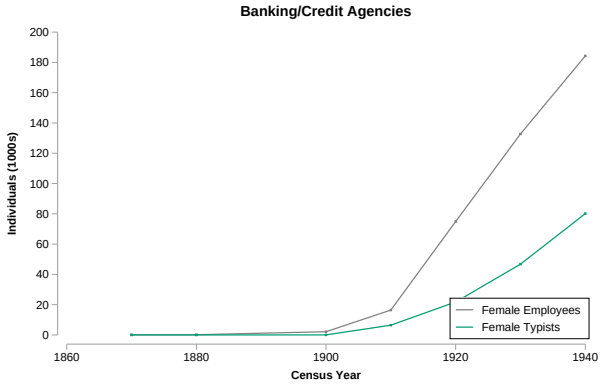
Notes: This figure plots the numbers of men and women working in the typing (Panel A) and telephone operation (Panel B) occupations from 1870-1940. The y-axis represents numbers of individuals in 10,000s. Green line plots number of women, gray plots men and black plots the total number of employees.

Appendix Figure 7: Entry of Women into Industries as Typists

Panel A: Legal Services

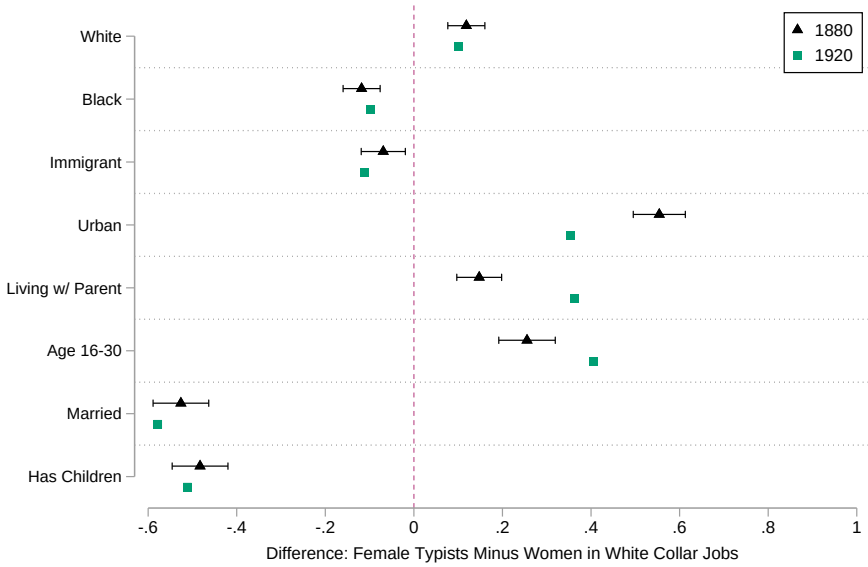


Panel B: Banking and Credit Agencies



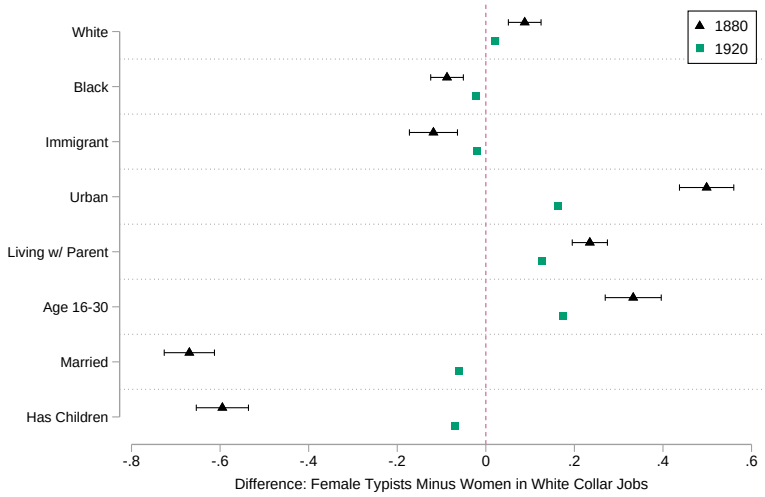
Notes: This figure plots the numbers of female employees (black line) and female typists (green) in 1000s for the legal services (Panel A) and banking industry (Panel B) from 1860-1940.

Appendix Figure 8: Characteristics of Typists in 1880 vs 1920 Compared to Working Age Women



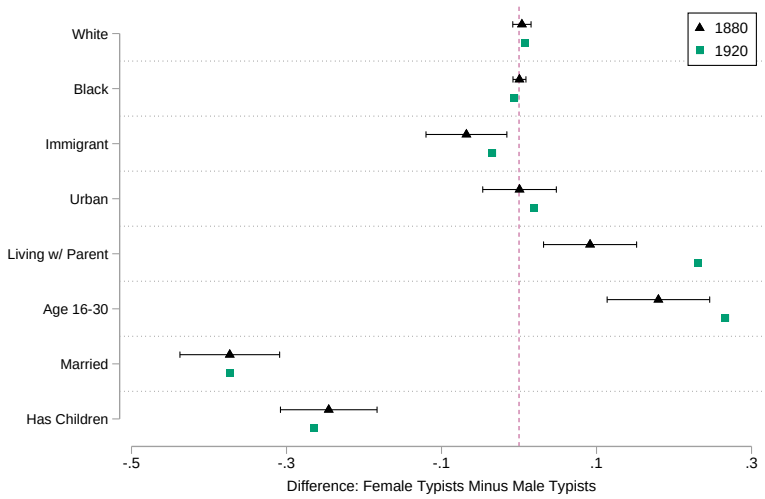
Notes: This figure plots the differences in means of typists and working age population for each of the characteristics listed in 1880 (black triangles) and 1920 (green squares). The coefficients represent how much more likely a typist is than the working age non-typist to satisfy the particular characteristic.

Appendix Figure 9: Characteristics of Typists in 1880 vs 1920 Compared to Other White-Collar Women



Notes: This figure plots the differences in means of typists and working age population for each of the characteristics listed in 1880 (black triangles) and 1920 (green squares). The coefficients represent how much more likely a typist is than the working age non-typist to satisfy the particular characteristic.

Appendix Figure 10: Characteristics of Female Typists in 1880 vs 1920 Compared to Male Typists



Notes: This figure plots the differences in means of typists and working age population for each of the characteristics listed in 1880 (black triangles) and 1920 (green squares). The coefficients represent how much more likely a typist is than the working age non-typist to satisfy the particular characteristic.

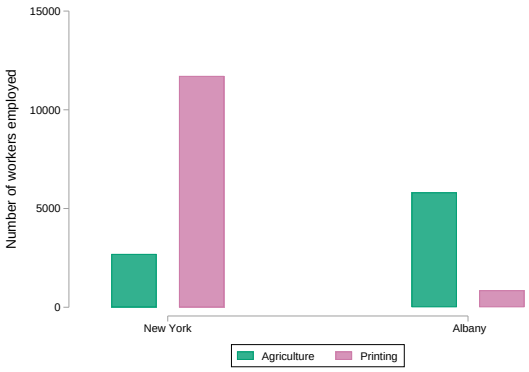
Appendix Table 3: Effect of Typewriter on Women's LFP, Marriage, and Fertility, Using Presence of WCA/YWCA

	LFP	LFP	Married	Married	Fertility	Fertility
Panel A: First Stage						
$\widehat{\Delta typ}^{1880-1920}$	0.00456	0.0107	0.00456	0.0107	0.00456	0.0107
	(0.006)	(0.007)	(0.006)	(0.007)	(0.006)	(0.007)
F-Stat	7	9.11	7	9.11	7	9.11
Panel B: OLS						
$\Delta typ^{1880-1920}$	0.305***	0.518***	-0.0947	-0.190***	-0.187*	-0.318***
	(0.117)	(0.088)	(0.068)	(0.040)	(0.109)	(0.061)
Panel C: Reduced Form						
$\widehat{\Delta typ}^{1880-1920}$	0.0767***	0.0741***	-0.0474***	-0.0430***	-0.0526***	-0.0532***
	(0.009)	(0.009)	(0.008)	(0.006)	(0.008)	(0.007)
Panel D: 2SLS						
$\Delta typ^{1880-1920}$	16.47	6.737	-10.28	-3.961	-11.12	-4.775
	(21.733)	(4.171)	(14.072)	(2.598)	(15.190)	(3.174)
Outcome Mean	0.256	0.256	0.646	0.646	0.535	0.535
Observations	31,221,453	31,221,453	31,221,453	31,221,453	31,221,453	31,221,453
Baseline Controls	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
State FE	N	Y	N	Y	N	Y

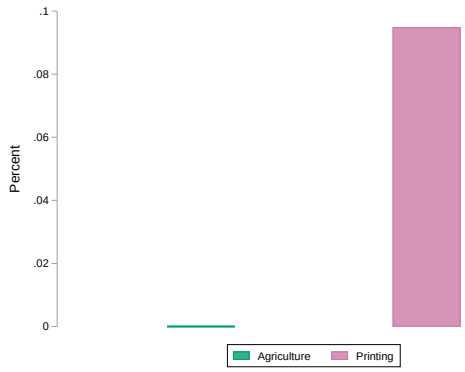
Notes: This table reports coefficients corresponding to the effect of typewriter on women's labor force participation (LFP), marriage, and fertility across different specifications using the presence of a WCA or YWCA branch in a county before 1880 as instrument. All regressions include baseline county level controls and individual level controls. Columns 2, 4, and 6 include state fixed effects.

Appendix Figure 11: Intuition Behind Instrumental Variable

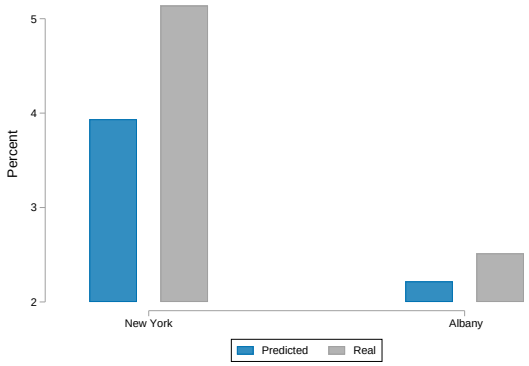
(a) Panel A: μ_{kc}^{1880}



(b) Panel B: θ_k

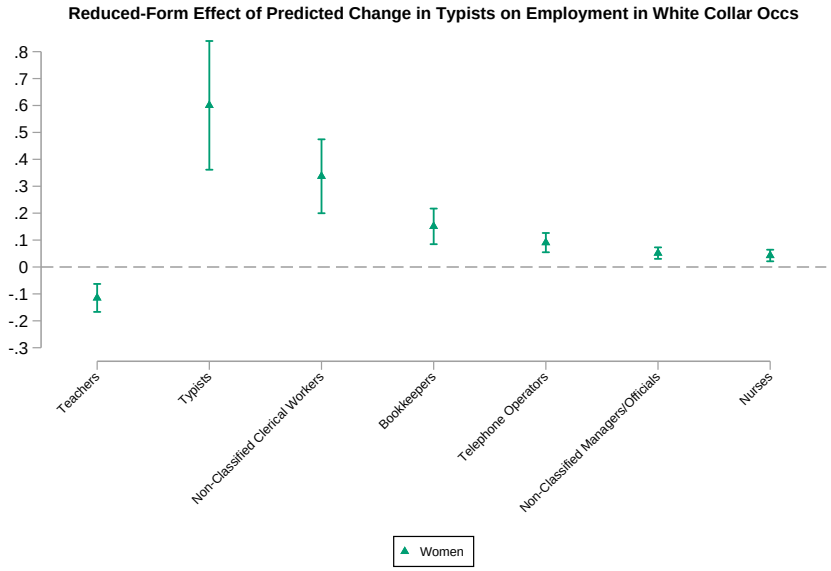


(c) Panel C: Predicted vs Actual Change in Typists



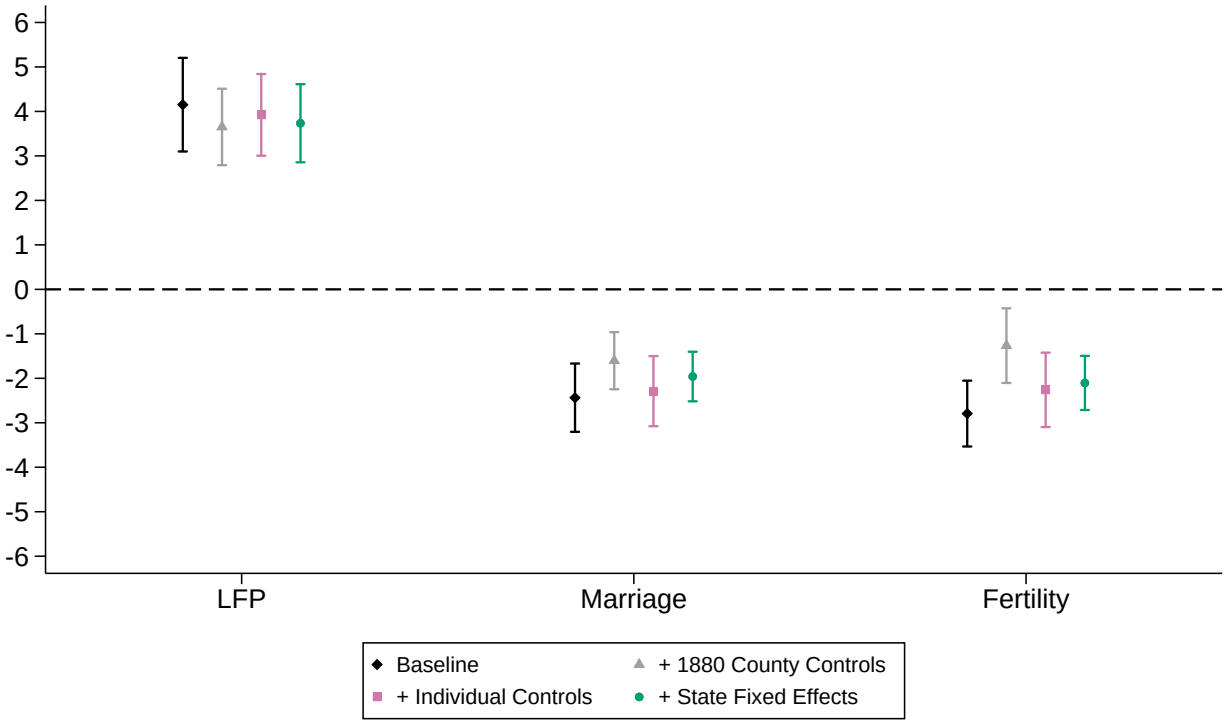
Notes: This figure plots example demonstrating different key components of the instrumental variable for 2 industries in 2 local areas. Panel A plots the number of workers employed in each industry in each locality (μ_{kc}^{1880}) . Panel B plots the national change in typists for each industry (θ_k). Panel C plots the resulting shift share IV (blue bar) after aggregating over all industries for each of two areas. It also plots the endogenous variable, actual change in typists in the gray bar.

Appendix Figure 12: Effect on Entry Into Comparable Occupations



Notes: This figure plots the the reduced form effect of the instrument on entry of women into the top white-collar occupations at the time: teaching, bookkeeping, telephone operation and nursing. It should be noted that many of the non-classified general clerical workers, managerial officials and bookkeepers also relied on using the typewriter

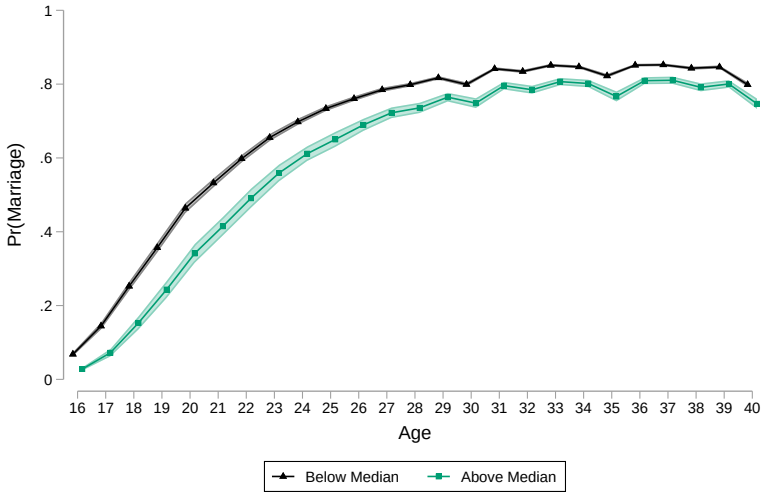
Appendix Figure 13: Effect of Typewriter on Women's Labor Participation, Marriage and Fertility Using Shifts from Canadian Censuses



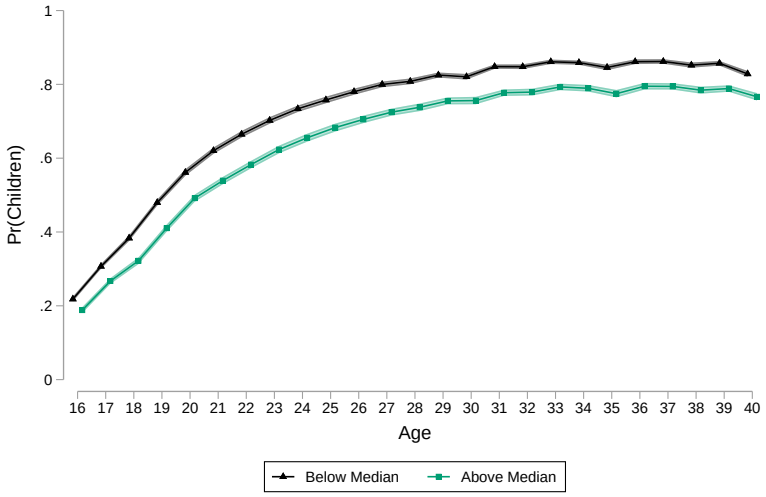
Notes: This figure plots the reduced form effect of the alternative instrument, using shifts from the Canadian 1891 and 1911 censuses, on working-age women's likelihood of: (1) participating in the labor force, (2) marriage , and (3) having children in 1920. Coefficients in black represent reduced form effects that do not include any controls. Gray represent coefficients that control for baseline county characteristics including share of the county population that is woman, share of population that is white, share that is young, and share that works in white collar occupations. Pink represent coefficients that in addition to controlling for county characteristics also control for 1920 women's individual level characteristics which include birthplace, birth year and race. In addition to controlling for baseline SEA and individual characteristics, coefficients in green include state-fixed effects.

Appendix Figure 14: Probability of Marriage & Fertility by Age, White Women

Panel A: Being Married



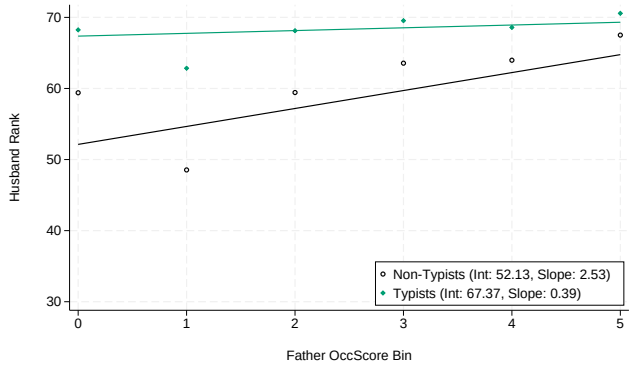
Panel B: Having Children, Conditional on Being Married



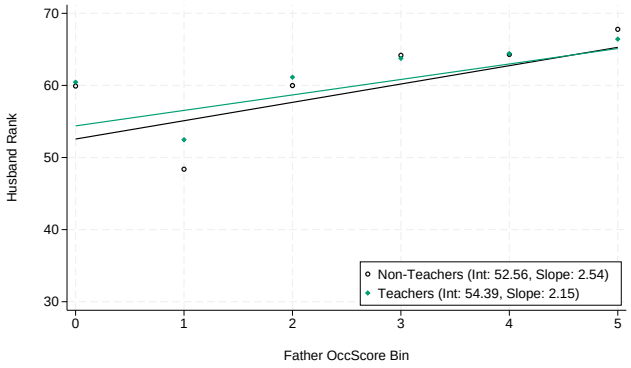
Notes: This figure reports the probability of being married and having children for women at various ages who are residing in SEAs with above vs below median predicted change in typists in 1920. Panel A reports the probability of being married for women in each age group and Panel B reports the probability of having children conditional on being married.

Appendix Figure 15: Typewriter and the Intergenerational Mobility of Women, using OccScore for Fathers

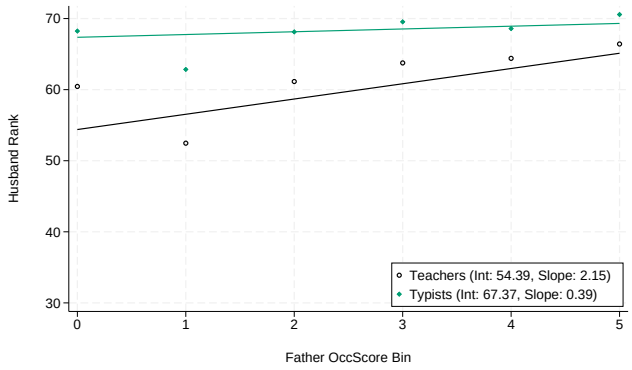
Panel A: Typists and Non-Typists in 1920



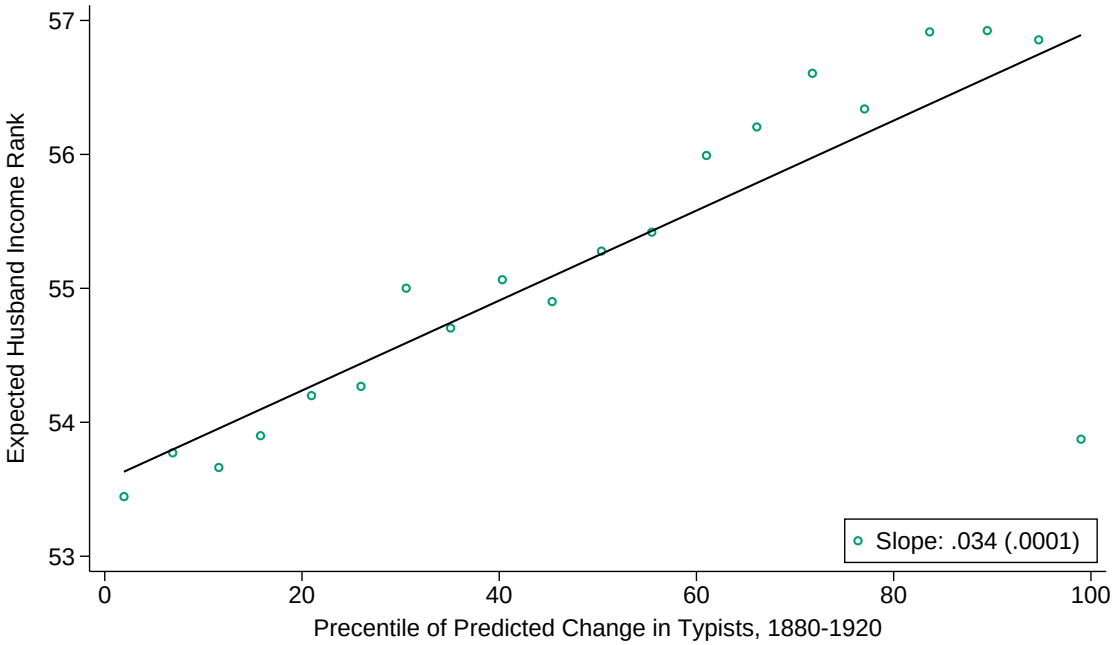
Panel B: Teachers and Non-Teachers in 1920



Panel C: Typists vs Teachers in 1920

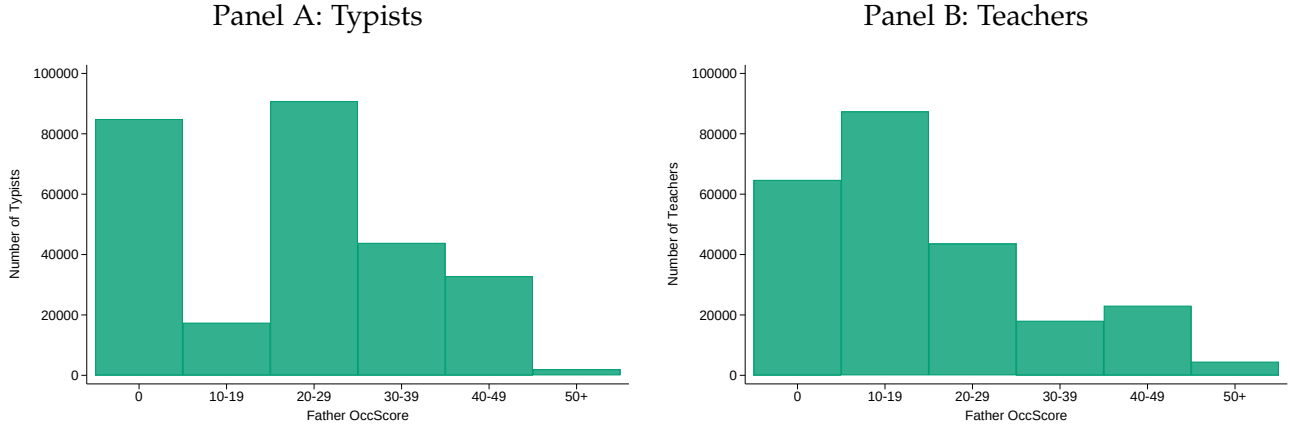


Appendix Figure 16: Relationship between Predicted Change in Typists and Expected Husband's Income Rank, Not Using Income Score for Father

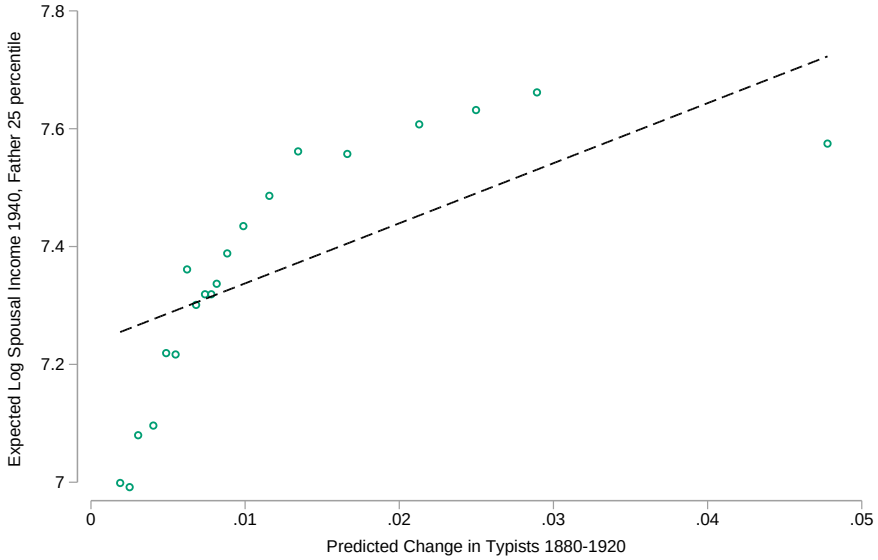


Notes: This figure plots a binned scatterplot depicting the relation between ventiles of the instrument, the 1880-1920 predicted change in typists, and expected income rank for husbands for women. Fathers occupation is directly included in the regression. Husband's income is recorded from the 1940 census. Women are linked from the 1920 to 1940 census. Controls include spouse's year of birth, spouse's birthplace, spouse's race, own birth year, own birthplace, father's birthplace and father's age.

Appendix Figure 17: Distribution of Typists and Teachers by Father OccScore Bins in 1920 Complete Census



Appendix Figure 18: Relationship between Predicted Change in Typists and Husband's Expected Log Income



Notes: This figure plots a binned scatterplot depicting the relation between the instrument, the 1880-1920 predicted change in typists, and spouse's expected log income for women with fathers at or below the 25th percentile of the father's income score distribution. Father's 1920 income is based on an occupational income score measure. Husband's income is recorded from the 1940 census. Women are linked from the 1920 to 1940 census. Controls include spouse's year of birth, spouse's birthplace, spouse's race, own birth year, own birthplace, own race, and father's age.