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Understanding the gender gap among turn-of-the-century Swedish compositors[a]

by

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Abstract

Women have always earned less than men, with men's greater physical strength explaining a large portion of the difference. This raises the question of why the gender gap did not disappear when the importance of physical strength waned with the emergence of the modern labor market. This paper explores the wage gap among Swedish compositors, an occupation featuring the main traits of modernity, circa 1900. We exploit matched employer-employee data with national coverage, and examine information on men and women holding the same jobs. On average, women's hourly wage was about 70 percent of men's. Individual characteristics explain much, but not all, of this gender gap. To explain the remainder of the gap, we examine training and differences across firms. Our findings suggest that women received less training than men, and accounting for differences across firms explains the gender gap. We also find differences across firms by size and location. Smaller firms outside the major cities treated men and women fairly, but large firms in big cities did not offer women the same opportunities as men, creating a gender wage gap. These results are consistent with the hypothesis that firms which set up internal labor markets treated men and women differently.

Keywords: Gender, earnings, manufacturing industry, firm-level data
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1 Introduction

Women have always earned less than men, with men's greater physical strength explaining a large portion of the difference. While industrialization in some cases increased the demand for strength (Samuel 1977, 1992), eventually machine power substituted for human strength and the rise of services demanded qualitatively different skills. This raises the question of why the gender gap did not disappear when the importance of physical strength waned with the emergence of the modern labor market. Wage discrimination appeared at a particular time in the development of the labor market, as has been shown for the U.S.; Goldin (1990, chapter 4) concludes that wage discrimination appeared there between 1890 and 1940. In the case of nineteenth-century manufacturing jobs, she finds that most of the wage gap was explained by differences in output.[1] In the case of clerical work in the 1940s, however, the gender wage gap cannot be explained by economic factors. In a similar vein, Burnette (2015) finds that the wage ratio matched the productivity ratio for nineteenth-century manufacturing workers, but that female clerical workers in 1900 were underpaid.

There is little evidence of the causes of the shift to wage discrimination, but extant literature provides us with hypotheses. Goldin (1990) explains the rise of wage discrimination in the U.S. as the result of the shift from spot markets to internal labor markets. With the emergence of the modern labor market, which implied internal labor markets, women did not have access to the same job ladders as men, and thus did not have the same opportunities for improving their pay through training and career advancement. Owen (2001), also drawing on the U.S. experience, suggests that firms offered men and women different incentives because male quits were more responsive to firm policies.

The timing is right for such an explanation. The transition from spot labor markets to internal labor markets occurred around the turn of the twentieth century, at the same time that gender wage discrimination emerged. During the nineteenth century most workers were hired in spot labor markets. Turnover was high, workers were paid their marginal

[1] This statement is largely based on assumptions relating to the fact that workers were paid according to productivity. Measuring differences in output (productivity) at the individual level is generally difficult, though easier in the past when products produced were simple and homogenous with respect to quality, which was easy to control. For workers who were paid piece rates, differences in hourly earnings reflected productivity differentials among those who worked for the same piece rates. The lack of information on working hours is a common problem, when estimating individual productivity, because working for a higher piece rate, producing a more complex product often implies that it takes longer.

product, and wage discrimination was not widespread (Rosenbloom and Sundstrom 2009; Stanfors et al. 2014). The institutional infrastructure of labor markets was essentially non-existent. Early in the twentieth century, firms sought to reduce turnover and developed internal labor markets (Jacoby 1985; Owen 1995). One method for reducing turnover was delayed compensation. Thus, wage profiles from the nineteenth and twentieth centuries look very different from each other. Nineteenth-century wage profiles increase rapidly during youth, but are fairly flat for adults (Hatton 1997). In contrast, twentieth-century profiles rise continually until middle age (e.g. Murphy and Welch 1990). The turn of the twentieth century saw the transition between the two labor market regimes. Some aspects of internal labor markets, such as internal promotion and long-term employment, were already appearing in the late nineteenth century (Sundstrom 1988). Other characteristics, such as delayed compensation and personnel departments, did not appear until later, and this was particularly the case in certain industries consisting of large firms such as banking, and firms with monopoly/monopsony power such as railroads across the U.S. and other Anglo-Saxon contexts (Howlett 2004; Seltzer 2011).

With the rise of internal labor markets, firms offered different opportunities for advancement to men and women. Often men were offered jobs with delayed compensation while women were not. Goldin (1986) suggests that firms chose different incentive structures for men and women based on their expected careers. Based on their shorter expected careers, women were segregated into jobs with short learning periods that paid piece rates while men, who had longer expected tenures, sorted into jobs where they were incentivized with on-the-job training and delayed compensation. Owen (2001, p. 63) suggests that men were the main beneficiaries of internal labor market policies instituted in the 1920s, and that: "men's greater access to internal labor markets…meant that women took on the status of residual workers." Thus, we expect to find that men were at an advantage compared to women when it comes to on-the-job learning and training, which affected their earnings positively. If this story is correct, we should see wage discrimination emerge at firms that adopted internal labor markets, offering men, but not women, training and higher wages through advancement.

This narrative still needs to be tested, as it is based on a limited set of facts, and primarily rests upon evidence from the U.S. and the Anglo-Saxon world. For long there has been a lack of wage data linked to individual characteristics such as experience and

tenure. Moreover, the availability of firm-level data has commonly been restricted to firm case studies, while data have not been generally available for whole industries. Further, the assessment of gender wage gaps has been complicated by the fact that men and women rarely do the same jobs. Although the literature on historical gender gaps in earnings is growing, we know little about the gender dimension of wage growth (see Burnette and Stanfors 2015 on turn-of-the nineteenth century Sweden, U.K. and the U.S. for an exception).

While most studies of the gender wage gap focus on individual characteristics, we think it is important to also examine firm characteristics. For example, Card, Cardoso and Kline (2016) find that about 15 percent of the gender wage gap in present-day Portugal can be explained by sorting across firms. A positive association between firm size and workers' wages is well documented for modern contexts (e.g. Mellow 1982; Brown and Medoff 1989; Oi and Idson 1999; Evan and MacPherson 2012), indicating that small and large firms differ with respect to training, productivity and wage structure. Historically, large firms were more likely than small firms to adopt internal labor markets. There are a number of reasons why this might be so. First, the managers in smaller firms knew the workers personally and thus had less reason to use internal labor markets for career decisions and monitoring. Managers, who have direct information about their workers, do not need to use gender as a signal of type, and this should mean less statistical discrimination. Also, larger firms were better able to take advantage of the division of labor[2], which complemented internal labor markets. Moriguchi (2003, p. 636) suggests that large firms are more likely to establish internal labor markets because small firms find it harder to establish credible commitments to honor their side of the implicit contract, which became increasingly important with modern industries and production techniques. We therefore explore the hypothesis that the practice of wage discrimination differed across firms, and emerged in larger firms, and we also test for the role of location in this respect since large firms were more likely to also be urban firms.

In this paper, we investigate the gender gap among Swedish manufacturing workers in a time when the old (spot) labor market regime was being phased out and the modern labor market (with internal labor markets) was emerging. We expand the discussion on

[2] Toman (2005) suggests that the ability to assign workers tasks appropriate to their comparative advantage increased productivity on farms using gang labor.

the emergence of wage discrimination, and its possible links to the modern labor market regime, to outside of the Anglo-Saxon countries, where most of the research on this transition has been located. Swedish labor markets, being part of the economic periphery, could have been quite different from those in the U.S. or Britain, but our research suggests that they were not. The industry in our study – the Swedish printing industry – featured wage profiles that become flat early in a worker's career, as do late nineteenth-century wage profiles in the U.S. and Britain (Hatton 1997; Boot and Maindonald 2008). Besides examining whether Sweden looks similar to the U.S. circa 1900, we make two contributions to the literature. First, we establish that firm characteristics explain a portion of the wage gap, which commonly is left unexplained. It is likely that there was discrimination in the form of which firms hired women, but we establish that, at least for small firms and firms located outside of the big cities Stockholm, Gothenburg, or Malmo, there was no wage discrimination. Second, we demonstrate that some firms rewarded male tenure and some did not. The firms that rewarded male tenure were large and located in big cities. Third, looking at wages within firms, we find that gender was never significant, even for large firms and firms in big cities. Wage discrimination occurred because firms that paid more hired fewer female compositors, and these firms were primarily large and urban.

We examine compositing, which was the main occupation of the printing industry. This occupation was neither a typical manufacturing job nor a white-collar job; it was a skilled blue-collar job. Compositors were regarded as part of the 'labor aristocracy' and were, in Sweden and elsewhere, among the very first to form trade unions (Wessel 1937; Schmick 2017). The turn of the twentieth century was a time of technological change in the printing industry, affecting typesetting in particular. The linotype machine was new, and some of the firms in our study adopted the new machine, while most of the work in the industry continued to be done on the traditional letterpress. Typesetting in Sweden was gender-mixed but male-dominated. There were no rules preventing female employment or union membership, though the compositors' union was strong and known to be male-biased (Karlsson and Stanfors 2017). In other contexts, such as Britain, where the compositors' union was similarly strong and biased (Webb 1891, p. 646), wage standards and union norms implied that few women worked in the industry.

Using a rich employer-employee matched data set with national coverage, we examine information on men and women in the same trade and even holding the same jobs; such data are rare but important for understanding gender gaps. We are able to explain the gender gap in compositing using individual and firm characteristics. Women's hourly wage was about 70 percent of men's. Individual characteristics explain much of this raw gap, but not all of it. To explain the remainder of the wage gap we examine training and differences across firms. Wage profiles indicate that women had a slightly higher average wage for six of the first seven years, but after seven years men's wages gained a substantial advantage over women's wages. We find that part of the gender wage gap relates to the fact that large firms and small firms behaved differently. While we can completely explain the wage gap in small firms, a portion of the wage gap across firms remains unexplained in larger firms. Consistent with the hypothesis that the larger firms introduced internal labor markets, we find that men were rewarded for staying with the same firm at larger firms and at firms in big cities, but not at smaller firms or at firms outside the major cities. We also find evidence that women were treated differently, as women were not rewarded for staying with the same firm. Apprenticeship patterns also differed by type of firm. Large firms in the big cities apprenticed women for shorter periods than men. For small firms and for firms outside the major cities, however, apprenticeship patterns were the same for men and women. When controlling for unobserved heterogeneity across firms, however, there is no indication that wage discrimination by gender was significant. This tells us that sorting across firms was important for large firms and for firms located in the big cities where men and women were treated differently. Our results are consistent with the story presented in the extant literature that wage discrimination emerged as some firms offered men and women different opportunities for training and different wage profiles.

2 Understanding the gender gap in past and present times

The gender wage gap, which is often defined as the differential between the male and female average wage, is an important indicator regarding the economic status of women. However, this standard of measurement is problematic if one only compares average wages without taking into account the actual differentials existing between the groups. One must standardize the wage gap so that it takes into account differences in personal

characteristics such as age, education, work experience, etc. The more factors taken into account in the calculations, the narrower the gender wage gap. This is essential if we are to understand the reasons for gender earnings differentials – not least in terms of whether or not they are the result of discrimination.

Earnings differentials can be structural and straightforward, made up of observable factors affecting wage, such as age, education, and work experience that differ between genders. Earnings differentials can thus arise from differences in human capital but also from differences in wages between typical female and typical male occupations. Finally, there are unexplained earnings differentials – that which is left after having taken into account the structural differentials. These might arise from lack of data on relevant characteristics and occupation/job, but they might also be the result of discrimination.

Therefore, although gender earnings differentials exist, it is not certain that these are due to unequal treatment in the labor market, i.e. discrimination. They might also be due to productivity differentials, in that men and women possess different qualifications or experience of relevance for performance on the job. Becker (1962) developed a formal model of human capital investment with respect to different returns to different levels of education. In Becker's original formulation, if workers are free to change employers and move between firms (as is the case in a spot market), and general skills increase their productivity (and earnings) at many workplaces, no single employer would be willing to pay for the acquisition of general skills since no firm can protect its investment and recoup the cost of training through higher worker productivity. The end result is that firms provide training that leads to general skills only if the workers bear the cost of training, typically by accepting lower (training) wages. When it comes to firm-specific skills, the employer may be willing to pay (at least part of) the training cost since the skills acquired are not transferable to other firms. This may result in the firm paying for the training and recouping the costs through future increases in labor productivity. There is always a risk that the worker will leave the firm, and the employer loses the investment, but this risk can be mediated. For example, the firm can try to influence worker turnover by offering higher wages than elsewhere. If compositing was a general skill, then we would expect to observe workers paying for their own training via lower wages during the apprenticeship period. If there were firm-specific skills, then we might expect firms to reward tenure to discourage quits.

Historical evidence, primarily U.S. studies, indicates that firm-specific skills were not very important among nineteenth-century workers. Many workers were unskilled, and most skilled workers had craft skills that could easily be transferred from one firm to another. Turnover was extremely high, partly because workers found it easy to find new employment after they quit (Hareven 1982, pp. 77, 130). Slichter (1919, pp. 18–19, 34) reports turnover rates of 72 percent at a steel mill, a staggering 232 percent in the clothing industry, and 370 percent at Ford. Carter and Savoca (1990), on the other hand, suggest, based on a survey of several thousand workers in 1892 San Francisco, that job attachment, in fact, was far greater than labor historians suggest, and not much different from findings for the post WWII-period (cf. Hall 1972), though their results have been debated (Jacoby and Sharma 1992). James (1994), however, finds support for a reconciliation of the two extremes with higher turnover then than now, especially for young workers; proposing that the end of the nineteenth-century labor market was half-way in between the spot market and the modern internal labor market. In the early decades of the twentieth century, things changed when firms instituted various policies designed to reduce turnover, a move that Owen (1995) suggests was due to the increase in firm-specific human capital.

According to human capital theory, differences in men's and women's education and work experience are key determinants of the gender wage gap. Sex differences in experience and tenure with the same employer are large because women have intermittent careers due to family responsibilities (Becker 1981).[3] It is possible that women voluntarily chose different levels of training than men. Individuals who expect to spend less time in the workforce would choose jobs with higher starting wages and lower wage growth compared to individuals who expect to spend more time in the labor force (Polachek 1981).[4] In line with such economic arguments, it was rational for women at the turn of last century – when most women left their job in connection with marriage – to be in occupations where training was task-specific and learning on the job was brief (Eichengreen 1984, p. 822). Firms' expectations that women were workers only for a

[3] Gary Becker (1985) also argued that specialization within the household means that women, by way of their reproductive responsibility for the home and children, have less energy to devote to paid work and therefore earn less.
[4] While Polachek (1981) suggests that women choose occupations where the skill depreciation resulting from time out of the labor force is relatively small, England (1982) questions this, showing that predominantly female occupations do not have smaller penalties for time out of the workforce than predominantly male occupations. This suggests that women are not choosing occupations for their low rates of skill depreciation.

limited period of their lives made them restrict training opportunities for women in order to minimize costs.[5] This resonates with accounts of women's work and wages from contemporary U.S. observers (Abbott and Breckinridge 1906; Abbott 1910).

In order to better understand the historical gender wage gap, we need to establish how extensive discrimination based on gender was in the past and when it emerged. This implies taking individual experience and tenure into consideration, generally but also within industries and firms.

3 Data

3.1 Sample

Our data serve our research purpose very well. They come from a survey of the printing industry in 1902/03, conducted by The *Swedish Board of Commerce* (Kommerskollegium). The industry was surveyed in its entirety with one set of questions for employers, and another for employees. The ambition was to collect data from all workers employed at the point in time when the agents visited the factory. In total, the agents managed to collect answers from 7,855 workers in the printing industry – a number which is very close to that reported by the employers in the official industrial statistics the same years. While all workers in the industry were included in the survey, we confine our analysis to compositors, as theirs was the most common and the key occupation within the industry. We know the hourly wage, experience in the occupation, and tenure with the present employer for every worker. Since workers are connected to firms, we are able to match the two, and examine whether firm characteristics such as size and location, and group dynamics at the firm level, mattered for the gender gap and individual wage profiles.

We restrict our analysis to compositors for whom we have data on all variables of interest, excluding foremen. We also limit the data to firms hiring at least three compositors. Our main sample consists of 2,558 individuals, 2,221 men and 337 women. In our sensitivity analysis we restrict our sample to only include workers in firms that had a gender-mixed set of compositors that is defined as having at least one male and at least

[5] Royalty (1996), however, finds that in a modern context only 25 percent of the gender difference in employer-provided training is due to differences in expected turnover, so there may be differences in training that are not explained by women's expected career length.

one female compositor. This sub-sample consists of 1,084 compositors, 783 men and 301 women. Though substantially smaller, the sample of 'gender-mixed' firms gives essentially the same results as the full sample, which indicates that our results are robust.

3.1.1 Compositing at the time of the survey

Compositing, or typesetting, was the most common occupational specialty in the printing industry, accounting for 36 percent of total employment. Typesetting is the composition of text by means of types. It requires the prior process of designing a font (*sort)* which is stored in some manner. During the letterpress era, moveable type was composed by hand for each page. Cast metal *sorts* were composited into words and lines of text and bound together to make up a page image called a *forme*, with all letter faces exactly the same height to form an even surface of type, which was then mounted in a press, inked, and pressed on paper.[6] Hand compositing was rendered obsolete by continuous casting or *hot-metal* typesetting machines such as the linotype machine and monotype at the end of the nineteenth century. The linotype enabled one machine operator to do the work of ten hand compositors by automating the selection, use and replacement of sorts, with a keyboard as input. This revolutionized typesetting as well as printing – before the invention of the linotype, no newspaper in the world had more than eight pages. Typesetting was especially important in newspaper and book printing, but also in factories producing other printed matters. It was skilled work with some compositors working by hand and some by machines, with work by machines being considered more challenging than work by hand. In our data most of the typesetting was done by hand, but there are a few compositors who worked using the linotype machine. Machine compositors earned about twice as much as hand compositors (see Table 1).

Typesetting required some formal skills, as workers had to have above-average literacy at the turn of the century and even be proficient at mirror-image reading. Typesetting as a trade was growing, with formal apprenticeship providing for rejuvenation. According to Elmquist (1909) there were 40–45 apprentices per every 100 skilled compositors in the entire industry, though after we limit the data set, the share of apprentices is smaller. Compositors worked with formatting and setting text and tables, but they also worked with typesetting sheet music and ads, etc.

[6] Sometimes copies of *formes* were cast when subsequent printings of a text were anticipated, freeing the type for other work. This process was called stereotyping.

In 1903, 13 percent of the compositors were women, which was less than the 25 percent for all occupations in the printing industry.[7] Women were less likely to be among the most skilled compositors operating a machine, and were more likely to work by hand. Nevertheless, men and women with similar skills worked side by side within individual factories (Elmquist 1909). Women could join the compositors' unions, but fewer women than men chose to do so.

3.2 Variables of interest

Because workers reported both weekly earnings and hours worked, we are able to use hourly wages as our dependent variable (i.e. the natural logarithm of weekly earnings divided by hours worked during a normal working week).[8] This is particularly useful in the case of gender analysis, since the danger of using weekly earnings is that women may have been paid less because they worked shorter hours. Earnings refer to cash earnings and do not include the value of fringe benefits; to control for differences in earnings arising from fringe benefits, we include a variable indicating for the free housing benefit received by some compositors. We also control for whether the individual worked night shifts or Sundays, which may have factored into his or her earnings.

Our data contain direct measures of experience in the trade, which is unusual. Typically labor economists follow Mincer (1974), who defined experience as the number of years since leaving school (age - years of schooling - 6). Instead, we have a direct measure of experience in the occupation. This is a better measure of experience because it is specific to the occupation. We also know how many years the worker was at the same firm, i.e. tenure with the current employer. In the context we study, it would be misleading to assume that a worker's education was equal to age minus years in the occupation minus six.[9] Though we have information on education (notably whether the individuals had any secondary or technical education beyond primary) in our data, we do not use this to calculate experience because the survey asked workers which year they started to work in the trade.

[7] The printing industry was segregated, with women dominating in book binding and men dominating in other occupations, such as compositing.
[8] The hourly wage is expressed in ore, which is one hundredth of a Swedish krona. We primarily use the workers' own statements of hours worked and income for a normal working week.
[9] The average age of starting in the trade was 14.7 for men and 16.7 for women. This does not, however, imply that women had on average two more years of schooling, but may rather indicate different inroads into manufacturing industry according to gender. On the contrary, men were much more likely to have some secondary education.

Information on the firm allows us to construct a number of firm-level indicators that reflect firm types of potential relevance for the gender gap. These variables are specific to the firm in which the individual worked, rather than to the individual. Some of them are straightforward firm characteristics (such as location and size) while others (such as share women and unionization) reflect workforce characteristics and group dynamics at the workplace level. The variable *Firm in big city* indicates that a firm was located in one of the three largest industrial towns: Stockholm, Gothenburg, or Malmo. The variable *Firm size* measures the total workforce of the firm (including workers who were not compositors). Table 1 reveals that men were more likely to work in larger firms.

Table 1 shows averages by gender for the variables used in this study. Women partly earned less than men (about 29 percent less) and they were younger and had less experience. Women were also less likely than men to be a member of a union or a mutual aid society. The majority of workers were single; women were far less likely to be married and/or with children then men, which was not always the case in manufacturing (Karlsson and Stanfors 2017). In line with extensive internal migration in Sweden at this time, a large share of workers was not born in the same location as the current workplace. Men were far more likely than women to have some secondary (including post-primary technical) education. At this time six years of schooling was compulsory for all Swedes, but secondary education was rare. Even though only 16 percent of male compositors had any secondary education this was well above the national average (Orring 1967). Women were more likely to be apprentices (due to their relative youth), but men were more likely to work night shifts and Sundays, which affected their earnings positively.

Table 1 Descriptive statistics: shares (in percent) and means of variables used in analysis

	Compositors in all firms			Compositors in gender-mixed firms		
	All	Men	Women	All	Men	Women
Hourly earnings (ore)	36.6 (19.8)	38.0 (20.2)	27.0 (13.9)	34.9 (17.6)	37.5 (18.2)	28.2 (13.7)
Hourly earnings if work by hand	34.2 (17.7)	35.5 (18.0)	26.3 (13.2)	33.6 (16.6)	36.0 (17.3)	27.5 (13.0)
Hourly earnings if work by machine	67.5 (20.1)	68.0 (20.3)	55.4 (12.8)	57.9 (18.1)	58.3 (18.9)	55.4 (12.8)
Hourly earnings if apprentice	14.1 (6.6)	14.2 (6.7)	13.7 (6.6)	13.9 (6.3)	13.6 (6.0)	14.4 (6.8)
Woman	13.2			27.8		
Age (years)	28.8 (11.5)	29.1 (11.7)	27.1 (9.8)	29.0 (11.4)	29.6 (12.0)	27.5 (9.8)
Age of starting work in industry	15.0 (3.5)	14.7 (3.4)	16.6 (3.4)	15.5 (4.1)	15.0 (4.2)	16.6 (3.4)
Experience (years)	13.8 (11.3)	14.3 (11.5)	10.4 (9.5)	13.6 (11.2)	14.6 (11.6)	10.9 (9.5)
Tenure (years)	7.1 (8.1)	7.2 (8.2)	6.0 (7.0)	6.4 (7.6)	6.4 (7.8)	6.2 (7.1)
Married	34.6	38.6	8.0	28.2	35.9	8.3
Children at home	27.3	30.5	6.5	22.7	28.9	6.6
Any secondary education	14.7	16.2	4.5	16.1	20.6	4.7
Not born in the same location as workplace	51.2	52.5	42.7	53.8	57.7	43.5
Union member	82.0	85.8	57.3	78.9	85.2	62.5
Member of mutual aid society	71.5	72.1	67.7	75.0	76.2	71.8
Machine compositor	7.2	7.9	2.4	5.4	6.5	2.7
Apprentice	24.5	23.2	32.9	23.3	20.7	30.2
Night work	4.4	4.9	1.5	2.6	2.9	1.7
Sunday work	3.1	3.5	0.6	2.5	3.2	0.7
Firm size (number of workers)	68.1 (110.2)	71.2 (115.4)	47.8 (74.5)	118.4 (154.1)	144.0 (167.9)	51.6 (77.9)
Firm in big city	46.6	46.1	49.9	57.9	60.3	51.8
N	2,558	2,221	337	1,084	783	301

Note: Standard deviations in parentheses.
Sources: Undersökning av tryckerier mm 1903, Avdelningen för arbetsstatistik, HII a:1 vol 1–6 samt HII a:2 vol 1–12, Kommerskollegiets arkiv, National Archives (*Riksarkivet*), Stockholm.

4 Results

This section presents the results from the empirical analysis. We begin by discussing the gender wage gap – its size and determinants – among compositors in 1902/03. Then we move on to examine the role of training more specifically. Finally, we investigate what were the important factors at the firm level affecting the gender gap among compositors.

4.1 The wage gap

On average, female compositors earned 71 percent as much per hour worked as did male compositors (see Table 1). Among the apprenticed, who earned less, the raw wage gap was much smaller, with female apprentices earning 96 percent as much as male apprentices. Among hand compositors, the wage gap was 26 percent, but among machine compositors, handling the new technology, women actually earned 81 percent as much as men. Women were, however, less likely to work with the linotype machine. The gender gaps were consistently smaller in gender-mixed firms compared to among all firms (of which some were single-sex), and among machine compositors in gender-mixed firms the wage gap was only five percent. Table 1 also suggests some potential explanations for the wage gap. Female compositors were, on average, younger than the men, and had less experience in the industry. Women were less likely to have family responsibilities or secondary education, to be union members, or to work nights or Sundays.

To examine how much of the wage gap can be explained by individual characteristics that we might expect to be correlated with productivity, we calculate standardized wage gaps, by estimating OLS wage models where the natural logarithm of gross hourly wage is modeled as a function of gender, age, experience, tenure, union status, other individual characteristics, and job characteristics, as well as factory fixed effects. The latter are important as we are interested in an unbiased estimation of individual-specific variables, and thus we control for the chance that there may be unobserved heterogeneity with respect to the labor force between firms, such as may arise from the recruitment of different kinds of labor. There may also be unobserved practices regarding management, including hiring/firing, and training between firms, affecting men's and women's earnings. We introduce explanatory variables in a stepwise manner. The full model we estimate is:

$$\ln E_i = \alpha_0 + \beta_1 \mathbf{X}_i + \beta_2 \mathbf{Z}_j + \mathrm{G}_j + \varepsilon_i$$

where ln E_i is the natural log of the hourly wage for individual i; **X** is a vector of individual and human capital-related characteristics; **Z** is a vector of firm-related characteristics; and G is the unobserved group fixed effect for individuals working in the firm j.[10] Explanatory variables are added to the models in a stepwise manner. This enables us to interpret the gender coefficients as the cost of being female, net of other factors. Table 2 shows the results.[11]

Table 2 The gender earnings gap among compositors (OLS estimates of eight model specifications)

	Compositors							
	1	2	3	4	5	6	7	8
Woman	-0.331*** (-4.97)	-0.289*** (-4.32)	-0.090** (-2.13)	-0.140*** (-4.44)	-0.100*** (-2.94)	-0.061** (-2.01)	-0.075** (-2.29)	-0.025 (-0.69)
Machine compositor		0.752*** (17.21)	0.507*** (12.03)	0.570*** (15.65)	0.549*** (15.17)	0.453*** (13.46)	0.420*** (12.58)	0.321*** (9.19)
Married					0.146*** (6.15)	0.111*** (5.42)	0.112*** (5.87)	0.101*** (5.23)
Previously married					0.105 (1.65)	0.117** (2.35)	0.092* (1.84)	0.086* (1.78)
Secondary education					0.046** (2.36)	0.049*** (2.79)	0.040** (2.18)	0.035* (1.84)
Union member						0.212*** (7.65)	0.200*** (7.61)	0.171*** (5.78)
Member of mutual aid society						0.116*** (4.88)	0.099*** (4.57)	0.078*** (4.03)
Apprentice						-0.380*** (-11.47)	-0.358*** (-10.20)	-0.391*** (-9.45)
Night work						0.199*** (3.09)	0.184*** (3.24)	0.101** (2.05)
Sunday work						0.082 (1.50)	0.129*** (2.87)	0.083 (1.53)
Firm size/100							-0.010 (-1.15)	
Firm in big city							0.192*** (8.02)	
Firm fixed effect	No	No	Yes	No	No	No	No	Yes
R2	0.03	0.12	0.42	0.75	0.76	0.81	0.82	0.87
N	2,558	2,558	2,558	2,558	2,558	2,558	2,558	2,558

Notes: T-statistics in parentheses. Robust standard errors clustered at firm level. Models 4-8 include controls for age at start of work, experience, and tenure, their squared terms, and a quadratic spline in experience, which breaks at eight years. Models 5-8 also control for whether the individual had children at home, and whether the individual was a migrant. Models 6-8 also control for whether the individual had access to free housing. *$p < .10$, **$p < .05$, ***$p < .01$.
Sources: See Table 1.

[10] Z includes a number of characteristics that vary by firm such as size and location, but also characteristics of the workforce such as the share of female workers, union density, and the share of workers who had secondary education. Due to collinearity Z and G cannot be estimated in the same model.
[11] Results for the limited data set of gender-mixed firms are reported in Table A 1. The results hold up for this sample too, though the raw gender gap was slightly smaller in gender-mixed firms.

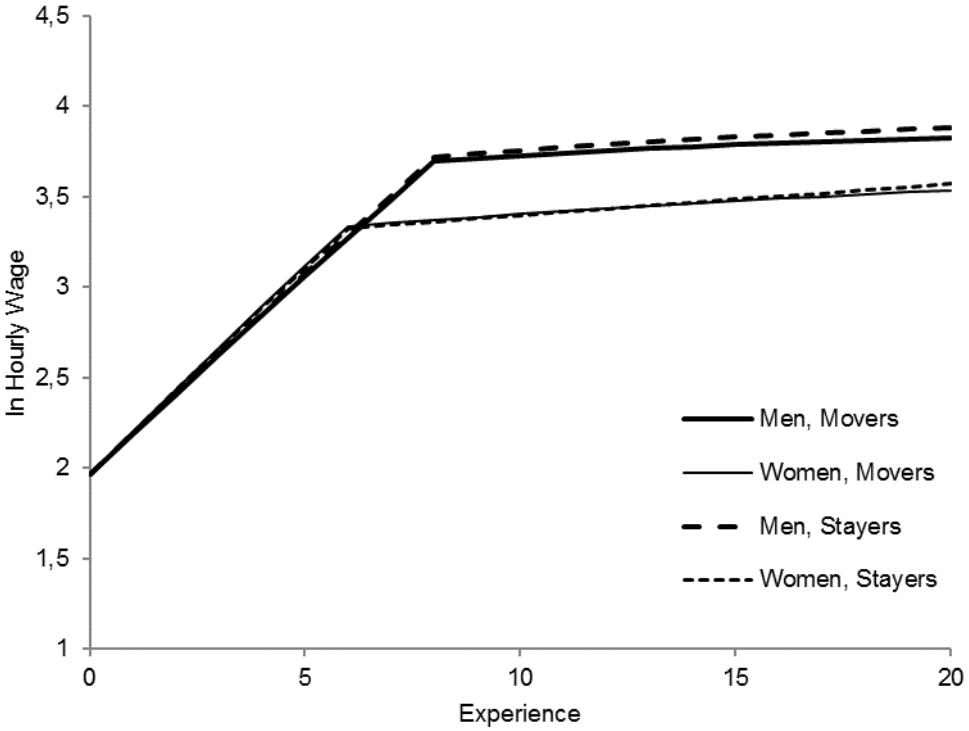
The first regression model estimates the raw gender gap, which was 33 log points, and the second model adjusts for working as a machine compositor, who earned significantly more than a compositor working by hand. Controlling for work with the new technology reduces the gender gap to about 29 log points. Model 3 estimates the within-firm gender wage gap, only adjusting for machine work, which is substantially reduced to 9 log points, indicating that the gender gap was largely due to sorting of men and women across firms that paid differently.

The fourth model does not include firm fixed effects, but introduces controls for age at start of work, experience, and tenure. These individual characteristics explain about half of the gender wage gap. Instead of including age, which is highly correlated with experience, we control for the age at which the worker started in the trade. The age of starting work has a small positive effect on wages (for everyone starting before age 38). We use a quadratic spline as the functional form for experience because this captures the shape of the profile better than a simple quadratic (Burnette and Stanfors, 2015).[12] Because the functional form is not linear, the best way to present the relationship between wage and experience is graphically. We first estimate separate regressions for men and women (presented in Table A2). We then graph predicted wages against experience for men and women, for an individual who begins work at age 16 (Figure 1). The figure graphs both a profile for movers (which assumes tenure is always zero) and a profile for stayers (which assumes tenure is equal to experience) for each gender. The mover and stayer profiles are indistinguishable, suggesting that firm tenure was not important in the labor market.[13] There is, however, a difference between the male and female profiles after six years of experience. The wage-experience profiles are similar to those observed by Hatton (1997) in that they are steep for a few years, and then suddenly become quite flat.

[12] The spline variable is max{0, age-k} where k is the break point. We determine the break point by estimating functions with a wide range of k's and choosing the break point that gives the highest R-squared. Burnette and Stanfors (2015) conclude that using a quadratic instead of a quadratic spline leads to underestimation of the wage gap for workers in their 20s.

[13] Table A 2 shows that the tenure variables are individually insignificant. We also use F-test to test whether tenure and tenure squared are jointly significant. Tenure is never statistically significant at small firms or at firms outside the major cities. Tenure will, however, be significant for men working at large firms and at firms in big cities.

Figure 1 Wage-experience profiles for male and female compositors



Notes: Based on regression model 1 from Table A2. The experience spline breaks at eight years for both genders, at eight years for men, and at six years for women. For each sex, we graph one line assuming tenure is always equal to zero, and one line assuming tenure is equal to experience. For each gender the line assuming increasing tenure is higher but not significantly so.
Sources: See Table 1.

Model 5 in Table 2 adds variables for family status, education, and migration experience. Family responsibilities affected earnings positively; married workers earned more than unmarried workers, which can be explained by human capital theory (i.e. that marriage makes men more productive) but also by selection (that men who marry are more productive) or positive discrimination (by employers who benefit men with breadwinning responsibilities regardless of productivity). The fact that previously married compositors also earned a similar premium suggests that this was not a treatment effect but rather a result of married workers being able to accumulate human capital when married, or that selection may explain the marriage premium observed.[14] Workers with some secondary education earned more, but the impact is fairly small (less than five log points), suggesting that most human capital accumulation of relevance for productivity took place on the job rather than in school. Model 6 adds more controls that may have impacted earnings, for example whether the worker was a union member or a member of a mutual aid society.

[14] Having children or having migrated had no effect on wages, so those coefficients are not presented.

Membership in these organizations was probably an indicator of commitment to the occupation or low discount rates, and was more common among men. As we would expect for those acquiring general skills, apprentices earned less than other workers. There was a compensating differential for working at night or on Sunday, which more men did.[15] Model 7 adds firm characteristics relating to size and location with potential relevance for earnings while column 8 adds a firm fixed effect to the full model and assesses the gender gap among workers in the same establishment. Firms in big cities paid more, which could be compensation for a higher cost of living. Controlling for location, firm size had no significant impact on the wage. The addition of controls for firm size and location increases the gender gap to 7.5 log points. Firms in the major cities, which paid more, also hired more women, so women's average wages were slightly higher due to their location; controlling for location thus increases the wage gap. The fixed-effect estimates indicate that, within firms, there was no significant gender wage gap among compositors at the turn of the last century, which is unexpected. Our results show that the firm mattered a lot for the gender gap, a result which has not been thoroughly explored before for historical contexts. The results from models 7 and 8 indicate that the gender wage gap cannot be fully explained by characteristics of the firm that we can easily observe, such as location or size; but that the gender gap is rather due to other, potentially unobservable, aspects of the firm, such as management practices and group dynamics, which calls for further investigation.

In order to disentangle what were the important factors at the firm level, captured by the firm fixed effect, we constructed a number of variables of potential relevance for group dynamics and earnings. We calculated the share of the firm's entire workforce (including non-compositors) which had any secondary education, was female, or was a member of a union, and the average experience of all workers at the firm. Then we ran regressions along the lines of Model 6 in Table 2 to see how various firm-level factors independently affected the gender gap among compositors (see Table 3). Both easily observable firm characteristics such as size and location and characteristics of the firm's labor force mattered for the gender gap. As in Table 2, we find that firms in the major cities paid more. If we do not control for location, firm size has a positive effect on wage.

[15] The effect of free housing is negative, which is consistent with the hypothesis that this fringe benefit was given in place of a portion of the wage, but the coefficient is not statistically significant.

This is different from the result in Table 2 where, controlling for location, firm size had a small (insignificant) negative effect on the wage, suggesting that firm size and location are correlated enough that it is difficult to disentangle the two effects.[16] Firms with more experienced workers also paid more. Working at a firm with high union density increased the wage and was associated with a smaller gender wage gap. It is highly likely that the experience and union density measures capture similar processes at the workplace. While the share of the workforce made up of women does not have a significant effect on wages, controlling for this factor makes the gender wage gap insignificant. If we only consider the share women among compositors[17], the variable is significant, negative, and about 11 log points. This implies that gender among compositors worked via two routes, namely (i) the individual's gender, and (ii) the share of women in the firm. The finding that the wage did not depend on the individual woman's own gender but rather on the gender composition of the compositors at the firm (though not the entire workforce) implies that women compositors working in firms with more female compositors (and workers as a whole), received fair, yet overall lower, wages.

Table 3 The gender wage gap among compositors and firm-level characteristics explaining it (OLS estimates of models that follow the same specification as Model 6 in Table 2)

	Compositors						
Woman	-0.060**	-0.054*	-0.071**	-0.060**	-0.044	-0.049*	-0.046
	(-2.00)	(-1.72)	(-2.21)	(-1.98)	(-1.49)	(-1.66)	(-1.58)
Firm size/100		0.025***					
		(3.88)					
Firm in big city			0.183***				
			(8.97)				
Share of workers with education				0.137			
				(1.36)			
Mean experience of workers					0.013***		
					(3.21)		
Union density						0.124**	
						(1.98)	
Share women							-0.044
							(-0.75)

Notes: T-statistics in parentheses. Robust standard errors clustered at firm level. Number of observations = 2558. The models include controls for working by the machine, age at start of work, experience, and tenure, their squared terms, and a quadratic spline in experience, which breaks at eight years. The models also control for civil status, whether the individual had children at home, whether the individual was a migrant, had any secondary education, was a member of a union or a mutual aid society. The models also control for whether the individual was an apprentice, worked nights or Sundays, and whether he/she had access to free housing. Firms are limited to those with at least three compositors. *$p < .10$, **$p < .05$, ***$p < .01$.
Sources: See Table 1.

[16] The correlation between firm size and city location is 0.61.
[17] Results not shown, but available from authors upon request.

By including firm characteristics we are able to fully explain the gender wage gap. Table 4 presents estimates of the wage gap among compositors with individual controls only, with the addition of measurable firm characteristics, and with firm fixed effects, for all firms and for firms with a gender-mixed workforce. With no firm-level controls the wage gap is 6 log points and it is statistically significant irrespective of sample. Including all six firm characteristics from Table 3 reduces the gap to 2 log points in all firms (or about 3 log points in gender-mixed firms), and the gap is no longer statistically significant. The resulting gap is similar to that of the regression with firm fixed effects, suggesting that our variables capture the most important differences across firms. Controlling for other firm characteristics, firm size, the share of workers with some secondary education, mean experience of the workforce, and union density no longer matter for the gender gap in the full sample. As in Table 2, firms in big cities pay more. Workers in firms with more female workers earn less. The full sample estimates are quite similar to the estimates based on gender-mixed firms, though the share female is marginally significant in the full sample, but this impact is not significant in the gender-mixed sample. The most important firm characteristic seems to be location in a major city. Obviously firms were different when it comes to the recruitment and retention of women, with implications for gender differences in earnings, which makes us ask through what processes this was channeled at the individual level.

Table 4 The gender earnings gap among compositors, controlling for firm characteristics (OLS estimates of models that follow the same specification as Model 6 in Table 2)

	All firms			Gender-mixed firms		
	Individual characteristics only	Firm characteristics	Including firm fixed effects	Individual characteristics only	Firm characteristics	Including firm fixed effects
Woman	-0.072***	-0.020	-0.029	-0.075***	-0.026	-0.026
	(-3.39)	(-0.68)	(-1.06)	(-2.88)	(-0.87)	(-0.96)
Firm size/100		-0.014***			-0.009	
		(-2.81)			(-1.16)	
Factory in big city		0.181***			0.130***	
		(14.27)			(5.38)	
Share with education		0.029			0.140*	
		(0.74)			(1.65)	
Mean experience		0.004***			0.002	
		(3.01)			(0.72)	
Union density		0.027			0.007	
		(0.73)			(0.10)	
Share female		-0.107***			-0.123**	
		(-2.77)			(-2.40)	
Firm fixed effects	No	No	Yes	No	No	Yes
R2	0.80	0.82	0.87	0.77	0.78	0.83
N	2,590	2,590	2,590	1,072	1,072	1,072

Note: T-statistics in parentheses. Robust standard errors clustered at firm level. The models include controls for working by the machine, age at start of work, experience, and tenure, their squared terms, and a quadratic spline in experience, which breaks at eight years. The models also control for civil status, whether the individual had children at home, whether the individual was a migrant, had any secondary education, was a member of a union or a mutual aid society. The models also control for whether the individual was an apprentice, worked nights or Sundays, and whether he/she had access to free housing. *$p < .10$, **$p < .05$, ***$p < .01$.
Source: See Table 1.

4.1.1 Training

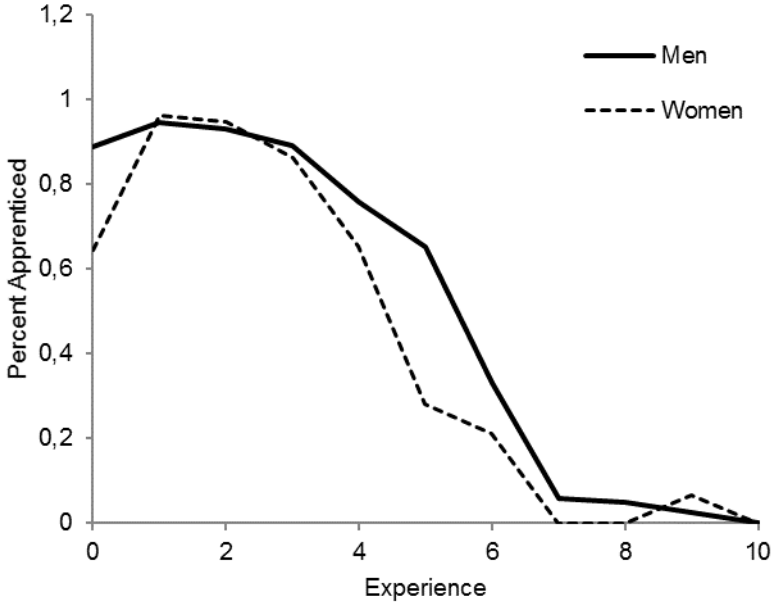
One possible reason why women might have earned less than men with the same experience level is that they spent less of their work time investing in training. Human capital theory suggests that workers can give up some current output in order to invest in human capital that pays off later in their career, and that individuals who expect to spend less time in the workforce tend to choose jobs with higher starting salaries and lower wage growth compared to individuals who expect to spend more time in the labor force. Thus, those who expect to spend more time in the labor force invest more in on-the-job training and have higher returns to labor market experience. Such expectations are not always correct; for example young women in the late 1960s U.S. underestimated their future participation rates, perhaps because there was rapid change in female labor force

participation rates during this time period (Sandell and Shapiro 1980; Goldin, Katz and Kuziemko 2006).

Differences in training may have been formal or informal. While we do not have information on informal training, we have some measures of formal training because we know which workers were apprentices at the time of the survey. Unfortunately we don't know whether workers had been apprenticed in the past. Our data, though limited, suggest that women received less formal training than men. At the time of the survey a greater percentage of the female workforce was apprentices (33 percent of women and 23 percent of men). However, this apparent female advantage results from the fact that women in compositing were concentrated at low levels of experience. If we divide the workforce into experience groups, each group contains a smaller percentage of female apprentices. Among compositors with up to five years of experience, 73 percent of women and 83 percent of men were apprentices. Among compositors with six to ten years of experience, seven percent of women and ten percent of men were apprentices. Thus, women were more likely to be apprentices at the time of the survey only because of their lower levels of experience. If we control for experience, women were less likely than men to be apprentices.

Women also seem to have been apprenticed for shorter periods. To demonstrate this, we look at how the likelihood of being an apprentice changed with experience. Figure 2 shows the percentage of workers who were apprentices at each level of experience. The increase in the percentage apprenticed in the first year is consistent either with women working for a time before starting their apprenticeship or with the presence of casual workers who very soon exited the industry and were never apprenticed. Such a pattern could have resulted from the common practice of trying out a job before starting a career (Schulz 2013). Women were nearly as likely as men to be apprentices after one, two, or three years of experience. However, for workers with four to six years of experience, women were less likely than men to be apprentices. At five years of experience, 65 percent of men were apprentices while only 28 percent of women were apprenticed. Figure 2 suggests that on average female compositors had shorter apprenticeships than male compositors, which could help to explain women's lower wages.

Figure 2 Apprenticeship rates by sex and years of experience



Sources: See Table 1.

If women did invest less in training, was this a voluntary choice or were they offered different options than men? It is possible that women chose to invest less in training because they expected to have a short working life. If the working life a woman expected was short enough, it may have been rational for her to choose the "female" profile rather than the "male" profile. We explore this possibility by examining which profile women would have preferred.

Table 5 examines whether a woman would have preferred the male or the female earnings profile in Figure 1. We annualize predicted earnings by assuming 57 hours per week and 50 weeks per year.[18] Up to six years of experience, earnings were quite similar among men and women. Men earned slightly more than women upon starting work, and women earned slightly more than men at one to six years of experience of the trade. Starting at seven years of experience, the male earnings profile gives substantially higher earnings. Which earnings profile was more remunerative overall depended on how long the worker expected to stay in the industry. Assuming an annual discount rate of five

[18] The standard working week was 60 hours. The actual working week among the workers included in our sample was about 57 hours, actually marginally higher among women than among men. We thus assume 57 hours per week, the sample average, in the calculations presented in Table 5. For robustness, we also did the same calculations for 60 hours. This makes the level of earnings change, but the pattern stays the same because it is just a matter of multiplying everything by a constant.

percent, a worker planning to stay in the industry one to seven years preferred the female earnings profile, while a worker planning to stay in the industry more than seven years preferred the male earnings profile.[19]

Table 5 Male wage premium by years of experience

Experience	Male earnings (krona/year)	Female earnings (krona/year)	Male premium	Discounted present value
All firms				
0	223.96	223.36	0.60	0.60
1	279.44	283.08	-3.64	-2.87
2	348.15	357.59	-9.44	-11.43
3	433.10	450.22	-17.12	-26.22
4	537.96	564.97	-27.01	-48.44
5	667.21	706.62	-39.41	-79.32
6	826.26	880.86	-54.60	-120.06
7	1021.69	896.79	124.90	-31.29
8	1261.45	912.47	348.98	204.91
9	1281.18	927.87	353.31	432.66
10	1300.12	942.98	357.14	651.91
11	1318.22	957.76	360.46	862.66
12	1335.45	972.20	363.24	1064.93
Gender-mixed firms				
0	221.33	220.90	0.43	0.43
1	281.61	287.21	-5.61	-4.91
2	355.55	368.75	-13.20	-16.88
3	445.44	467.48	-22.04	-35.92
4	553.78	585.21	-31.43	-61.78
5	683.15	723.38	-40.22	-93.30
6	836.27	882.94	-46.66	-128.12
7	1015.83	898.16	117.68	-44.49
8	1224.44	913.10	311.34	166.24
9	1241.15	927.75	313.41	368.26
10	1257.05	942.08	314.97	561.63
11	1272.08	956.07	316.01	746.39
12	1286.22	969.70	316.53	922.65

Notes: Based on regression model 1 from Tables A2 and A3. Estimates are annualized assuming 57 hours per week and 50 weeks per year. Discounted present value is the cumulative male premium assuming a 5 percent discount rate.
Sources: See Table 1

The average experience of female compositors in our sample was ten years (see Table 1), and the median experience was seven years. Since we have cross-sectional data, this estimate of time in the industry is biased in two ways. First, observed median experience is an underestimate of median experience because we observed uncompleted spells, and

[19] This result is not sensitive to the discount rate. Any discount rate between 0 zero and 40 percent gives the same result.

most of the women we observed would continue to work and acquire experience. That said, we are less likely at any point in time to encounter a given short spell than a given long spell. If we randomly choose a date during a twenty-year period we are sure to encounter a worker who worked the whole twenty years, but we have only a five percent chance of encountering a worker who worked only one year. This means we would underestimate the number of short spells. These biases work in opposite directions but do not necessarily cancel each other out. As a result, we cannot accurately measure median completed tenure from our cross-sectional data.

An alternative estimate of how long a woman would expect to be in the labor market is the typical window between start of work and marriage. Our data suggest that on average women started in the compositing industry at age 16.6. The average age at marriage in 1900 was 26.4 in the east and 27.8 in the west, so a woman who was average in both regards and quit at marriage would spend approximately 10 or 11 years in the industry. If a woman did expect to spend this long as a compositor, she would have preferred the male profile to the female profile. While it is possible that women chose the low-training wage profiles because they expected to spend only less than eight years in the industry, it is also possible that women did not have the option of choosing the same training as men.

4.2 Firm size and location

Next we look for differences in the gender wage gap across types of firm. Since size and location were highly correlated, we divided firms by both size and by location, in order to make a number of relevant comparisons according to firm's size and location. We define a large printing firm as one hiring at least 40 workers.[20] These firms make up the employers for 34 percent of our compositor sample. Table 6 shows the female penalty from wage regressions on different subsamples of the data by firm size, location, and a combination of the two.[21] The results shown in Table 6 correspond to the models with the same number in Table 2 and include the same set of control variables. For all subsamples there is, to begin with, a large and statistically significant gender wage gap when estimating a parsimonious model (1). Including all measured individual characteristics

[20] We have also run these estimations defining large firms as having 30 or 50 workers, and get similar results.
[21] The combined categories exclude firms that are small firms in big cities or large firms outside the three major cities, which in total make up about 20 percent of all firms.

(model 6) explains the gender wage gap at small firms and at firms outside major cities, but at large firms and at firms in big cities the gender gap remains significant, ranging from 9.6 to 13.6 log points for the full sample.[22] For firms outside the major cities, individual characteristics explain 90 percent of the wage gap, but for big city firms individual characteristics explain less; only 72 percent.

Table 6 The gender wage gap by firm size and location (OLS estimates of models that follow the same specifications as models 13, 5–6 and 8 in Table 2, for various subsamples)

Coefficient of female dummy variable							
			All firms				
Model	1	2	3	5	6	8	N
Small firm	-0.290***	-0.227***	-0.038	-0.081**	-0.023	-0.036	
	(-3.75)	(-3.01)	(-0.74)	(-1.98)	(-0.62)	(-0.094)	1,682
Large firm	-0.367***	-0.364***	-0.224***	-0.121**	-0.125***	-0.012	
	(-5.24)	(-5.66)	(-5.10)	(-2.36)	(-3.03)	(-0.018)	876
Firm outside big city	-0.355***	-0.327***	-0.067	-0.108**	-0.037	-0.056	
	(-4.16)	(-3.87)	(-1.05)	(-2.32)	(-0.86)	(-1.27)	1,366
Firms in big city	-0.340***	-0.292***	-0.109**	-0.114**	-0.096**	0.012	
	(-6.27)	(-6.30)	(-2.12)	(-2.62)	(-2.26)	(0.22)	1,192
Small and outside big city	-0.331***	-0.296***	-0.053	-0.099**	-0.033	-0.053	
	(-3.78)	(-3.43)	(-0.79)	(-2.01)	(-0.74)	(-1.12)	1,266
Large and in big city	-0.351***	-0.342***	-0.224***	-0.119*	-0.136***	-0.007	
	(-5.80)	(-9.29)	(-4.92)	(-2.04)	(-2.85)	(0.09)	776
Firm fixed effect	No	No	Yes	No	No	Yes	
			Gender-mixed firms				
Model	1	2	3	5	6	8	N
Small firm	-0.207**	-0.145**	-0.039	-0.084*	-0.035	-0.036	
	(-2.63)	(-2.04)	(-0.74)	(-1.68)	(-0.79)	(-0.89)	612
Large firm	-0.299***	-0.313***	-0.209***	-0.084**	-0.111***	-0.037	
	(-6.12)	(-5.92)	(-4.41)	(-2.72)	(-3.71)	(-0.70)	472
Firm outside big city	-0.254***	-0.212***	-0.067	-0.094	-0.048	-0.058	
	(-3.18)	(-2.73)	(-1.03)	(-1.65)	(-1.04)	(-1.26)	456
Firm in big city	-0.238***	-0.228***	-0.104*	-0.077**	-0.060	0.008	
	(-4.73)	(-4.69)	(-2.05)	(-2.08)	(-1.47)	(0.016)	628
Small and outside big city	-0.233***	-0.189**	-0.049	-0.084	-0.038	-0.046	
	(-2.75)	(-2.30)	(-0.72)	(-1.35)	(-0.076)	(-0.093)	424
Large and in big city	-0.264***	-0.281***	-0.210***	-0.069	-0.092**	-0.019	
	(-6.13)	(-8.22)	(-4.13)	(-1.70)	(-2.61)	(-0.030)	440
Firm fixed effect	No	No	Yes	No	No	Yes	

Notes: All models include a gender dummy. Models 2-8 include a control for working by the machine. Models 3 and 8 also includes a firm fixed effect. Models 5–8 control for age at start of work, experience, and tenure, their squared terms, and a quadratic spline in experience, which breaks at eight years, civil status, whether the individual had children at home, whether the individual was a migrant, and had any secondary education. Models 6 and 8 control for whether the individual was a member of a union or a mutual aid society, whether the individual was an apprentice, worked nights or Sundays, and whether he/she had access to free housing Small firms have less and large firms have more than 40 workers. T-statistics are in parentheses. *$p < .10$, **$p < .05$, ***$p < .01$.
Sources: See Table 1.

[22] Similar results apply for gender-mixed firms with the exception that gender is not significant for firms in big cities in model 6.

However, if we include firm fixed effects (model 8), gender is never a significant determinant of the wage, even at large firms and firms in big cities. This suggests that wage discrimination did not occur because individual employers paid their female compositors less than male compositors, but because women did not have access to the same high-wage firms as men. To examine sorting across firms, we divided the sample into high-wage, medium-wage, and low-wage firms based on the fixed effect coefficients in model 8 of Table 2. High-wage firms are the one-third of firms with the largest firm fixed effects, and low-wage firms are the third with the lowest fixed effects. Table 7 shows average characteristics of workers and firms across the three categories of firms. We find that women were less likely to be employed at high-wage firms. High-wage firms also hired workers with greater experience and tenure, and their workers may have been high-quality in terms of unobservable characteristics as well. High-wage firms were also larger and more likely to be located in a big city than low-wage firms.

Table 7 Average workforce and firm characteristics by size of firm fixed effect

	Percent women	Percent machine compositors	Average experience	Average tenure	Percent married	Workplace size	Percent in big city
Low-wage firm	15.4	2.8	10.5	5.9	23.7	19.4	8.5
Medium-wage firm	17.3	3.2	14.5	7.2	35.2	63.8	41.6
High-wage firm	8.3	13.3	15.2	7.6	40.3	100.4	73.3

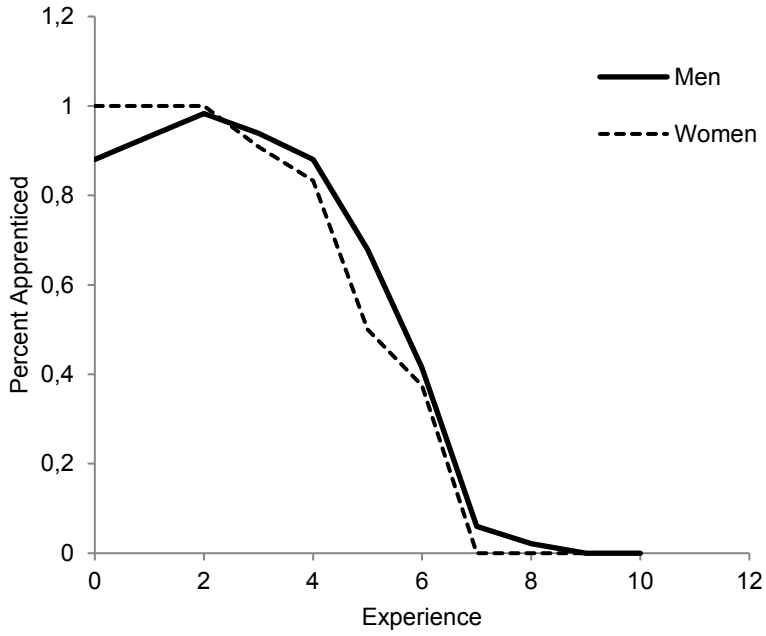
Notes: Low-wage firms are the one-third of firms with the smallest fixed effects. High-wage firms are the one-third of firms with the largest fixed effects. Medium-wage firms are the remainder.
Sources: See Table 1

To further examine differences in outcome by type of firm, we examine apprenticeship patterns by type of firm. Figure 3 shows apprenticeship rates by experience level, for small outside of the major cities and large firms in the major cities. These figures reveal that the differences in apprenticeship patterns observed in Figure 2 are entirely due to large firms in big cities. At small firms outside the big cities, men and women had nearly identical apprenticeship patterns. At large firms in big cities, by contrast, women did not become apprentices immediately upon starting work, and women were much less likely than men to be apprentices if they had four or five years of experience.[23]

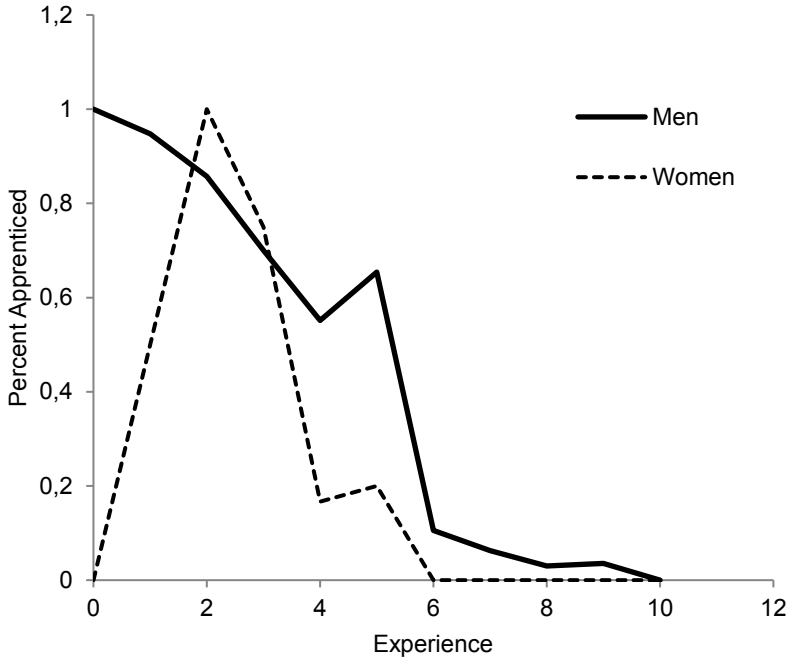
[23] At large firms in the big cities there are *no* female apprentices at zero years of experience, which suggests that heterogeneity is not the explanation.

Figure 3 Apprenticeship rates by sex and experience and by firm type (i.e. size and location)

A. Small firms outside big cities



B. Large firms in big cities



Notes: Figures show the percentage of men and women (by experience) who were apprentices at the time of the survey.
Sources: See Table 1.

That the gender gap in apprenticeship appears only among a certain type of firms casts doubt on the hypothesis that women chose less training. If the gap were entirely due to

choice, then what explained the difference across firms? It is possible that women sorted across firms and thus women at small firms would have made different choices, but it is also possible that large firms in big cities treated men and women differently. One clear difference is among women with zero experience. At smaller firms, women who had just started in compositing were all apprentices. At large firms, none of them were. It would seem that the large firms did not start women on apprenticeships immediately.

One common characteristic of internal labor markets is delayed compensation. Firms encourage hard work and discourage quits by underpaying young workers and overpaying older workers (Lazear 1979; Kotlikoff and Gokhale 1992). Goldin (1986) suggests that men were offered delayed compensation and women were not, and that as a result men earned more. Do we observe such patterns among compositors? Figure 1 suggests that wages did not respond to firm tenure, which suggests there was no delayed compensation. However, if we divide firms by size and location we find a different story. We use F-tests to determine if the quadratic function of tenure contributes significantly to estimating the wage (see Table 8). Using a five percent level of significance, tenure is never significant at small firms or firms outside the big cities. At large firms and at firms in big cities, tenure is significant for men but not for women. Our explanation for these patterns is that large firms offered delayed compensation schemes to men, to keep them as workers, but were reluctant to hire women. At the same time market forces in line with the old labor market regime (i.e. more like a spot labor market) prevailed at small firms.

Table 8 Returns to tenure by sex and type of firm

	Tenure wage premium (log points)		p-value for tenure
	10 years	20 years	
Men			
Small firm	0.014	0.015	0.775
Large firm	**0.073**	**0.126**	**0.014****
Firm outside of big cities	-0.009	-0.010	0.938
Firm in big cities	**0.088**	**0.148**	**0.002*****
Small firm outside of big cities	-0.023	-0.032	0.682
Large firm in big cities	**0.068**	**0.120**	**0.016****
Women			
Small firm	0.003	0.091	0.259
Large firm	0.049	0.011	0.791
Firm outside of big cities	-0.059	-0.028	0.735
Firm in big cities	0.106	0.194	0.218
Small firm outside of big cities	-0.063	-0.014	0.595
Large firm in big cities	0.079	0.081	0.699

Notes: Tenure wage premium equals the difference between the predicted wage of a worker with given years of experience and the same number of years of tenure (i.e. a stayer) and a worker with the given years of experience and zero tenure (i.e. a mover). Wage premia are calculated based on model 4 of Table 2. The p-value for tenure is equal to the p-value for an F-test for the joint signficiance of tenure and tenure squared.
Sources: See Table 1.

The high-wage firms were more likely to use the new linotype machine than low-wage firms, as indicated by the higher share of machine compositors in Table 7. The new machine, since it required a significant capital investment, may have encouraged firms to use delayed compensation to encourage workers to learn how to operate and to treat the machines well. Such firms may have paid a wage premium, but may also have been reluctant to hire women who were expected to have shorter tenures. As seen in Table 1, women were much less likely than men to be working as a machine compositor.

We conclude that, while small firms outside of large cities treated men and women similarly, large firms in big cities seem to have treated them differently. At these firms, men were apprenticed for longer periods than women, and were rewarded for firm tenure. While there is no evidence that men and women were paid differently within firms, women were less likely to be hired at high-paying firms, a difference which created a gender wage gap unrelated to individual characteristics.

5 Conclusion

Based on a study of turn-of-the last-century Swedish compositors, we find that the gender wage gap, at least in the case of smaller firms outside of the big cities of Stockholm, Gothenburg and Malmo, can be entirely explained by observable characteristics. We also find that men and women had identical apprenticeship patterns at these firms. For large firms in the big cities, worker characteristics explain most of the gender wage gap, but there remains a sizable and statistically significant gap. Within firms, though, women were not paid significantly less than men even at these firms. We also find evidence that apprenticeship patterns in these firms differed for men and women, and that men, but not women, were rewarded for firm tenure. Our results show that the firm matter a lot for understanding the gender gap that many others before us have observed on group level. The gender wage gap appeared among large firms in the big cities because the firms paying the highest wages were less likely to employ women.

The historical literature suggests that labor markets were changing at the time which we study, and that wage discrimination was emerging in large firms because these offered different training opportunities and job ladders to men and women. In the U.S. labor market, the nineteenth century was characterized by spot labor markets without wage discrimination, but wage discrimination appeared around the beginning of the twentieth century in white-collar occupations, probably because of the rise of internal labor markets in which men and women were not offered the same career ladders. Previous studies of the U.S. labor market have found no wage discrimination among manufacturing production workers in the nineteenth century, but have found wage discrimination among clerical workers in the early twentieth century (Goldin 1990; Burnette 2015). While our data are cross-sectional and thus cannot tell us about change over time, our results adds to the story of the emergence of wage discrimination. The present study study holds occupation and time constant, but finds a difference between large and small firms. The historical literature tells us that, while internal labor markets became popular over time, the earliest adopters were larger firms (Howlett 2004; Seltzer 2011), so in 1902/03 larger firms were more likely to have adopted internal labor markets than smaller firms. Thus, larger firms treated men and women differently, while smaller firms did not. We also find that, consistent with Goldin (1986) and Owen (2001), men but not women were rewarded for firm tenure at large firms.

Our unique opportunity to explore individual and firm characteristics simultaneously provides us with new insights on how gender affected pay in turn-of-the last century Sweden. Controlling for both worker characteristics and unobserved heterogeneity across firms through firm fixed effects, there was no significant difference between men's and women's wages. Controlling only for individual characteristics, there was a significant wage gap among large firms and firms in big cities, but not at small firms or firms outside big cities. This suggests that there were some larger firms in big cities that paid a wage premium, but that women were less likely to be employed at those firms. Among large firms in big cities, there were also important differences in training and in how firms rewarded tenure. Thus wage discrimination appeared where some firms gave men and women different career opportunities. Our results show that it is important to also examine firm characteristics when explaining the gender wage gap. While Card, Cardoso and Kline (2016) find that about 15 percent of the gender wage gap in present-day Portugal can be explained by sorting across firms, our results show that about 11 percent of the gender wage gap among Swedish compositors circa 1900 can be explained by sorting across firms.[24]

Our results also strengthen our conviction that, to understand the gender wage gap, it is essential to understand internal labor markets and how they vary across firms. Gender gaps cannot be explained or understood by examining only the workers; we must examine the firms where they worked, i.e. the context for production and wage setting, and relationships between firms and their workers. When firms have different expectations for male and female employees, they offer sex-specific contracts for training and compensation, leading to systematic differences in wage by gender. These are the patterns that must be addressed if we wish to eliminate gender wage discrimination that still affect men and women today.

[24] Comparing models 6 and 8 in Table 2, fixed effects reduce the gender gap by 3.6 log points, which is 11 percent of the raw gap.

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Appendix

Table A 1 The gender wage gap among compositors in gender-mixed firms (OLS estimates of eight model specifications, cf. Table 2)

	Compositors in gender-mixed firms							
	1	2	3	4	5	6	7	8
Woman	-0.279*** (-4.38)	-0.257*** (-3.75)	-0.091** (-2.18)	-0.148*** (-4.79)	-0.099*** (-2.85)	-0.066** (-2.12)	-0.051 (-1.49)	-0.022 (-0.67)
Machine compositor		0.578*** (7.22)	0.443*** (6.32)	0.540*** (6.97)	0.528*** (6.94)	0.459*** (7.61)	0.467*** (7.71)	0.353*** (5.02)
Married					0.155*** (5.59)	0.139*** (5.90)	0.135*** (5.58)	0.112*** (4.03)
Previously married					0.082 (1.00)	0.082 (1.28)	0.076 (1.10)	0.066 (0.96)
Secondary education					0.059* (1.86)	0.059* (1.86)	0.059* (1.70)	0.045 (1.28)
Union member						0.199*** (4.51)	0.183*** (4.27)	0.145*** (2.92)
Member of mutual aid society						0.135*** (3.54)	0.115*** (3.06)	0.082** (2.49)
Apprentice						-0.380*** (-5.90)	-0.351*** (-5.42)	-0.411*** (-5.72)
Night work						-0.145** (-2.46)	-0.103* (-1.88)	-0.099 (-1.11)
Sunday work						0.163** (2.13)	0.227*** (3.04)	0.154 (1.32)
Firm size/100							0.005 (0.46)	
Firm in big city							0.124*** (3.51)	
Firm fixed effect	No	No	Yes	No	No	No	No	Yes
R2	0.04	0.09	0.39	0.72	0.73	0.79	0.79	0.84
N	1,084	1,084	1,084	1,084	1,084	1,084	1,084	1,084

Notes: T-statistics in parentheses. Robust standard errors clustered at firm level. Models 4-8 include controls for age at start of work, experience, and tenure, their squared terms, and a quadratic spline in experience, which breaks at eight years. Models 5-8 also control for whether the individual had children at home, and whether the individual was a migrant. Models 6-8 also control for whether the individual had access to free housing. *$p < .10$, **$p < .05$, ***$p < .01$.
Sources: See Table 1.

Table A 2 Gender-specific wage regressions among compositors (OLS estimates)

	All		Men		Women	
	1	2	1	2	1	2
Female	-0.140***	-0.061**				
	(-4.44)	(-2.01)				
Machine compositor	0.570***	0.453***	0.521***	0.404***	1.331***	1.160***
	(15.65)	(13.46)	(14.69)	(12.70)	(4.53)	(4.41)
Age at start of work	0.050***	0.025***	0.047***	0.024***	0.089**	0.070**
	(7.41)	(4.51)	(5.54)	(3.45)	(2.12)	(2.09)
Age at start of work sqrd/100	-0.066**	-0.033***	-0.063***	-0.031***	-0.157	-0.130*
	(-6.57)	(-4.18)	(-5.13)	(-3.35)	(-1.65)	(-1.76)
Experience	0.219***	0.156***	0.222***	0.160***	0.239***	0.220***
	(7.49)	(6.43)	(9.00)	(7.14)	(3.70)	(3.89)
Experience squared/100	-0.157	-0.397*	-0.075	-0.343	-0.166	-1.169
	(-0.57)	(-1.88)	(-0.31)	(-1.62)	(-0.19)	(-1.50)
Spline	-0.177***	-0.083***	-0.194***	-0.097***	-0.201***	-0.069
	(-10.50)	(-6.45)	(-12.63)	(-6.81)	(-4.14)	(-1.51)
Spline squared/100	0.115	0.370*	0.033	0.317	0.136	1.152
	(0.41)	(1.75)	(0.14)	(1.50)	(0.16)	(1.49)
Tenure	0.002	0.001	0.003	0.002	-0.003	0.003
	(0.81)	(0.53)	(1.34)	(0.74)	(-0.30)	(0.030)
Tenure squared/100	0.001	0.003	-0.003	0.001	0.025	0.015
	(0.14)	(0.45)	(-0.34)	(0.11)	(0.65)	(0.39)
Married		0.111***		0.101***		0.187***
		(5.42)		(4.70)		(3.09)
Previously married		0.117**		0.153***		0.123
		(2.35)		(2.91)		(0.80)
Has children at home		0.006		0.011		-0.101
		(0.23)		(0.44)		(-1.00)
Migrant		0.000		-0.002		-0.010
		(0.00)		(-0.10)		(-0.31)
Secondary education		0.049***		0.041**		0.131
		(2.79)		(2.52)		(1.63)
Union member		0.212***		0.215***		0.217***
		(7.65)		(6.80)		(4.04)
Member of mutual aid society		0.116***		0.096***		0.216***
		(4.88)		(4.07)		(4.21)
Apprentice		-.0380***		-0.389***		-0.223***
		(-11.47)		(-13.22)		(-3.46)
Night work		0.199***		0.247***		-0.303***
		(3.09)		(4.44)		(-5.82)
Sunday work		0.082		0.058		0.459***
		(1.50)		(1.13)		(9.54)
Constant	1.392***	2.013***	1.4369***	2.009***	0.942**	1.297***
	(13.54)	(20.00)	(11.63)	(20.10)	(2.12)	(3.47)
R2	0.75	0.81	0.76	0.81	0.72	0.79
N	2,558	2,558	2,221	2,221	337	337

Notes: T-statistics in parentheses. Robust standard errors clustered at firm level. The experience spline breaks at eight years for both genders, at eight years for men, and at six years for women. Model 2 also includes controls for whether the individual had children at home, was a migrant, or had access to free housing. *$p < .10$, **$p < .05$, ***$p < .01$.
Sources: See Table 1.

Table A 3 Gender-specific wage regressions among compositors in gender-mixed firms (OLS estimates)

	All		Men		Women	
	1	2	1	2	1	2
Female	-0.148***	-0.066**				
	(-4.79)	(-2.12)				
Machine compositor	0.540***	0.459***	0.390***	0.339***	1.315***	1.146***
	(6.97)	(7.61)	(5.96)	(6.05)	(4.53)	(4.38)
Age at start of work	0.046***	0.026***	0.029**	0.013	0.120***	0.093**
	(4.58)	(3.09)	(2.10)	(1.21)	(2.70)	(2.54)
Age at start of work sqrd/100	-0.058**	-0.033***	-0.038**	-0.018	-0.217**	-0.173***
	(-4.45)	(-2.93)	(-2.11)	(-1.24)	(-2.16)	(-2.18)
Experience	0.242***	0.169***	0.245***	0.166***	0.269***	0.252***
	(4.37)	(3.82)	(5.55)	(4.35)	(3.54)	(3.51)
Experience squared/100	-0.572	-0.673*	-0.386	-0.476	-0.632	-1.631**
	(-1.10)	(-1.77)	(-0.94)	(-1.28)	(-0.65)	(-1.68)
Spline	-0.135***	-0.052**	-0.169***	-0.084***	-0.176***	-0.044
	(-4.47)	(-2.41)	(-7.03)	(-3.22)	(-3.46)	(-0.81)
Spline squared/100	0.531	0.643*	0.345	0.451	0.603	1.610*
	(1.02)	(1.70)	(0.84)	(1.22)	(0.62)	(1.67)
Tenure	0.004	0.005	0.009**	0.008**	-0.001	0.006
	(1.04)	(1.21)	(2.19)	(2.05)	(-0.06)	(0.51)
Tenure squared/100	-0.002	-0.004	-0.015	-0.015	0.017	0.006
	(-0.23)	(-0.38)	(-1.59)	(-1.53)	(0.42)	(0.14)
Married		0.139***		0.129***		0.188***
		(5.90)		(4.08)		(3.35)
Previously married		0.082		0.129*		0.098
		(1.28)		(1.72)		(0.63)
Has children at home		0.014		0.013		-0.066
		(0.53)		(0.45)		(-0.63)
Migrant		0.010		0.015		-0.013
		(0.45)		(0.57)		(-0.37)
Secondary education		0.0519*		0.054**		0.130
		(1.86)		(2.24)		(1.59)
Union member		0.199***		0.216***		0.190***
		(4.51)		(3.38)		(3.61)
Member of mutual aid society		0.135***		0.096**		0.198***
		(3.54)		(2.51)		(3.74)
Apprentice		-0.380***		-0.396***		-0.242***
		(-5.90)		(-6.88)		(-3.44)
Night work		-0.145**		-0.055		-0.310***
		(-2.46)		(-1.01)		(-4.94)
Sunday work		0.163**		0.120*		0.477***
		(2.13)		(1.75)		(9.88)
Constant	1.488***	2.035***	1.592***	2.138***	0.586	1.054**
	(8.61)	(11.25)	(7.52)	(12.06)	(1.20)	(2.51)
R2	0.72	0.79	0.75	0.81	0.71	0.77
N	1,084	1,084	783	783	301	301

Notes: T-statistics in parentheses. Robust standard errors clustered at the firm level. The experience spline breaks at eight years for both gender, at eight years for men, and at six years for women. Model 2 also includes controls for whether the individual had children at home, was a migrant, or had access to free housing. *$p < .10$, **$p < .05$, ***$p < .01$.

Sources: See Table 1.

Table A 4 The gender wage gap among compositors in gender-mixed firms and firm-level characteristics explaining it (OLS estimates of models that follow the same specification as Model 6 in Table 2)

	Compositors in gender-mixed firms						
Woman	-0.064** (-2.10)	-0.044 (-1.31)	-0.053* (-1.68)	-0.065** (-2.15)	-0.060** (-2.00)	-0.065** (-2.13)	-0.051* (-1.69)
Firm size/100		0.024*** (2.80)					
Firm in big city			0.132*** (4.50)				
Share of workers with education				0.0.45 (0.24)			
Mean experience of workers					0.010 (1.35)		
Union density						0.105 (1.01)	
Share female							–0.082 (–1.07)

Notes: T-statistics in parentheses. Robust standard errors clustered at firm level. Number of observations = 1084. The models include controls for working by the machine, age at start of work, experience, and tenure, their squared terms, and a quadratic spline in experience, which breaks at eight years. The models also control for civil status, whether the individual had children at home, whether the individual was a migrant, had any secondary education, was a member of a union or a mutual aid society. The models also control for whether the individual was an apprentice, worked nights or Sundays, and whether he/she had access to free housing. Firms are limited to those with at least three compositors. *$p < .10$, **$p < .05$, ***$p < .01$.
Sources: See Table 1.