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Felix Schran
University of Bonn and IZA

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Changing Returns to Occupational Skill and Women's Wages*

This paper investigates to what extent changes in the returns to occupational skill and declining occupational segregation have reduced wage inequality between men and women. As a first pass, I find that roughly 65% of the decline in the gender wage gap between 1985 and 2010 can be explained by a reduction in occupational segregation between the genders. The remaining 35% are explained by shifts in occupational wages which increased within occupations important for female employment, and declined in many occupations important for male employment such as producing occupations. Motivated by the central of Böhm et al. (2019) that average wages do not move as much as skill prices, I reestimate the part of the declining wage gap attributed to changes in (selection corrected) skill prices. The impact of movements in skill prices on the reduction in gender wage inequality was roughly 13 percentage points larger than the impact of changes in average wages alone. Similar findings hold when decomposing the rise in the proportion of women at higher percentiles of the wage distribution and vice versa for lower percentiles. This underscores the importance of accounting for selection effects in decompositions.

JEL Classification: J16, J31, J24

Keywords: gender wage gap, inequality, Roy model, returns to skill, occupational choice

Corresponding author:
Felix Schran
IZA
Schaumburg-Lippe-Straße 5-9
53113 Bonn
Germany

E-mail: felixschran@uni-bonn.de

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1 Introduction

This paper investigates the importance of changing returns to occupational skill and declining occupational segregation for the reduction in wage inequality between men and women. During the last three decades, wage inequality has increased in almost all developed countries (Acemoglu and Autor, 2011). This increase has taken place within as well as between observable groups defined by variables such as education, occupation, region or industry. The major exception to the rule – some authors even argue, paradoxical exception to the rule (Blau and Kahn, 1997; Card and DiNardo, 2002) – has been the convergence of male and female wages over time (Olivetti and Petrongolo, 2016; Blau and Kahn, 2017).

Many possible explanations for the declining gender wage gap exist and have been raised in the literature such as rising female labor market experience (Olivetti, 2006), positive selection of women into the labor force (Mulligan and Rubinstein, 2008), gender biased shifts in labor demand (Heathcote et al., 2010), structural change (Ngai and Petrongolo, 2017), or declining discrimination (Hsieh et al., 2019). Apart from that, another very popular explanation is concerned with returns to skill having changed in a women benefiting way, despite these changing skill returns might have raised overall inequality (Altonji and Blank, 1999).

The idea for this goes back to Goldin (1990) who hypothesized that women have a comparative advantage in tasks that require "brains" rather than "brawns". If changes in labor demand (for instance, due to technical change) induced an increase in the price paid for brain skills, then wage inequality *between* men and women should decline; although inequality *within* male and female samples is likely to rise.[1]

In line with this demand side driven view, this paper investigates the importance of changes in occupational demand and supply for the declining gender wage gap between men and women. Using German administrative panel data with consistent and accurate information on workers' detailed occupations and their wages, I find that almost all of the decline in the gender wage gap between 1985 and 2010 can be explained by a convergence in occupational choices between men and women as well as changing occupational wages.

The reason for this is that men and women have worked (Weisskoff, 1972) and still do work (Cortés and Pan, 2018) in very different occupations. This segregation leads to two potential sources of convergence between men's and women's wages. These sources are commonly referred to as the "wage structure effect" and the "composition effect" in the literature (Blau and

[1] See Welch (2000) for a formalization of this argument.

Kahn, 2017): a change in the wage structure benefits women's relative wages if wages are increasing in occupations which make up a great share of female employment. In turn, a change in employment composition reduces the wage gap if the relative number of women in high wage occupations increases.

So far, these two hypothesized effects have been analyzed in isolation from each other. However, recent research suggests that changes in occupational employment growth might have a direct, attenuating effect on occupational wage growth (and thereby the wage structure effect). The reason for this is that workers self select into occupations depending on skill prices (Cortes, 2016; Hsieh et al., 2019; Böhm et al., 2019). Hence, contingent on the magnitude of workers' selection response, the wage structure effect might not reflect the causal influence of changing skill prices on changes in gender wage inequality. For instance, the selection response in the model of Hsieh et al. (2019) exactly offsets a change in skill prices so that wage and employment growth are completely uncorrelated. US data are consistent with this theoretical prediction. The same finding holds for Germany (Böhm et al., 2019). When ignoring this, the result might be an overestimation of the composition effect and an underestimation of the wage structure effect. This is because wages do not move as much as predicted by changing skill prices alone, that is, in absence of worker self selection.

Nevertheless, to identify the influence of the wage structure and composition effect, most existing work has typically relied on simple regression models for estimating occupational wage premia in a base period and then asked:[2] how would the wage gap have changed if only employment but not wages had changed? In turn, estimates for the wage structure effect are derived from holding employment shares constant and only letting average wages change over time. For instance, following the Juhn et al. (1993) approach, Bacolod and Blum (2010) find that rising wages in cognitive and social occupations can explain 20% of the decline in the US gender wage gap. The bulk of the remaining convergence is explained by the changing composition of female work. Weinberg (2000) and Borghans et al. (2014) confirm this finding for the US and complement it with evidence for the UK and Germany. Black and Spitz-Oener (2010) employ data on tasks which workers execute on the job and estimate that about half of the declining gap can be traced back to an increase in the non-routine component of work.

To repeat the argument from above: what connects these approaches in identifying changes of skill prices from time series variation in wages is the implicit assumption that the quality of

[2]This approach goes back to a larger literature on estimating changes in wage differentials (see Smith and Welch, 1989; Juhn et al., 1991, 1993).

the average worker within an occupation must not change in response to shifting skill prices.[3] In a first step, I follow this approach and decompose the change in the gender wage gap into a wage structure effect, a composition effect and a residual. Overall, I find that the gender wage gap within a sample of full time working 25–54 year old workers declined from being as high as 44 log points in 1985 to 36 log points in 2010. Roughly 35% of that decline are explained by changes in average occupational wages: women have worked and still do work in occupations in which average wages increased relatively more than in occupations in which many men work (such as manufacturing). In turn, nearly 65% of the decline can be attributed to changing employment patterns: women moved into high wage, professional and managerial occupations previously dominated by men (Ngai and Petrongolo, 2017). In fact, cohort analyses show that the proportion of women at labor market entry in managerial occupations increased dramatically over time, rising from 40% for women born between 1945–1955 to 68% for those born after 1965.

In the next step, I then move beyond equating changes in skill prices with changes in average occupational wages. I take (quality adjusted) skill price change estimates from earlier work in Böhm et al. (2019). They identify the part of average wage growth which is due to changing skill prices by employing long term panel data which allow them to hold constant occupation specific changes in worker quality. Using these skill price estimates, I decompose the wage structure effect further into a price effect and a skill selection effect. Importantly, the skill price estimates come from a sample of prime age men as the underlying (static) occupational choice model is less likely to be misspecified for men because forward looking behavior might play a less prominent role for men compared to women (Adda et al., 2017). Hence, I implicitly assume that men and women do not work in segmented labor markets but instead are paid the same price for a unit of skilled labor as it would be the case in a competitive labor market without discrimination.[4]

The exercise shows that the raw wage structure effect indeed underestimates the contribution of changing skill prices on the convergence of male and female wages. In fact, the results suggest that changing skill prices contributed roughly 13 percentage points more to the decline in the gender wage gap than changes in average wages alone. The main reason for that is

[3] Contrary to relying on time series variation in occupational wages, Beaudry and Lewis (2014) exploit variation in wage gaps together with variation in PC adoption across local labor markets. They find that the gender wage gap decreased more in areas with higher PC adoption. They interpret this result as being driven by higher increases in cognitive skill prices paid within areas that experienced more abundant PC adoption.

[4] See Hsieh et al. (2019) for a setup which explicitly allows for discrimination having changed over time within a Roy model framework.

a large increase in female labor force participation during the late 1980s. By definition, this rise brought a lot of inexperienced, low wage, low skill women into work. The increasing female participation rate initially counteracted skill price movements which were essentially beneficial for women's wages. Further, the results suggest that women not only benefited from rising prices paid for tasks women perform more often than men (such as service and care), but they also benefited from declining prices paid for tasks men are engaged in more often than women (mostly manufacturing occupations). Interestingly, a similar result was found by Yamaguchi (2018) who used an alternative approach to estimate the influence of skill prices on the declining gender wage gap in US panel data (also in terms of timing).

In the last step, I investigate the importance of changing returns to occupational skill and changing employment patterns for the proportion of women at different parts of the combined male and female wage distribution. The observed proportion of women at the 85th percentile of the wage distribution increased from 12 percentage points in 1985 to 20 points in 2010. In contrast, the proportion of women at the 15th percentile was 61 percentage points in 1985. This share decreased to 50 points over time. Hence, gender wage inequality declined in both the upper and lower part of the wage distribution.

Using a reweighting approach by following DiNardo et al. (1996), I estimate how large the share of women by percentile would have been if, ceteris paribus, skill prices had not changed or the distribution of occupational employment had not changed over time (or both). In summary, if skill prices and employment had not changed over the years, the share of women at the 85th percentile would have increased by 50% less. Similarly, the share of women at the 15th percentile would have fallen by 55% less. Therefore, changes in prices and occupational employment induced a decline in gender wage inequality in both the upper and lower part of the wage distribution.

The remainder of this chapter is structured as follows. Section 2 presents the data and evidence on the declining wage gap. Section 3 decomposes the wage gap into wage structure, skill price and composition effects. Section 4 concludes.

2 Male and Female Wage and Employment Patterns

2.1 Data

Data comes from the Sample of Integrated Labor Market Biographies (SIAB) Scientific Use File provided by the IAB Institute at the German Federal Employment Agency. The SIAB is

a 2% random sample of administrative social security records from 1975 to 2014. It is representative of 80% of the German workforce and includes employees covered by social security, marginal part-time employment, benefit receipts, officially registered as job-seeking or participating in programs of active labor market policy. It excludes the self-employed, civil servants, and individuals performing military service. Most notably, it contains individuals' full employment histories including detailed data for workers' occupations along with socio-demographics such as age, gender, or the level of education. The contained wage measure corresponds to the daily gross wage.

I prepare the data analog to Böhm et al. (2019). I transfer the spell structure into a yearly panel by deleting all spells except for the longest spell within a year. I impute wages above the social security limit, and restrict the main sample to 25 to 54 year old Germans working full-time in former West Germany between 1975 and 2010.

The SIAB Scientific Use File contains information on 120 different occupations on which the decompositions are based. For some parts of the analyses, I categorize these detailed occupations into 10 broader groups broadly following Acemoglu and Autor (2011): managers, professionals, technicians, sales, office, production, operators, craftsmen, service and care occupations with managers, professionals, and technicians being high wage, analytical occupations. In contrast service and care occupations represent low wage, manual occupations whereas production, operators and craftsmen consist of middle wage, routine and manual occupations. Sales and office lie in between high and middle wage occupations. See Böhm et al. (2019) for the mapping.

In robustness checks, I relax the data restrictions to also include part-time workers. Unfortunately, the data do not contain any information on the exact number of hours so that I cannot construct hourly wages. Instead, the wage of a part-time worker will also refer to the daily wage and, hence, be lower than a full time wage because of differences in working hours. Although most of the existing literature about changes in the gender wage gap also restricts the analyses to full time working men and women (e.g., Bacolod and Blum, 2010; Black and Spitz-Oener, 2010; Blau and Kahn, 2017; Yamaguchi, 2018), I view the inclusion of part time workers a crucial validity check because, contrary to the US, working part-time has been very prevalent for women in Germany and has even increased over time. In fact, data from the OECD (2019) show that the share of women aged 25–54 in part-time work increased from 35% in 1990 to 39% in 2010. In contrast, the proportion of women working part-time in the US decreased from 15%

to 13% over time.[5]

2.2 Trends in Gender Wage and Employment Gaps in Germany

Germany has one of the highest and most persistent gender wage gaps among developed countries (Olivetti and Petrongolo, 2016). Panel A in Table 1 shows the level and evolution of the gap for full time-working 25–54 year old men and women over time in the SIAB data. The difference in average log wages between the sexes was 44.24 log points in 1985. This gap declined by 8.42 log points until 2010 with most of the convergence in wages taking place until 1993. This timing is similar to the US (e.g. Figure 4, p. 414 in Olivetti and Petrongolo, 2016).

Table 1: Gender gaps in wages and occupational employment

	Level	Difference			
	1985	1993 - 1985	2001 - 1993	2010 - 2001	2010 - 1985
Panel A					
Observed wage gap	44.24	-4.66	-2.41	-1.34	-8.42
Pred. gap, occupation × year	20.45	-3.73	-3.13	-1.50	-8.37
Pred. gap, occupation	19.09	-2.37	-2.30	-1.37	-6.05
Panel B					
Duncan index	61.05	-1.51	-3.08	-1.81	-6.40
Occupation mix effect		-1.06	-1.46	-0.76	-3.28
Panel C					
Proportion of women					
Mgr	17.23	6.56	4.86	2.21	13.62
Prof	20.88	5.47	1.48	2.97	9.91
Tech	10.45	4.40	0.08	0.40	4.88
Sales	43.41	4.59	-1.10	-1.28	2.21
Office	64.99	3.15	-3.31	-2.75	-2.91
Prod	16.79	-0.27	-1.73	-3.28	-5.29
Op	9.16	1.61	1.03	1.19	3.84
Crafts	10.48	-0.40	-0.98	-0.98	-2.35
Srvc	58.12	-0.79	-5.19	-3.39	-9.37
Care	85.20	1.14	-1.96	-0.20	-1.02

Notes: Panel A shows log wages of men minus log wages of women for three different wage measures: observed wages, predicted wages from a regression of wages on 120 occupation dummies interacted with year dummies as well as predictions from a regression of wages on occupation dummies only. Panel B shows the Duncan index computed as in Equation (1). Occupation mix effect refers to the change in the Duncan index attributable to economy wide changes in occupation sizes, see Blau et al. (2013) for the details. Panel C shows the proportion of women within professions: Mgr: managers; Prof: professions; Tech: technicians; Prod: production; Op: Operators; Crafts: craftsmen; Srvc: services. Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping. Values ×100. Full-time working 25-54 year old West German men and women.

When I replace individual wages with average occupational wages by means of the prediction from a regression of log wages on occupation times year dummies, the resulting wage gap amounts to 20.45 log points in 1985. Hence, compared to the overall gap, 46% of the gender

[5]The proportions of prime age men working part-time are quite low in both countries although having slightly increased between 1990 and 2010 from 2% to 6% (Germany) and from 3% to 4% (US).

wage gap in 1985 can be explained by differences in the occupational structure between men and women. This already shows the importance of occupations for gender wage inequality. What is even more noteworthy, however, is the relevance of *changes* in the occupation structure for the *change* in the gender wage gap.

The last column of Table 1 shows changes between 1985 and 2010. To repeat, the observed log wage gap shrunk by 8.42 log points. In turn, the decrease in the wage gap predicted by changing occupational employment as well as changing occupational wages amounts to 8.37 points coming very close to the observed decline. This implies that the overwhelming majority of the closing of the gap can be attributed to either converging occupational employment of men and women (composition effect) or to relative wage increases of occupations which are important for female employment (wage structure effect). As a first pass, to distinguish the influence of the wage structure effect from the composition effect, Table 1 also shows the change in the wage gap predicted by a regression of wages on occupation dummies alone. The result of that exercise is informative about the influence of changes in occupational segregation, i.e. the composition effect. The predicted decline in the wage gap amounts to 6.05 log points which is substantial compared to the overall decrease.

In turn, the difference between the two predicted declines is informative about the wage structure effect. The comparably small magnitude of 8.37 - 6.05 = 2.32 log points might, however, underestimate the influence of changing skill prices as workers in occupations are a self selected group. Section 3 makes this more formal. Before that, I will provide some more information on differences in employment between the sexes as well as information on how wage and employment gaps evolve over the life cycle.

Panel B of Table 1 shows level and changes of a segregation index originally proposed by Duncan and Duncan (1955). The index ranges between zero and one:

$$\text{Duncan index} = \frac{1}{2} \sum_k |P_t(k|m) - P_t(k|f)| \tag{1}$$

$P_t(k|g)$ denotes the share of employment in occupation k at time t for gender g. This index is zero if the share of men and women in every occupation equals the share of men and women in the overall working population and hence there is no segregation. In turn, the Duncan index is one if men and women work in completely distinct occupations.

In 1985, the Duncan index amounted to 61%.[6] The interpretation of this number is that

[6] Cortés and Pan (2018, Fig. 18.1, p.427) compute an index of roughly 56% in 1985 for the US with a continuous decline to 51% in 2009.

61% of men or women would have to switch occupations for the occupational employment distribution to be the same across sexes. Until 2010, the index decreased by 6%. There are two possible reasons for this decrease in segregation as noted by Fuchs (1975) and Blau et al. (2013). First, the aggregate size of previously large, male dominated occupations might have declined over time. In fact, when holding the proportion of women within occupations constant, I find that roughly 3% out of 6% are attributable to this aggregate change in occupation structure. This is mainly because of shrinking manufacturing occupations with large shares of men. Second, the proportion of women increased in occupations which once exhibited small female proportions. Panel C in Table 1 shows that this primarily happened within high wage managerial and professional occupations in which the share of women increased by roughly 14 and 10 percentage points. In addition, the proportion of women in service occupations declined over time so that more than 50% of (full-time) service workers today are men compared to only 42% in 1985.

Table 2: Wage and employment gaps when including part-time workers

	Level	Difference			
	1985	1993 - 1985	2001 - 1993	2010 - 2001	2010 - 1985
Panel A					
Observed wage gap	59.09	-4.48	-3.57	0.27	-7.79
Pred. gap, occupation × year	31.59	-3.82	-3.98	-0.38	-8.17
Pred. gap, occupation	30.41	-3.04	-3.08	-1.69	-7.81
Panel B					
Duncan index	63.58	-1.95	-3.19	-1.65	-6.79
Occupation mix effect		-1.56	-1.61	-1.18	-4.36
Panel C					
Proportion of women					
Mgr	19.22	7.21	5.59	3.75	16.55
Prof	26.63	6.04	3.96	5.07	15.07
Tech	12.58	5.13	0.95	1.16	7.24
Sales	53.26	4.67	-0.58	0.81	4.90
Office	71.78	2.87	-2.81	-1.14	-1.08
Prod	19.17	-0.36	-1.84	-2.78	-4.97
Op	15.74	1.41	0.05	1.20	2.66
Crafts	12.49	-0.80	-0.99	-0.60	-2.38
Srvc	71.78	-1.48	-3.86	-1.73	-7.07
Care	88.05	1.77	-0.93	0.39	1.22

Notes: Panel A shows log wages of men minus log wages of women for three different wage measures: observed wages, predicted wages from a regression of wages on 120 occupation dummies interacted with year dummies as well as predictions from a regression of wages on occupation dummies only. Panel B shows the Duncan index computed as in Equation (1). Occupation mix effect refers to the change in the Duncan index attributable to economy wide changes in occupation sizes, see Blau et al. (2013) for the details. Panel C shows the proportion of women within professions: Mgr: managers; Prof: professions; Tech: technicians; Prod: production; Op: Operators; Crafts: craftsmen; Srvc: services. Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping. Values $\times 100$. Full-time and part-time working 25-54 year old German men and women. The wage of a part-time worker is not adjusted for hours. Instead, the wage refers to a working day as is also the case for full-time workers.

As the number of part time workers has increased a lot in Germany over the last decades, Table 2 repeats the exercise including part-time workers. As the SIAB data do not contain any information on the exact number of hours, I cannot adjust wages for working times. Instead, the wage of a part-time worker also refers to the daily wage. Therefore, it will also be lower than the wage of full time workers because of lower hours worked (see Section 2.1).

The level of the wage gap becomes substantially larger when including part-time workers. It rises from a baseline of 44 log points to 59 log points in 1985 since working part time is much more common for women. The part of the gap explained by differences in occupations becomes disproportionately larger as well, however, increasing to 32 log points compared to 20 log points full-time sample. Additionally, both the change in the observed gap as well as the change in the predicted gap are very similar to the decline of the wage gap when excluding part-time workers. Hence, not only for the subsample of full-time workers, changes in occupational demand and supply seem to have reduced the gender wage gap; but these changes also seem to have been important for the relative wage changes of part-time working women.

2.3 Life Cycle Employment and Wage Patterns

The average gender wage gap masks substantial heterogeneity between cohorts as well as over the life cycle. Figure 1a shows the evolution of the wage gap by age for several cohorts.[7] Starting at low levels ranging between 10 and 26 log points at age 25, the wage gap roughly doubles for every given cohort in the sample with the highest gaps observed between ages 35–40; a point in the life cycle where average male wages are between 41 and 54 log points higher than average female wages. The shape of the life cycle profiles seems not to have changed much between the cohorts except for the intercept continuously declining. Hence, most of the decline in the wage gap is due to between cohort effects whereas most of the level of the wage gap is best explained by sources happening within cohorts.[8]

Figure 1b plots the predicted wage gap for different cohorts from a regression of log wages on occupation times year dummies as shown in Table 1. This changes the shape of the wage gap profiles which become rather flat. This implies that changes in the occupational structure (over time) are not very informative about the rising wage gap over the life cycle. For instance, women always might have switched to lower ranked occupations after giving birth; but this

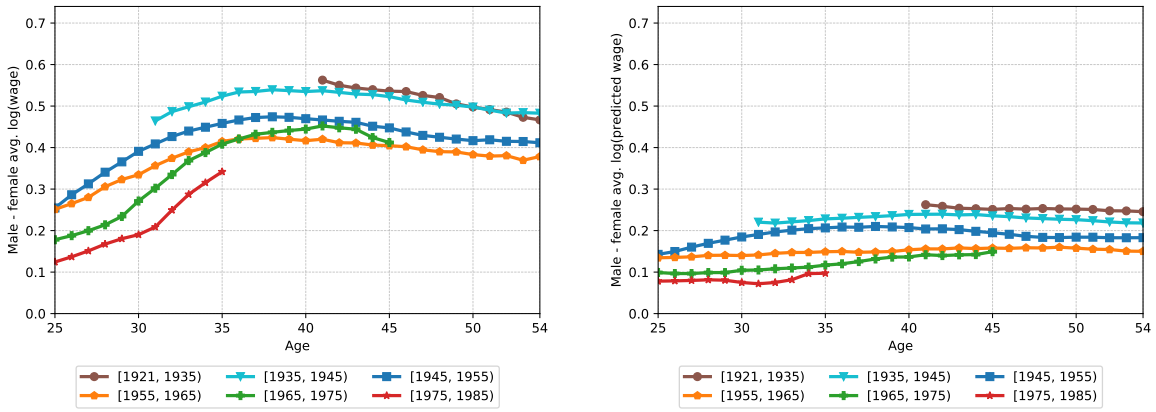
[7] See Appendix Figure A.1 for the results including part-time workers.

[8] Notice that this is fully consistent with Kleven et al. (2018, p. 1) who find that the child penalty has not changed over time despite diminishing gender inequality: "we provide a simple explanation for the persistence of gender inequality: the effects of children on the careers of women relative to men are large and have not fallen over time".

Figure 1: Wage gap by cohort

(a) Observed

(b) Predicted by occupations × year dummies



Notes: Figure 1a shows log wages of men minus log wages of women by cohort and age. Figure 1b repeats this but uses the predictions from a regression of log wages on occupation times year dummies to calculate the wage gap. Full-time working 25-54 year old West German men and women.

behavior was the same in 1985 as it was in 2010 (similar to the findings in Kleven et al., 2018). Nevertheless, the predicted values match the observed decline in the intercepts and therefore the overall decline of the wage gap very well.

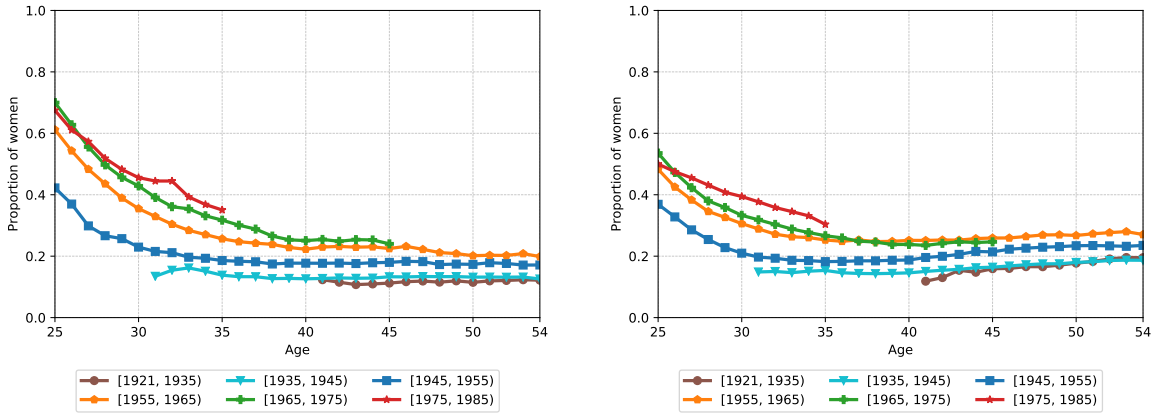
One important reason for this has been the changing female occupation distribution – at least at the start of women's working life cycle. Figure 2 shows the proportions of women in two high wage occupation groups, managers and professionals, for different cohorts. There is a striking rise in the share of women at the beginning of a cohort's life cycle over time. Whereas the share of women in managerial occupations was 40% for the 1945–1955 born, this proportion increased up to 68% for the cohorts born after 1965. A similar increase, though smaller, is observable for professional occupations. As cohorts age, however, the proportion of women drops significantly to around 15 – 25%. In part, this reflects decreasing female labor participation in fertile ages: the overall proportion of employed women shrinks from around 46% at age 25 to 30% after age 35. Nevertheless, the decrease of the proportion of women is much stronger in managerial and professional occupations compared to other occupations (for related findings see also Kleven et al., 2018). For comparison, Appendix Figure A.2 shows the remaining broad profession groups which feature much less distinct declines.

In summary, most of the decline of the wage gap has taken place between cohorts as the occupational structure of more recent cohorts is very different from the structure of older cohorts.

Figure 2: Proportion of women in professions by cohort

(a) Managerial occupations

(b) Professional occupations



Notes: Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping. Full-time working 25-54 year old West German men and women.

2.4 Difference Between Changing Average Wages and Changing Skill Prices

In the next section, I will decompose the changing wage gap into changes in the returns to skill, changes in skill selection, and changes in employment. In this section, I will highlight why it might be important to explicitly distinguish changes in average wages and changes in skill prices from each other.

Several authors starting with Goldin (1990), Welch (2000), and Weinberg (2000) have noted that advances in technology over the last few decades should have been beneficial for female labor market outcomes. For instance, Welch (2000, p. 1) argues: "In any case, if women are relatively intensive in intellectual skills and the value of such skills increase, then women's wages will increase relative to men's".

To estimate the impact of changing returns to skill on the change of the gender wage gap $\Delta[\bar{w}_t^m - \bar{w}_t^f]$, with Δ denoting changes between t and $t-x$, most of the recent literature has typically decomposed changes in the gap into a part explained by the changing employment composition of men and women (or other observables), a part explained by differential changes in wage returns to occupations, and a residual part describing differences in male and female

wages within occupations:

$$\Delta[\bar{w}_t^m - \bar{w}_t^f] = \underbrace{\Delta[\bar{\hat{w}}_t^m - \bar{\hat{w}}_t^f]}_{\text{between occupations}} + \underbrace{\Delta[\bar{\hat{e}}_t^m - \bar{\hat{e}}_t^f]}_{\text{within occupations}} \tag{2}$$

$$= \sum_{k=1}^{K} \underbrace{\Delta\bar{\hat{w}}_{k,t}[p_{k,t}^m - p_{k,t}^f]}_{\text{wage structure effect}} + \sum_{k=1}^{K} \underbrace{\bar{\hat{w}}_{k,t-x}[\Delta p_{k,t}^m - \Delta p_{k,t}^f]}_{\text{composition effect}} + \Delta[\bar{\hat{e}}_t^m - \bar{\hat{e}}_t^f] \tag{3}$$

The wage structure effect holds constant occupational employment shares $p_{k,t}^g = P(k|g,t)$ of men and women over time, and so estimates how the overall gap would have changed, had only average wages $\bar{\hat{w}}_{k,t}$ changed. In contrast, the composition effect holds constant average wages at a given time point to compute how the gap would have changed, had only the distribution of men and women across occupations changed.[9]

Typically, the literature has found modest results for the wage structure effect and large composition effects. For instance, Bacolod and Blum (2010) find that only 20% percent of the narrowing US gender wage gap can be explained by changing wage returns. The opposite is true for work by Yamaguchi (2018), however, who finds that changes in the returns to motor skills were most important for the decline in the US wage gap. The main reason for the difference is that Yamaguchi (2018) allows average wages to also change because of changing skills motivated by Roy (1951): if the price paid for a task increases, workers will self select into performing more of that task; even if they are endowed with less skills in that task than in their origin occupation. Hence, wage returns might not necessarily reflect how skill prices change over time depending on workers' selection response. Therefore, estimates of the impact of changing skill prices may be heavily biased when (selection confounded) changes in average wages are used as a proxy for changes in skill prices.

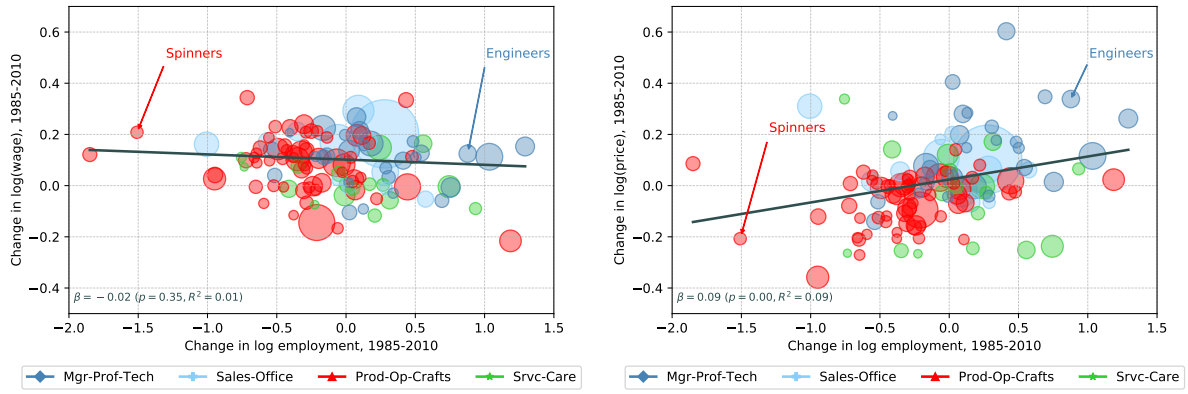
In line with that, Böhm et al. (2019) show that occupational wage and employment changes are essentially uncorrelated for both men and women in Germany. This raises serious doubts about the equivalence between changes in skill prices and changes in average wages. Figure 3a shows that the coefficient from a regression of average wage changes between 1985 and 2010 on log employment changes is $\beta = -0.02$ with a p-value of 0.35. This non-correlation might be due to large selection effects taking place in the labor market which offset changing skill returns within a Roy model setup (see also Hsieh et al., 2019).

[9] Notice that the point in time (i.e., t or $t-x$), at which wages or employment are held constant, is arbitrary in these types of decompositions. For that, in practice, I follow Neumark (1988) and use an average decomposition where I take both $t-x$ and t as base years and then average the results from the two decompositions. This does not substantially affect the magnitude of the estimates.

Figure 3: Correlating employment, wage, and skill price changes

(a) Average wage changes

(b) Skill price changes



Notes: The vertical axis in Figure 3a shows the change in average log wages between 1985 and 2010. The vertical axis in Figure 3b shows the change in selection corrected skill prices between 1985 and 2010. Results are taken from Böhm et al. (2019). The horizontal axes depict the change in log employment between 1985 and 2010. One bubble represents one of the 120 detailed occupations in the SIAB SUF. The four groups show an aggregation of these detailed occupations. Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping. Bubble size corresponds to the number of employed men and women in an occupation averaged across years 1985 until 2010. The Regression line is weighted by bubble size. Full-time working 25-54 year old West German men and women.

In fact, when holding constant the skill distribution over time, selection corrected skill prices $\Delta\hat{\pi}_{k,t}$ and employment are highly correlated. The regression coefficient is $\beta = 0.09$ ($p - \text{value} < 0.01$).[10]

According to the Roy framework in Böhm et al. (2019), the difference between average wage changes and skill price changes is attributed to changes in average skills $\Delta\bar{\hat{s}}_{k,t}$ which counteract the changing skill prices because of worker self selection:

$$\Delta\bar{\hat{w}}_{k,t} = \Delta\hat{\pi}_{k,t} + \Delta\bar{\hat{s}}_{k,t} \tag{4}$$

Hence, it might be very important to distinguish wage changes that occur because of changing skill prices from wage changes which appear because of a changing skill selection for the estimation of the wage structure effect. For instance, such an exercise is informative about the question: did the gap close because workers became more skilled over time in occupations important for female employment; or did the gap close because of rising returns to skill within occupations important for female employment? Only the latter effect would be informative about the role of demand changes for the declining gender wage gap. The next section

[10]The variation in the data causing the positive relationship between employment and skill price growth comes from growing occupations having accelerating individual wage growth relative to a base period. A difference between average individual wage growth and changes in average wages partly arises because of the mechanically large number of workers entering growing occupations as well as low wages of these entrants relative to incumbents.

investigates this in more detail.

3 Impact of Changing Skill Returns on Gender Wage Gap

The previous section showed that most of the decline in the German gender wage gap is explained by changes in the occupational structure between men and women. One the one hand, the proportion of women employed in high wage occupations increased substantially over time. On the other hand, changes in average wages were also beneficial for women's wages compared to men. The literature has attributed a changing occupational wage structure to shifts in labor demand moving away from male dominated occupations which require physical strength and so are less suited for women (Acemoglu and Autor, 2011). However, changes in average wages not only reflect the influence of changing skill prices; but they also reflect how the quality of workers within these occupations changes due to supply effects (Roy, 1951). This section explicitly separates these two explanatory approaches to get a more comprehensive estimate for the influence of changing skill prices on the declining gender wage gap.

3.1 Decomposition of the Average Gender Wage Gap

In the Roy type framework of Böhm et al. (2019), average wages either change because of changing skill prices or because of changing skills workers possess. This allows me to rewrite the wage structure effect of Equation (3) as:

$$\sum_{k=1}^{K} \underbrace{\Delta\bar{\hat{w}}_{k,t}[p^m_{k,t} - p^f_{k,t}]}_{\text{wage structure effect}} = \sum_{k=1}^{K} \underbrace{\Delta\hat{\pi}^{>0}_{k,t}[p^m_{k,t} - p^f_{k,t}]}_{\text{growing prices}} + \underbrace{\Delta\hat{\pi}^{\leq 0}_{k,t}[p^m_{k,t} - p^f_{k,t}]}_{\text{declining prices}} + \underbrace{\Delta\bar{\hat{s}}_{k,t}[p^m_{k,t} - p^f_{k,t}]}_{\text{skill changes}} \tag{5}$$

Table 3 shows the results of this decomposition. As already noted before, the between occupation gap declined by 8.37 log points between 1985 and 2010. Roughly 65% of this between effect can be explained by changes in occupational employment whereas 35% can be attributed to changes in average occupational wages.

However, the overall wage structure effect differs from the effect due to changing skill prices; and therefore differs from the causal effect of changing skill prices. In fact, decreasing prices in some occupations contributed the greatest part to the decline inducing the gender wage gap to decrease by minus three log points. The main cause for this are declining prices in crafts and production occupations. See Appendix Table A.1 which breaks up the impact of changing prices by broad profession group. Rising prices, in turn, contributed another one log

point to the decline mostly because of growing prices in sales and office occupations with large proportions of women. Hence, the causal effect of changing skill prices on the the decline in the gender wage gap was 13% larger than the raw wage structure effect.

The reason for this is that changing skills of men and women increased the gender wage gap in the aggregate thereby mitigating the wage structure effect. Improving male skills in production and crafts occupations were mostly responsible for this effect (see Appendix Table A.1). This is in line with the strong positive selection effects in declining occupations found by Böhm et al. (2019).[11]

Table 3: Effect of changing skill prices on gender wage inequality

	Level	Difference			
	1985	1993 - 1985	2001 - 1993	2010 - 2001	2010 - 1985
Panel A					
Observed gap	44.24	-4.66	-2.41	-1.34	-8.42
Pred. gap, occupation × year	20.45	-3.73	-3.13	-1.50	-8.37
Panel B					
Wage structure effect		-1.44	-0.97	-0.55	-2.96
Growing prices		-1.47	0.23	0.21	-1.03
Declining prices		-3.49	0.35	0.14	-3.01
Skill changes		3.52	-1.54	-0.89	1.08
Composition effect		-2.29	-2.17	-0.95	-5.41
Panel C					
Within occupation gap	23.79	-0.93	0.72	0.16	-0.06
$\Delta p^m_{k,t} > \Delta p^f_{k,t}$		-1.38	-0.67	-0.75	-2.80
$\Delta p^m_{k,t} \leq \Delta p^f_{k,t}$		0.45	1.39	0.91	2.75

Notes: Panel A shows log wages of men minus log wages of women for two different wage measures: observed wages and predicted wages from a regression of wages on 120 occupation dummies interacted with year dummies, i.e. the between occupation gap in Equation (2). Panel B shows the separate parts of Equation (5) as well as the composition effect described in Equation (3). Panel C presents the results from decomposing the change in the within occupation gap following Equation (6). Values ×100. Full-time working 25-54 year old West German men and women.

The long term effects mask variation between different episodes, however, with the largest effects taking place between 1985 and 1993. In fact, changes in skill prices were only beneficial for women's relative wages in that period but became small and even harmful for a decline in the wage gap afterwards. The opposite is true for skill changes which raised the wage gap between 1985 and 1993. This is also the time in which female labor force participation increased most. In fact, the share of women in the labor force rose by 3 percentage points during that

[11] Appendix Table A.2 repeats the analysis including part-time workers. The inclusion does not change the results qualitatively but the skill change estimate rises up to an overall effect of 3.44 log points between 1985 and 2010. The reason for this is the increasing number of female part-time workers with lower wages than full time workers. Notice that the decomposition attributes these lower wages to lower skills although differences in wages between part-time and full-time workers also reflect differences in hours because the wage measure in the SIAB refers to the daily, not hourly, wage.

episode. Hence, an explanation for the declining relative female skills could be the comparably large amount of new female labor market entrants with little experience.

Interestingly, similar timing results were found by Yamaguchi (2018, Table 12, p. 62) for the US: the return to motor skills declined up to 2000 inducing male and female wages to converge on average. After 2000, motor skill returns stayed roughly constant with no further effect on the gender wage gap. In contrast, changes in women's cognitive skills only had a small impact on the gap during 1980 – 1990 but induced a convergence of male and female wages after 2000.

In the last step, I decompose changes in the within wage gap (i.e., the unexplained part) further. I distinguish occupations in which male occupation shares $P_t(k|m)$ increased more than female occupation shares $P_t(k|f)$. This separates occupations which became more important for male employment over time from occupations which became more important for female employment:

$$\underbrace{\Delta[\bar{\hat{e}}_t^m - \bar{\hat{e}}_t^f]}_{\text{within gap}} = \sum_{k=1}^{K} \underbrace{\Delta[\bar{\hat{e}}_t^m - \bar{\hat{e}}_t^f]\mathbb{1}(\Delta p_{k,t}^m > \Delta p_{k,t}^f)}_{\text{becoming more important for men}} + \underbrace{\Delta[\bar{\hat{e}}_t^m - \bar{\hat{e}}_t^f]\mathbb{1}(\Delta p_{k,t}^m \leq \Delta p_{k,t}^f)}_{\text{becoming more important for women}} \tag{6}$$

Interestingly, the small overall residual effect of -0.06 log points hides that there have been converging wages between the sexes within occupations that became more important for men relative to women. This effect is substantial contributing -2.80 log points to the declining gap and, hence, comparable in magnitude to the overall wage structure effect. In contrast, however, male and female wages diverged by 2.74 log points within occupations which became more important for female employment over time. The bottom panel in Appendix Table A.1 shows that male and female wages especially diverged in professional occupations contributing 1.44 log points to a growing gender wage gap whereas wages converged most within producing occupations leading to a decline of the wage gap by 2.29 log points. A possible explanation for this could be skill selection effects similar to the findings in Böhm et al. (2019). If many more women than men enter an occupation over time, they are likely to be less skilled than the incumbents partly because entrants are typically younger and therefore less skilled. The opposite effect might be true for occupations in which female employment declined more over time than male employment, with only the most skilled women remaining.

3.2 Decomposition of Proportion of Women Along the Wage Distribution

The influence of changing skill prices and changing occupational employment might be very different along the wage distribution. Whereas changing prices may be important for the decline in the average wage gap, the gap at the top or bottom of the wage distribution might be completely unaffected; for instance, because the distribution of occupational employment is very different at low and high wage percentiles; with workers in professional and managerial occupations at the top and workers in producing occupations located at middle and low percentiles (see Appendix Figure A.3). For this reason, Table 4 decomposes the proportion of women at different percentiles of the combined male and female wage distribution into skill price and composition effects.

Table 4: Decomposition of proportion of women by percentile

	Level	Difference			
	1985	1993 - 1985	2001 - 1993	2010 - 2001	2010 - 1985
Proportion of women in sample	30.40	3.37	-0.48	0.13	3.02
Panel A					
Proportion of women at 85th percentile	11.85	5.60	1.88	0.83	8.30
Scenarios relative to observed proportion					
$\Delta\hat{\pi}_{k,t} = 0$		-2.57	0.48	0.48	-1.61
$\Delta\bar{\hat{s}}_{k,t} = 0$		0.67	0.22	0.68	1.57
Rewgt. occupations		-0.71	0.61	-0.87	-0.97
Rewgt. occupations + $\Delta\hat{\pi}_{k,t} = 0$		-2.62	-2.01	-0.01	-4.64
Panel B					
Proportion of women at 50th percentile	20.10	4.96	1.90	3.83	10.68
Scenarios relative to observed proportion					
$\Delta\hat{\pi}_{k,t} = 0$		0.76	-0.40	-1.16	-0.80
$\Delta\bar{\hat{s}}_{k,t} = 0$		-0.23	1.95	-3.29	-1.58
Rewgt. occupations		-1.87	-0.81	0.62	-2.06
Rewgt. occupations + $\Delta\hat{\pi}_{k,t} = 0$		0.33	-1.29	-1.10	-2.07
Panel C					
Proportion of women at 15th percentile	60.87	-3.95	-4.49	-2.65	-11.10
Scenarios relative to observed proportion					
$\Delta\hat{\pi}_{k,t} = 0$		5.31	-2.92	-0.70	1.70
$\Delta\bar{\hat{s}}_{k,t} = 0$		3.35	-3.53	-1.94	-2.12
Rewgt. occupations		3.96	1.44	-3.12	2.28
Rewgt. occupations + $\Delta\hat{\pi}_{k,t} = 0$		8.06	-0.37	-1.13	6.55

Notes: The panels show the proportion of women in 0.5% bins around the 85th, 50th, and 15th percentile of the combined male and female wage distribution. The scenarios show counterfactual changes in proportions of women by percentile relative to the observed change. Hence, adding the observed change to the relative counterfactual numbers gives the counterfactual change in the proportion of women by percentile. The scenarios are as follows: $\hat{\pi}_{k,t} = 0$: subtract price growth between t and 1985 from wages observed in t; $\bar{\hat{s}}_{k,t} = 0$: subtract average occupational skill growth between t and 1985 from wages observed in t; *Rewgt. occupations*: reweight occupations in t to match the occupation structure of 1985; *Rewgt. occupations* + $\hat{\pi}_{k,t} = 0$: reweight occupations in t to match the occupation structure of 1985, additionally subtract price growth between t and 1985 from wages observed in t. Values $\times 100$. Full-time working 25-54 year old West German men and women.

In total, the share of women in the full-time working labor force aged 25–54 increased

from 30.4% in 1985 to 33.42% in 2010. Essentially, all of this rise took place during 1985–1993. The share of women differs strongly across different parts of the wage distribution, however. Whereas only 11.85% of workers at the 85th percentile were women in 1985, the proportion was 60.87% at the 15th percentile. Hence, women were both underrepresented at the top as well as overrepresented at the bottom of the wage distribution; compared to their overall representation in the work force. Over time, male and female wages converged because of both a rising share of women at the 85th percentile amounting to 20.15% in 2010 as well as a declining share at the 15th percentile resulting in a proportion of 49.77% in 2010. The share of women at the median was 20.10% in 1985 and increased over time up to 30.78%; so that by 2010, the representation of women at the median was almost equal to the representation of women in the overall sample.

To investigate the importance of changing prices on the change in female proportions by percentile, I perform the following exercise: take wages in year t and subtract the estimated change in skill prices between 1985 and t. Then, recalculate the proportion of women in this counterfactual wage distribution.

The results show that without skill prices having changed and everything else equal, the share of women at the 85th percentile in 2010 would have been 1.61 percentage points lower than observed as well as 1.7 percentage points higher at the 15th percentile.[12] This shows that changing prices led to less gender inequality across the distribution although the effects are modest. The women benefiting price changes were partly offset by changing skills as shown before for changes in the average gender wage gap. The scenario $\bar{\hat{s}}_{k,t} = 0$ shows the results when deducting average skill growth in occupation k between 1985 and t from wages observed in t. In fact, if skills had not changed, the proportion of women at the 85th percentile would have been 1.57 percentage points higher than observed. Roughly 40% of this dampening effect took place during 1985–1993 consistent with the large increase of inexperienced women into the labor force during that time. In line, the share of women at the 15th percentile would have declined by 2.12 percentage points more than observed if skills had not changed. Changing skills therefore contributed to a rise in gender wage inequality in all parts of the wage distribution. Hence, this effect has partly offset the women benefiting skill price changes.

Next, I investigate the influence of changing occupational employment for the proportion of women along the wage distribution. For that, I reweight observations following DiNardo

[12]Of course, a different evolution of skill prices would also have induced a different selection of men and women into the labor force and into occupations. In this paper, I abstract from that possibility. See Hsieh et al. (2019) for a structural approach which incorporates general equilibrium responses.

et al. (1996) to estimate how the shares of women by percentile would have looked like if the occupational distribution of both men and women had not changed over time. The proportion of women would have been lower at the 85th percentile (0.97 percentage points) and higher at the 15th percentile (2.28 percentage points) if occupational employment patterns had not changed. This is mainly because women increasingly started to move into high wage occupations over time.

Last, I combine the experiments on skill price changes and employment changes by reweighting the skill price deducted wages to match the 1985 employment composition of men and women. This exercise shows that the proportion of women at the 85th percentile would have been 4.64 percentage points lower in 2010 whereas the share at the 15th percentile would have been 6.55 percentage points higher. Compared to an overall increase of the female share of 8.30 percentage points at the 85th percentile and a decrease of 11.10 points at the 15th percentile, the influence of the combination of changing employment and changing skill prices seems substantial, therefore. In summary, if skill prices and employment had not changed over the years, the proportion of women at the 85th percentile would have risen by 50% less compared to the observed increase. In line with that, the share of women at the 15th percentile would have declined by 55% less. Hence, changing skill prices and changing occupational employment patterns led to a decrease in gender wage inequality in both the upper and lower part of the wage distribution.

4 Conclusion

Starting in the 1980s, gender wage inequality has decreased in almost all developed countries (Olivetti and Petrongolo, 2016; Blau and Kahn, 2017). This paper has revisited the old question as to what extent changes in returns to occupational skill as well as changes in the occupational employment distribution were responsible for declining inequality between men and women.

In a first step, I found that almost the complete decrease of the gender wage gap can be attributed to changes in both occupational wages and the movement of women into high wage, managerial, and professional occupations. A simple decomposition into wage and composition effects showed that roughly 35% of the declining wage gap are explained by changing average occupational wages; with the remaining 65% being explained by changing employment patterns between the genders.

In the next step, I then made use of estimates for selection corrected skill price changes

which hold constant the shifting skill composition by occupation over time. This accounts for the fact that the skill of the average worker in an occupation is endogenous to changing skill prices (Böhm et al., 2019); and hence, changes in average wages (wage structure effect) do not reflect the causal influence of changing prices on movements in the gender wage gap. Decomposing the wage structure effect further by means of these quality adjusted wages showed that women's wages profited both from declining prices in manufacturing occupations (employing large shares of the male workforce) as well as rising prices in sales and office occupations which are important for the female employment distribution.

Overall, changes in average skill by gender contributed to an increase of the wage gap during the last half of the 1980s and early 1990s. The main reason for that is the large rise in female labor force participation during that time, coming in hand with many inexperienced women entering the labor market. Changes in skill prices, in contrast, were beneficial for women's relative wages in the late 1980s. This trend reversed after mid 1990 in line with the findings of Yamaguchi (2018). In summary, I found that the effect attributed to changes in average wages is smaller than the causal effect that can be explained by changing skill prices. Therefore, the response of workers' skills to changing skill returns might have been the reason for the small (or even negative) wage structure effects in much of the previous literature concerned with explanations for why the gender wage gap declined (e.g., Blau and Kahn, 1997; Bacolod and Blum, 2010).

After having shown the importance of changes in skill returns as well as male and female occupational choices, an interesting topic for future research would be the question about why women increasingly started to move into professional and managerial occupations over time. Reasons for this could be occupation dependent changes in demand for female work and expanding possibilities to work part-time (Heathcote et al., 2010), lower frictions with respect to occupational choice including discrimination (Hsieh et al., 2019), or supply side changes that made it possible for women to work longer hours; for instance, because of changes in fertility over time (Bailey et al., 2012; Cortés and Pan, 2019; Wasserman, 2019). In addition, investigating why male and female wages converged in only some (mostly low paying) but not all occupations would be important to understand why the level of gender wage inequality is still large and persistent with convergence having ceased since the early 2000s (Goldin, 2014; Goldin and Katz, 2016). The finding that gender inequality increased in occupations which became more important for female employment than male employment is suggestive that selection effects might also be important in that respect.

References

ACEMOGLU, D. AND D. H. AUTOR (2011): "Skills, Tasks and Technologies: Implications for Employment and Earnings," in *Handbook of Labor Economics, vol. 4 Part B*, ed. by D. Card and O. Ashenfelter, Elsevier, chap. 12, 1043–1171.

ADDA, J., C. DUSTMANN, AND K. STEVENS (2017): "The Career Costs of Children," *Journal of Political Economy*, 125, 293–337.

ALTONJI, J. G. AND R. M. BLANK (1999): "Race and Gender in the Labor Market," *Handbook of Labor Economics*, 3, 3143–3259.

BACOLOD, M. P. AND B. S. BLUM (2010): "Two Sides of the Same Coin US "Residual" Inequality and the Gender Gap," *Journal of Human Resources*, 45, 197–242.

BAILEY, M. J., B. HERSHBEIN, AND A. R. MILLER (2012): "The Opt-in Revolution? Contraception and the Gender Gap in Wages," *American Economic Journal: Applied Economics*, 4, 225–54.

BEAUDRY, P. AND E. LEWIS (2014): "Do Male-Female Wage Differentials Reflect Differences in the Return to Skill? Cross-City Evidence from 1980-2000," *American Economic Journal: Applied Economics*, 6, 178–94.

BLACK, S. E. AND A. SPITZ-OENER (2010): "Explaining Women's Success: Technological Change and the Skill Content of Women's Work," *The Review of Economics and Statistics*, 92, 187–194.

BLAU, F. D., P. BRUMMUND, AND A. Y.-H. LIU (2013): "Trends in Occupational Segregation by Gender 1970–2009: Adjusting for the Impact of Changes in the Occupational Coding System," *Demography*, 50, 471–492.

BLAU, F. D. AND L. M. KAHN (1997): "Swimming Upstream: Trends in the Gender Wage Differential in the 1980s," *Journal of Labor Economics*, 15, 1–42.

——— (2017): "The Gender Wage Gap: Extent, Trends, and Explanations," *Journal of Economic Literature*, 55, 789–865.

BÖHM, M., H.-M. VON GAUDECKER, AND F. SCHRAN (2019): "Occupation Growth, Skill Prices, and Wage Inequality," Working Paper.

BORGHANS, L., B. T. WEEL, AND B. A. WEINBERG (2014): "People Skills and the Labor-Market Outcomes of Underrepresented Groups," *ILR Review*, 67, 287–334.

CARD, D. AND J. E. DINARDO (2002): "Skill-Biased Technological Change and Rising Wage Inequality: Some Problems and Puzzles," *Journal of labor economics*, 20, 733–783.

CORTES, G. M. (2016): "Where Have the Middle-Wage Workers Gone? A Study of Polarization Using Panel Data," *Journal of Labor Economics*, 34, 63–105.

CORTÉS, P. AND J. PAN (2018): "Occupation and gender," in *The Oxford Handbook of Women and the Economy*, ed. by M. Kosters, Oxford University Press, 425–452.

——— (2019): "When Time Binds: Substitutes for Household Production, Returns to Working Long Hours, and the Skilled Gender Wage Gap," *Journal of Labor Economics*, 37, 351–398.

DiNardo, J., N. M. Fortin, and T. Lemieux (1996): "Labor Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach," *Econometrica*, 64, 1001–1044.

Duncan, O. D. and B. Duncan (1955): "A methodological Analysis of Segregation Indexes," *American Sociological Review*, 20, 210–217.

Fuchs, V. R. (1975): "A Note on Sex Segregation in Professional Occupations," in *Explorations in Economic Research*, NBER, vol. 2, 105–111.

Goldin, C. D. (1990): *Understanding the Gender Gap: An Economic History of American Women*, Oxford University Press.

——— (2014): "A Grand Gender Convergence: Its Last Chapter," *American Economic Review*, 104, 1091–1119.

Goldin, C. D. and L. F. Katz (2016): "A Most Egalitarian Profession: Pharmacy and the Evolution of a Family-Friendly Occupation," *Journal of Labor Economics*, 34, 705–746.

Heathcote, J., K. Storesletten, and G. L. Violante (2010): "The Macroeconomic Implications of Rising Wage Inequality in the United States," *Journal of Political Economy*, 118, 681–722.

Hsieh, C.-T., E. Hurst, C. I. Jones, and P. J. Klenow (2019): "The Allocation of Talent and U.S. Economic Growth," Working Paper, forthcoming in: Econometrica.

Juhn, C., K. M. Murphy, and B. Pierce (1991): "Accounting for the Slowdown in Black-White Wage Convergence," in *Workers and Their Wages*, ed. by M. Kosters, AEI Press, 107–143.

——— (1993): "Wage Inequality and the Rise in Returns to Skill," *Journal of Political Economy*, 101, 410–442.

Kleven, H., C. Landais, and J. E. Søgaar (2018): "Children and Gender Inequality: Evidence from Denmark," Working Paper, forthcoming in: American Economic Journal: Applied Economics.

Mulligan, C. B. and Y. Rubinstein (2008): "Selection, Investment, and Women's Relative Wages Over Time," *Quarterly Journal of Economics*, 123, 1061–1110.

Neumark, D. (1988): "Employers' Discriminatory Behavior and the Estimation of Wage Discrimination," *Journal of Human resources*, 23, 279–295.

Ngai, R. L. and B. Petrongolo (2017): "Gender Gaps and the Rise of the Service Economy," *American Economic Journal: Macroeconomics*, 9, 1–44.

OECD (2019): "Employment: Share of Employed in Part-Time Employment, by Sex and Age Group," Data retrieved from OECD.Stat on 19.07.2019.

Olivetti, C. (2006): "Changes in Women's Hours of Market Work: The Role of Returns to Experience," *Review of Economic Dynamics*, 9, 557–587.

Olivetti, C. and B. Petrongolo (2016): "The Evolution of Gender Gaps in Industrialized Countries," *Annual Review of Economics*, 8, 405–434.

Roy, A. D. (1951): "Some Thoughts on the Distribution of Earnings," *Oxford economic papers*, 3, 135–146.

SMITH, J. AND F. R. WELCH (1989): "Black Economic Progress after Myrdal," *Journal of Economic Literature*, 27, 519–64.

WASSERMAN, M. (2019): "Hours Constraints, Occupational Choice, and Gender: Evidence from Medical Residents," Working Paper.

WEINBERG, B. A. (2000): "Computer Use and the Demand for Female Workers," *ILR Review*, 53, 290–308.

WEISSKOFF, F. D. B. (1972): ""Women's Place" in the Labor Market," *American Economic Review*, 62, 161–166.

WELCH, F. (2000): "Growth in Women's Relative Wages and in Inequality among Men: One Phenomenon or Two?" *American Economic Review: Papers and Proceedings*, 90, 444–449.

YAMAGUCHI, S. (2018): "Changes in Returns to Task-Specific Skills and Gender Wage Gap," *Journal of Human Resources*, 53, 32–70.

A Appendix

A.1 Additional Tables

Table A.1: Gender wage gap decomposition by professions

	Level	Difference			
	1985	1993 - 1985	2001 - 1993	2010 - 2001	2010 - 1985
Observed gap	44.24	-4.66	-2.41	-1.34	-8.42
Pred. gap, occupation × year	20.45	-3.73	-3.13	-1.50	-8.37
Price structure		-4.96	0.57	0.35	-4.04
Mgr		0.10	-0.05	-0.02	0.03
Prof		1.25	-0.06	-0.21	0.97
Tech		-0.16	0.02	0.01	-0.13
Sales		-0.69	0.05	0.03	-0.62
Office		-3.76	0.27	0.20	-3.29
Prod		-0.67	0.00	0.02	-0.65
Op		-0.54	0.02	0.03	-0.49
Crafts		-1.73	0.20	0.13	-1.41
Srvc		0.07	0.04	-0.02	0.09
Care		1.19	0.08	0.18	1.45
Skill structure		3.52	-1.54	-0.89	1.08
Mgr		0.10	0.06	0.08	0.24
Prof		-1.04	0.31	0.52	-0.21
Tech		0.73	0.15	-0.07	0.81
Sales		-0.20	-0.27	0.10	-0.37
Office		0.79	-1.18	-0.52	-0.91
Prod		2.07	0.10	-0.07	2.09
Op		1.35	-0.53	-0.98	-0.17
Crafts		3.21	-0.50	-0.77	1.94
Srvc		-0.82	0.26	0.45	-0.11
Care		-2.66	0.06	0.38	-2.23
Composition effect		-2.29	-2.17	-0.95	-5.41
Mgr		-5.01	-6.26	-2.31	-13.58
Prof		-5.35	-3.68	-12.61	-21.64
Tech		-7.43	-3.34	-2.93	-13.70
Sales		-7.10	1.98	6.73	1.61
Office		4.65	15.64	16.02	36.31
Prod		12.89	-1.20	4.33	16.02
Op		-2.01	1.38	0.82	0.19
Crafts		7.37	-12.56	-9.35	-14.54
Srvc		16.09	12.86	11.60	40.55
Care		-16.39	-7.00	-13.25	-36.64
Within occupation gap	23.79	-0.93	0.72	0.16	-0.06
Mgr		0.03	0.20	0.46	0.69
Prof		0.48	0.48	0.48	1.44
Tech		0.11	-0.06	-0.09	-0.05
Sales		0.05	0.03	-0.12	-0.04
Office		-0.64	0.62	0.76	0.75
Prod		-0.74	-0.55	-0.99	-2.29
Op		0.13	0.11	-0.01	0.22
Crafts		-0.14	-0.18	-0.32	-0.64
Srvc		-0.27	-0.11	-0.03	-0.41
Care		0.06	0.18	0.03	0.27

Notes: The panels show the results from Equation (2) and Equation (5) split by profession. Values ×100. Full-time working 25-54 year old West German men and women.

Table A.2: Average gender wage gap decomposition including part-time workers

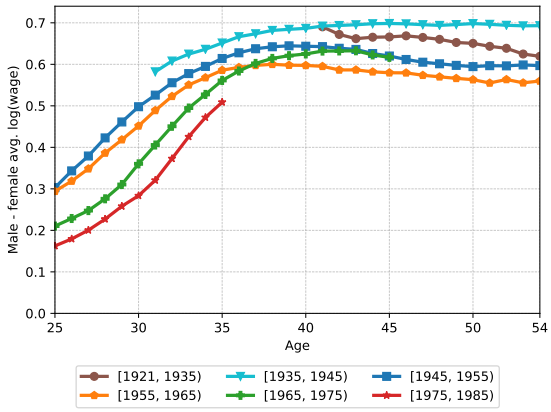
	Level	Difference			
	1985	1993 - 1985	2001 - 1993	2010 - 2001	2010 - 1985
Panel A					
Observed gap	59.09	-4.48	-3.57	0.27	-7.79
Pred. gap, occupation × year	31.59	-3.82	-3.98	-0.38	-8.17
Panel B					
Wage structure effect		-0.79	-1.05	1.08	-0.76
Growing prices		-1.43	0.23	0.23	-0.98
Declining prices		-4.06	0.50	0.34	-3.22
Skill changes		4.70	-1.78	0.52	3.44
Composition effect		-3.03	-2.93	-1.46	-7.41
Panel C					
Within occupation gap	27.51	-0.67	0.40	0.65	0.38
$\Delta p^m_{k,t} > \Delta p^f_{k,t}$		-1.44	-0.83	-0.60	-2.86
$\Delta p^m_{k,t} \leq \Delta p^f_{k,t}$		0.77	1.23	1.24	3.24

Notes: Panel A shows log wages of men minus log wages of women for two different wage measures: observed wages and predicted wages from a regression of wages on 120 occupation dummies interacted with year dummies, i.e. the between occupation gap in Equation (2). Panel B shows the separate parts of Equation (5) as well as the composition effect described in Equation (3). Panel C presents the results from decomposing the change in the within occupation gap following Equation (6). Values ×100. Full-time and part-time working 25-54 year old German men and women. The wage of a part-time worker is not adjusted for hours. Instead, the wage refers to a working day as is also the case for full-time workers.

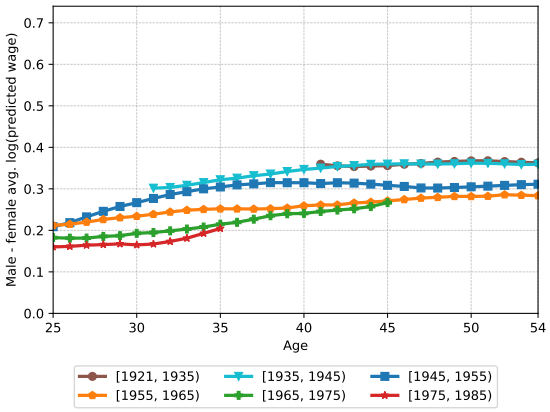
A.2 Additional Figures

Figure A.1: Wage gap by cohort including part-time workers

(a) Observed

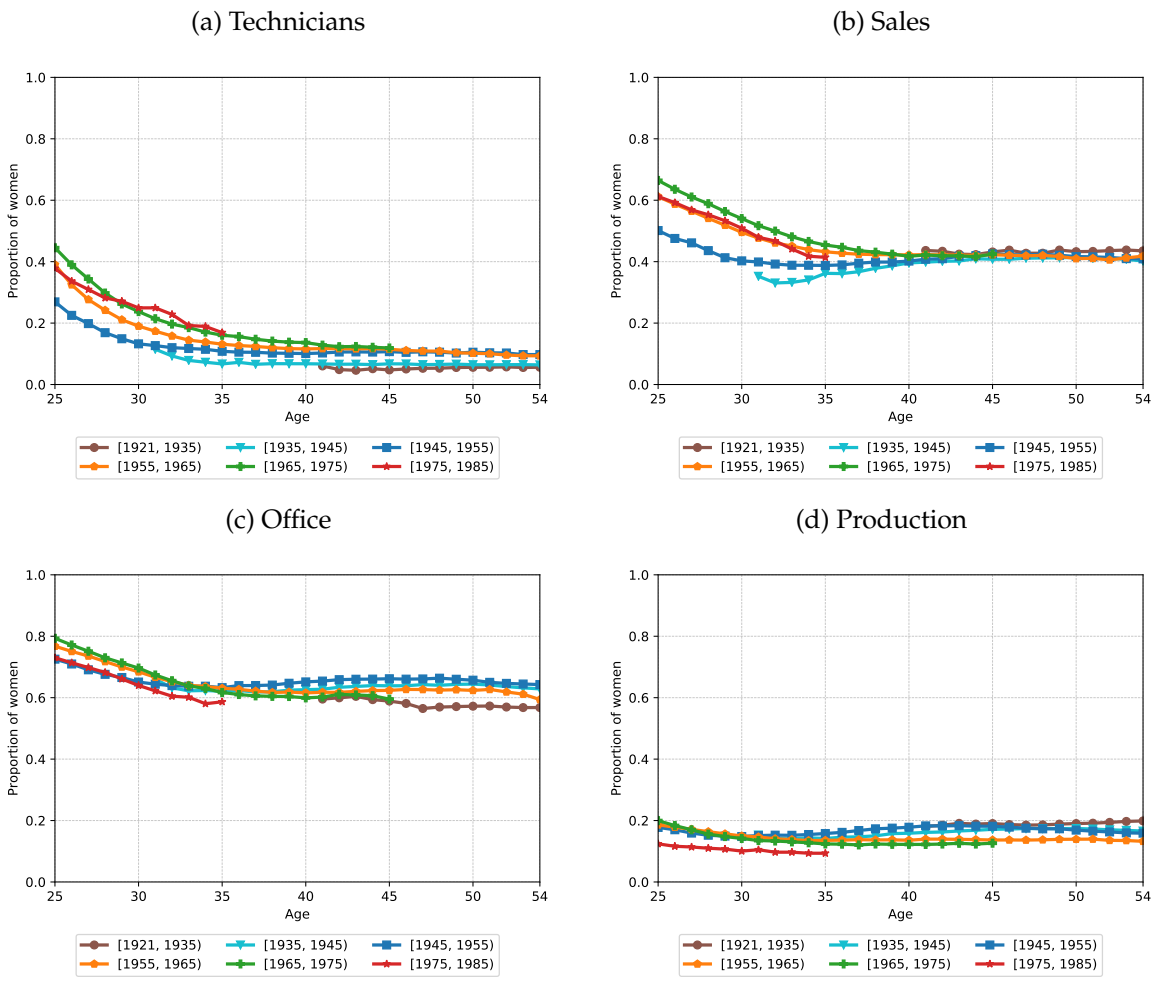


(b) Predicted by occupations × year dummies



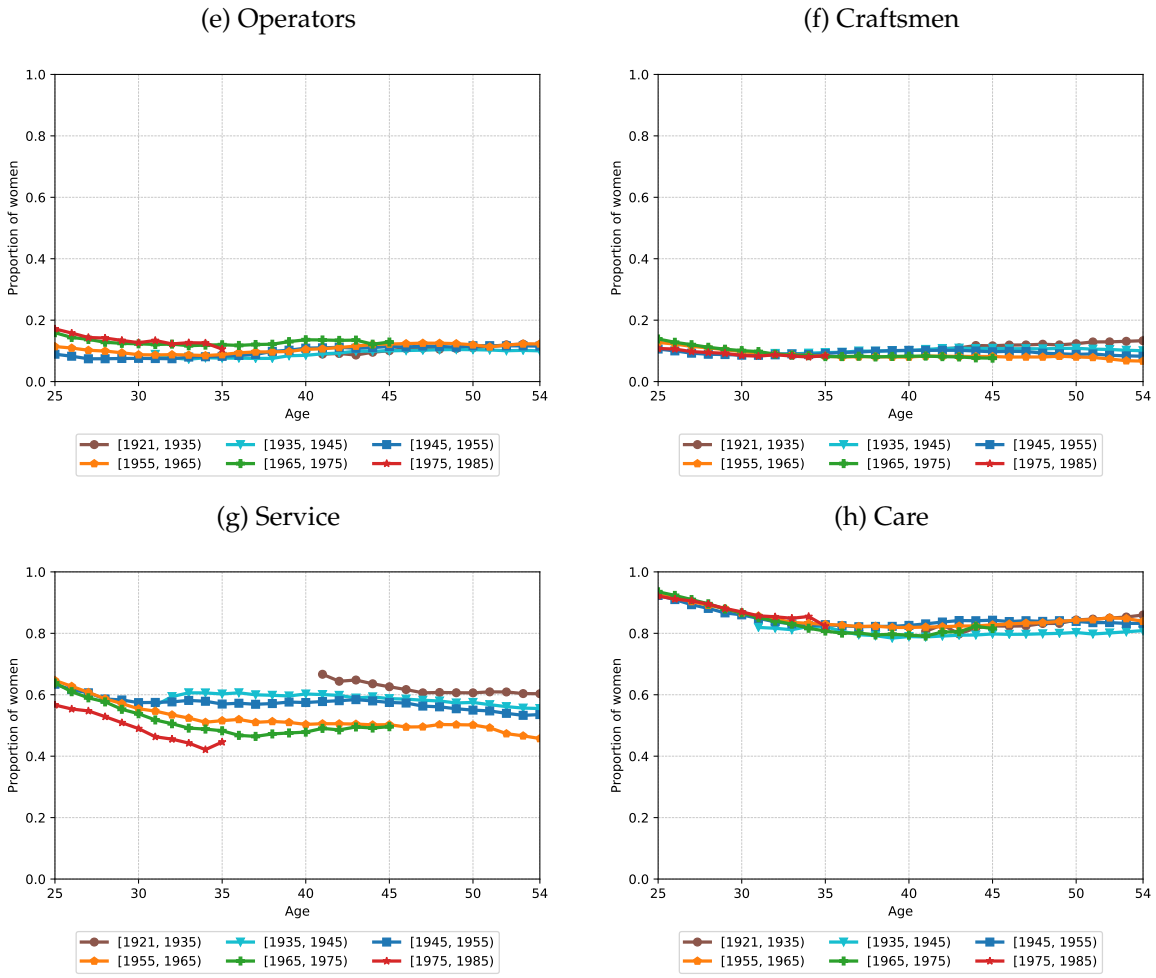
Notes: Figure A.1a shows log wages of men minus log wages of women by cohort and age. Figure A.1b repeats this but uses the predictions from a regression of log wages on occupation times year dummies to calculate the wage gap. Full-time and part-time working 25-54 year old German men and women. The wage of a part-time worker is not adjusted for hours. Instead, the wage refers to a working day as is also the case for full-time workers.

Figure A.2: Proportion of women in professions by cohort



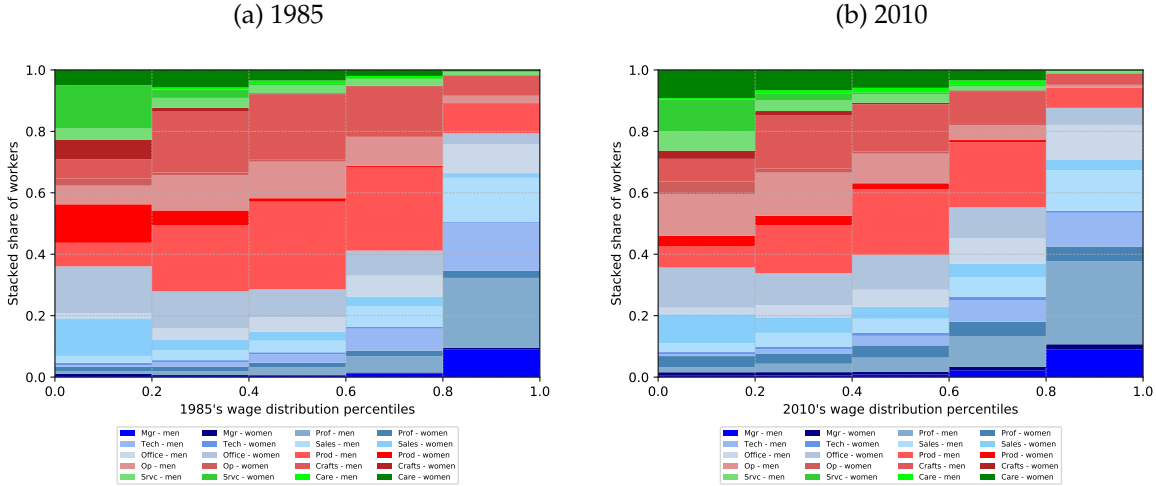
Notes: Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping. Full-time working 25-54 year old West German men and women.

Figure A.2: Proportion of women in professions by cohort



Notes: Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping. Full-time working 25-54 year old West German men and women.

Figure A.3: Proportion of profession × gender combinations in the wage distribution



Notes: Each rectangle is proportional to the share of workers in the respective occupation times gender bin. Wage distribution refers to the combined male and female wage distribution. Full-time working 25-54 year old West German men and women.