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The gender wage gap in Austria: *eppur si muove!*

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Abstract We examine the change of the gender wage gap in Austria between 2002 and 2007 using Juhn et al. (Workers and their wages, AEI Press, Washington DC, pp 107–143, 1991) decomposition. We analyze data from Austrian tax records which we merge with social security records and Austrian micro-censuses of the years 2002 and 2007. We find that the gender wage gap declined from 21 % in 2002 to 18 % in 2007. The main determinant of this decline is the relative improvement of women's unobserved characteristics. The decline of the gender wage gap is also due to women having attained more formal education and to a convergence of men's and women's returns to education. Women's improved educational attainments were partly offset by a shift in the demand for skilled workers that disadvantaged unskilled workers, most of whom are women, resulting in a moderate decrease of the gender pay gap over these years. Robustness checks confirm our results.

Keywords Gender wage differentials · Wage inequality · Decomposition · Matched employer-employee data

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1 Introduction

Econometric analyses of the gender wage gap estimate that women earn between 10 and 25 % less than men in OECD countries, e.g., Blau and Kahn (2003), Olivetti and Petrongolo (2008), or Arulampalam et al. (2007). In a meta-analysis, Weichselbaumer and Winter-Ebmer (2005) find that the gender wage gap in OECD countries has declined over the last 30 years and that a large part of the gap is due to differences in observed characteristics. Black and Spitz-Oener (2010) conclude that some part of the closing of the gap is due to skill-biased technological change that has worked in favor of women. Other researchers, for example, Antonczyk et al. (2010) for Germany, find that the overall gender wage gap changed only slightly between 2001 and 2006, except at the bottom of the wage distribution, where men are doing extremely poorly.

According to past research the gender wage gap in Austria did hardly change during the 1990s (Böheim et al. 2007). Since then, women have become more educated and more attached to the labor market than before (Statistik Austria 2010). These developments have been accompanied by legal efforts to ensure equal opportunities for men and women (Kreisky and Löffler 2010). In addition, skill-biased technological change increased demand for skilled workers. This higher demand resulted in relatively higher wages for skilled workers, but lowered wages for unskilled workers in the service sector, work that is typically performed by women. If these changes have translated into more equal pay for men and women over time is therefore an empirical question.

We contribute to the literature on the gender wage gap in Austria by applying the decomposition approach suggested by Juhn et al. (1991) to a novel dataset. For the empirical analysis, we merged data from Austrian tax records with social security records and augmented these with personal characteristics from the Austrian micro-censuses of the years 2002 and 2007. The data provide detailed information on hourly wages, educational attainments, and workplace characteristics. The data also include the reasons for and the length of work interruptions, such as unemployment spells or the birth of a child, over the careers of workers.

To investigate the persistence of the gender wage gap in Austria between 2002 and 2007, we use the decomposition approach suggested by Juhn et al. (1991).[1] This technique permits the decomposition of changes of the gender wage gap over time into a portion due to gender-specific factors and a portion due to differences in the overall level of wage inequality. With this technique we account for differences in observed characteristics such as education or labor market experience and also for differences in unobserved characteristics such as labor market attachment, statistical discrimination, or attitudes towards risk and competition.

By combining various data sources, our data overcome potential weaknesses of earlier research for Austria. For example, Böheim et al. (2007), who estimate a

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[1] See also Blau and Kahn (1992, 2003) for applications to the gender wage gap.

gender wage gap of about 17 % for 1983 and 14 % for 1997, did not have firms' characteristics or workers' exact experience in their data. Pointner and Stiglbauer (2010), who find that the unexplained wage gap was about 17 % and did not change between 1996 and 2002, had no information on workers' labor market experience. Grünberger and Zulehner (2009) use data from the EU-SILC 2004–2006 and estimate the unexplained wage gap at about 12 %; they, however, have comparably few observations and their data do not provide information on firms' characteristics. Our data, in comparison, provide not only detailed information on past experience and firms characteristics, but we also have detailed wage data from income tax statements. We have therefore reliable wage data for high-wage earners, who often refuse to declare their wages in surveys.

Over these five years, we estimate that the gender wage gap shrank by about three percentage points from 21.1 % in 2002 to 18.0 percent in 2007. These three percentage points represent a relative gain for women of about 15 % of the average gender wage gap in 2002. The narrower gender wage gap is the result of three developments, where the first is that women improved their formal education, especially through obtaining tertiary formal education. The second development is a convergence of the returns to education for men and women. These two developments would have contributed to a larger decline of the gender gap, but the overall increase in the returns to education disadvantaged the relative high number of women with compulsory schooling only. The third development was the relative improvement of women's unobserved characteristics over time, which also contributed to a narrower gender wage gap.

2 Data and summary statistics

We combine data from several Austrian administrative sources to construct a novel data set to overcome potential weaknesses in earlier studies. Data are from the Austrian General Income Report, which itself uses data from tax records and the quarterly Austrian micro-censuses, and from the Austrian social security records.[2] An anonymous personal identifier allows the combination of these data, which provides us with data on human capital variables, such as education and experience; workplace characteristics, such as the number of women or the fraction of young workers in a particular workplace; and also complete work histories since 1972. The sample size corresponds to the number of observations in the micro-censuses.

The Austrian General Income Report, published every other year, provides statistics on the income of all employees, self-employed persons, and pensioners in Austria. This report uses data from approximately 8.4 million pay slips collected by the Austrian tax authorities and provides information on gross yearly income, paid taxes, paid social contributions, and extra compensations. The tax data do not contain information on the number of hours worked. Austrians are taxed individually and it is therefore not possible to extract household information from

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[2] The Austrian General Income Report is described in Statistik Austria (2009) and in Rechnungshof (2008). The social security records are described in Zweimüller et al. (2009).

the tax records. For the purposes of the Austrian General Income Report, the tax data are combined with data from the Austrian micro-censuses to generate household level information and to obtain information on e.g., hours worked or formal qualifications. It is therefore an excellent source of information on wage income for employees (Statistik Austria 2008).

The Austrian micro-census is a quarterly panel survey which collects information on private households. It is representative of the Austrian population and contains information on about 80,000 individuals per year. Every quarter, a fifth of the sample is renewed. The micro-census provides information on hours worked per week, education, and detailed information on individual and household characteristics, but it does not contain income information. We compute gross hourly wages by combining the information on the hours worked per week from the micro-census, the number of days worked per year from the social security data, and the yearly gross income from the tax records.

In order to obtain data on actual career interruptions, we use data from Austrian social security records. These contain information on individual work experience, tenure, and characteristics of the workplace, such as industry or region. The data also include the reasons for and the length of work interruptions such as unemployment spells or the birth of a child. In addition, firm identifiers permit the construction of workplace characteristics such as the number of women or the fraction of young workers in a particular workplace.

For the decomposition of the gender wage gap over time, we use data from 2002 and 2007. The data from the micro-census for 2002 include only one of four quarterly surveys and cover about 20,000 individuals.[3] Some categories in the micro-census changed over time and some minor adjustment to categories were required, however, no adjustments to variables from the tax records and the social security were necessary.[4]

The combination of the micro-census, the tax records, and the social security data provides hourly wages and detailed information on the actual workplace and a worker's career. Because the data are mainly obtained from administrative sources, the data are reliable and, for the parts that were obtained from surveys, representative for the Austrian population. Our estimating sample consists of workers in the private and the public sector who were between 16 and 60 years of age. To account for possible seasonal fluctuations, we restrict our sample to workers who worked for at least 270 days in each year. As Table 1 reports, the sample consists of 5,677 women for 2002 and 10,617 for 2007. There are 7,280 men for 2002 and 12,102 for 2007. The sample for 2007 is larger because for 2002 we could obtain only one of four quarterly surveys. The restriction to cases with stable employment reduces our sample by about 26–31 %. We also list further restrictions which we use for our robustness checks.

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[3] For administrative reasons we could only obtain one quarter for 2002; we use data from all four quarters in 2007.

[4] Note that the data are a combination of two cross-sections and, despite the sources, are not a panel. Because the micro-census is a rotating panel, we cannot obtain personal characteristics, such as hours worked, over time.

Table 1 Sample sizes as a result of data restrictions

	Men	Women	All
Employed in 2002	10,602	7,891	18,493
At least 270 days a year (*as % of all*)	7,280 (68.7)	5,677 (71.9)	12,957
Private sector (*as % of all*)	5,369 (50.6)	3,249 (41.2)	8,618
Private sector, full-time employees (*as % of all*)	4,991 (47.1)	1,768 (22.4)	6,759
Employed in 2007	16,186	13,764	29,950
At least 270 days a year (*as % of all*)	12,102 (74.8)	10,167 (73.9)	22,269
Third quarter (*as % of all*)	7,466 (46.1)	6,201 (45.1)	13,667
Private sector (*as % of all*)	9,806 (60.6)	6,415 (46.6)	16,221
Private sector, full-time employees (*as % of all*)	8,907 (55.0)	3,444 (25.0)	12,351

Table 2 provides summary statistics of our estimating sample.[5] We calculate the gross hourly wage from the three different sources. Wages are calculated as the ratio of the gross yearly income (obtained from the tax records) over the product of the number of days employed (obtained from the social security data) and the average number of hours worked per day (obtained from the census). Wages are deflated to the year 2002. On average, men earned some €15.70 gross per hour in 2002 and women about €12.42, a difference of about €3.28, or about 20.9 percent of men's average wages. In 2007, the difference of the mean wages was slightly less than in 2002, it was about €3.02, or 19.1 % of men's average wages.

The amount of formal education is probably the most important determinant of wages. Formal education of Austrian women and their labor market attachment have steadily increased throughout the last decades. Austrian women overtook men in educational attainments and have nowadays on average more formal qualification than men. Statistik Austria (2010) document that in 2000 for the first time more women than men studied at a university. In 2004, more women than men obtained a degree (Statistik Austria 2010). The descriptive statistics of our samples show that women gained in terms of formal education between 2002 and 2007, which, other things equal, would lead us to expect a decrease of the gender wage gap. More women had secondary school degrees in 2007 than in 2002, and the number of university degrees increased, too. For men, we also find a trend towards higher formal qualifications between 2002 and 2007; it is however less marked than the trend for women. At the lower end of the educational distribution, women appear to obtain only compulsory education, whereas men tend to complete an apprenticeship.

Turning to other determinants of wages, we see that women were on average about half a year younger than men. Their average labor market experience was about two years shorter than men's, owing to motherhood and child care responsibilities. The summary statistics also show that fewer women than men were married, possibly indicating differences in productivity, differences in labor supply due to small children, or discriminating hiring practices.

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[5] Note that the number of observations in our estimating sample is limited by observations on which we have tax data. Persons who do not file income tax such as children or pensioners are included in the micro-census, but are excluded from our estimating sample.

Table 2 Summary statistics, mean (S.D.)

	2002		2007	
	Men	Women	Men	Women
Gross hourly wage (€)	15.698	12.424	15.830	12.811
	(7.008)	(5.629)	(7.354)	(5.793)
Formal education				
Compulsory schooling	0.128	0.205	0.139	0.182
Apprenticeship	0.579	0.330	0.539	0.314
Secondary school	0.074	0.177	0.080	0.212
High school	0.143	0.186	0.141	0.166
Craftsmen diploma	0.018	0.042	0.021	0.048
University degree	0.055	0.057	0.077	0.075
Other human capital variables				
Age	37.758	38.410	38.458	38.743
	(10.656)	(10.096)	(11.231)	(10.670)
Experience	17.192	14.514	18.709	15.737
	(8.745)	(7.684)	(10.217)	(8.853)
Tenure	10.916	10.295	10.036	8.061
	(8.444)	(7.244)	(8.699)	(7.133)
Length of interruptions	0.503	1.011	0.583	1.386
	(0.863)	(1.356)	(1.067)	(1.764)
Married	0.636	0.636	0.666	0.637
	(0.481)	(0.481)	(0.471)	(0.480)
Austrian citizenship	0.933	0.942	0.922	0.934
	(0.249)	(0.232)	(0.267)	(0.247)
Part-time	0.020	0.372	0.033	0.403
	(0.140)	(0.483)	(0.179)	(0.491)
Worker status				
Blue-collar worker	0.550	0.273	0.422	0.211
	(0.497)	(0.445)	(0.494)	(0.408)
White-collar worker	0.339	0.609	0.497	0.724
	(0.473)	(0.487)	(0.500)	(0.446)
Executive position	0.040	0.026	0.077	0.031
	(0.197)	(0.159)	(0.267)	(0.174)
Firm specific variables				
log firm size	4.733	4.707	4.750	4.623
	(2.097)	(2.465)	(2.066)	(2.456)
Average age in the firm	37.285	37.840	38.477	39.146
	(4.634)	(5.071)	(5.025)	(5.480)
Public sector	0.263	0.431	0.190	0.369
	(0.440)	(0.495)	(0.392)	(0.483)
Ratio female to male workers in the firm	0.292	0.657	0.301	0.653
	(0.231)	(0.243)	(0.234)	(0.254)

Table 2 continued

	2002		2007	
	Men	Women	Men	Women
Worker turnover in the firm	1.948	1.386	4.671	17.826
	(22.014)	(4.606)	(252.873)	(670.355)
Occupation				
Administrative officers	0.040	0.026	0.080	0.024
Researchers	0.074	0.122	0.082	0.094
Engineers and equivalent non-technical jobs	0.131	0.160	0.196	0.239
Office workers	0.096	0.237	0.085	0.232
Sales and other services	0.082	0.242	0.085	0.232
Craftspersons	0.342	0.036	0.258	0.023
Assembly workers	0.140	0.041	0.116	0.018
Unskilled workers	0.091	0.132	0.093	0.134
Industry				
Agriculture	0.011	0.008	0.010	0.008
Mining	0.004	0.000	0.004	0.001
Food products and beverages	0.024	0.015	0.026	0.022
Textile	0.008	0.019	0.008	0.010
Leather	0.002	0.002	0.001	0.001
Wood and products of wood	0.016	0.004	0.021	0.007
Paper and paper products	0.020	0.012	0.018	0.011
Coke, refined petroleum products	0.000	0.000	0.001	0.000
Chemicals and chemical products	0.016	0.009	0.013	0.006
Rubber and plastics products	0.010	0.005	0.012	0.005
Glassware	0.013	0.006	0.015	0.005
Metals	0.080	0.021	0.070	0.015
Machinery and equipment	0.038	0.005	0.048	0.010
Office, accounting and computing machinery	0.031	0.016	0.031	0.014
Motor vehicles	0.018	0.004	0.020	0.005
Manufacture of other products and recycling	0.033	0.008	0.017	0.006
Electricity, gas and water supply	0.015	0.001	0.014	0.004
Whole sale and retail	0.106	0.202	0.146	0.206
Construction	0.182	0.015	0.127	0.024
Hotels and restaurants	0.025	0.067	0.024	0.068
Transport, storage and communications	0.083	0.038	0.062	0.035
Financial intermediation	0.031	0.044	0.039	0.044
Real estate	0.003	0.015	0.010	0.011
Business services	0.038	0.057	0.046	0.067
Public administration and defence	0.084	0.070	0.103	0.086
Education	0.038	0.127	0.032	0.097
Health	0.032	0.161	0.036	0.165
Other services	0.025	0.053	0.033	0.052

Table 2 continued

	2002		2007	
	Men	Women	Men	Women
Population density				
High	0.254	0.312	0.453	0.413
Medium	0.254	0.265	0.266	0.261
Low	0.490	0.422	0.279	0.324
Region				
Burgenland	0.097	0.101	0.086	0.088
Lower Austria	0.135	0.144	0.128	0.125
Vienna	0.099	0.125	0.103	0.125
Carinthia	0.082	0.078	0.103	0.099
Styria	0.129	0.118	0.118	0.113
Upper Austria	0.163	0.151	0.134	0.119
Salzburg	0.093	0.098	0.111	0.123
Tyrol	0.115	0.107	0.106	0.103
Vorarlberg	0.087	0.078	0.111	0.105
Number of observations	7,280	5,677	12,102	10,167

The differences in wages might also be related to differences of the workplaces in which women and men worked. The summary statistics support such a hypothesis since, for example, many more women worked in the public sector than men did. Whether this is the outcome of a selection process or due to discrimination against women is beyond the scope of the current analysis. The composition of the private and the public sector changed over time; in 2002, 43 % of female workers were working in the public sector and in 2007 about 37 %. We observe a similar change for male workers where the numbers are 26 and 19 %. One reason is the increase in the number of formerly state owned firms that have been privatized, e.g. in the telecommunications sector.

There were differences in the distribution across industries. The relative majority of women worked in the retail sector (in 2002: 20.2 %, in 2007: 20.6 %), while the relative majority of men in construction (in 2002: 18.2 %, in 2007: 27.7 %). Women are predominantly office workers or sales persons, while men are typically working in crafts or as assembly workers. Not only do we observe differences in the occupations in which men and women worked, there is also clear evidence for differences in within-firm hierarchies as merely 2.6 (3.1) percent of women, in contrast to some 4.0 (7.7) percent of men, had an executive position in 2002 (2007). Some of this difference is perhaps due to the large numbers of women working in part-time jobs, we see that about 37.2 (40.0) percent of women had a part-time job (less than 35 h/week), whereas only 2.0 (3.3) percent of men worked part-time in 2002 (2007).

We do not find any differences in the sizes of the firms. For both men and women, the average firm size is about 100 employees. The average age of workers

in the firm is also similar for men and women. There are differences in the worker composition and the turnover in the firms in which men and women work. Women tend to work in firms with a higher share of women (in 2002: 0.657, in 2007: 0.653) than men (in 2002: 0.292, in 2007: 0.301) do. We observe a rather large increase of the turnover over time, especially for women. This is however due to some outliers; the median remains constant over time (in 2002: 0.61, in 2007: 0.55 for both men and women).

3 Methods

Since it is evident from the descriptive statistics that men and women differ in their average characteristics, it is therefore not unexpected that their average wages do differ. Political debates typically center on the question of how much of this difference is justified, i.e., due to differences in characteristics, and how much is unjustified, i.e., due to unfair treatment of women. The discussions also wish to clarify when or how much of women's catching up in the educational attainment and labor market experience will contribute to a closing of the gender wage gap.

To answer these questions, we use decomposition techniques and follow Juhn et al. (1991), who have devised a method that allows to decompose differences in the gender wage gap over time into a portion due to gender specific factors and a portion due to differences in the overall level of wage inequality.

Suppose that wages for a worker i in period t is given by the following equation:[6]

$$Y_{it} = X_{it}B_t + \sigma_t\theta_{it},$$

where Y_{it} is the log of wages, X_{it} is a vector of explanatory variables, B_t is a vector of explanatory coefficients, θ_{it} is a standardized residual (i.e., with mean zero and variance one for each point in time), and σ_t is the period's residual standard deviation of wages (i.e., the unexplained level of wage inequality among men).

The average male-female wage gap for period t is given by:

$$D_t \equiv Y_{mt} - Y_{ft} = (X_{mt} - X_{ft})B_t + \sigma_t(\theta_{mt} - \theta_{ft}) = \Delta X_t B_t + \sigma_t \Delta\theta_t,$$

where the m and f subscripts refer to male and female averages and Δ indicates the average male-female difference for the variable immediately following. The change in the wage gaps between two periods t and s can then be decomposed as follows:

$$D_t - D_s = (\Delta X_t - \Delta X_s)B_s + \Delta X_s(B_t - B_s) + (\Delta X_t - \Delta X_s)(B_t - B_s)$$
$$+ (\Delta\theta_t - \Delta\theta_s)\sigma_s + \Delta\theta_s(\sigma_t - \sigma_s) + (\Delta\theta_t - \Delta\theta_s)(\sigma_t - \sigma_s),$$

where the first term on the right hand side of the equation is the change in the differences in observed labor market qualifications X over time. The second term measures changes in observed prices, while the third term adjusts for the simultaneous changes in quantities and prices. The fourth term measures the effect of differences in the relative residual wage position of men and women over time, i.e., the relative

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[6] Our presentation follows Blau and Kahn (1992) and Jann (2008). For a more general discussion of this method see Fortin et al. (2011).

Table 3 Blinder-Oaxaca decomposition of wage differentials

	Year	Difference	Explained gap	Unexplained gap
Male-based				
	2002	0.237	0.085	0.152
	2007	0.200	0.068	0.132
	Difference	−0.036	−0.016	−0.020
Female-based				
	2002	0.237	0.026	0.211
	2007	0.200	0.041	0.160
	Difference	−0.036	0.015	−0.051

Results from Blinder-Oaxaca decompositions. Dependent variable is the logarithm of hourly gross wages. Number of observations: 12,957 in 2002 and 22,269 in 2007

ranking of women within the male residual wage distribution. Such differences in rankings may reflect gender differences in unmeasured characteristics or the impact of labor market discrimination against women. The fifth term denotes the part that is due to changes in residual inequality, i.e., how changes in unobserved prices for the unobserved quantities affect the change in the wage gap. The last term again adjusts for simultaneous changes in unobserved quantities and unobserved prices.

4 Estimation results

Table 3 presents the results from the Blinder-Oaxaca decompositions of the gender wage gap for 2002 and 2007.[7] The average gender wage gap shrank by about three percentage points from 21.1 % (0.237 log points) in 2002 to about 18.0 % (0.200 log points) in 2007. The difference in mean wages in 2002, using men's wages as the reference distribution, indicates that about 36 % can be attributed to observed characteristics. The majority of the gap remains unexplained. For 2007, the decomposition indicates that a similar portion, 34 %, of the gap can be attributed to observed characteristics. For all our analyzes below, it matters little whether we use men's or women' wage distribution as the reference wage distribution, however, when we use women's wages as the reference distribution, we typically estimate a smaller explained part of the gender wage gap.

Table 4 presents the estimated coefficients from the wage regressions.[8] They indicate, for example, that more formal education or more experience is associated with higher wages, similar to results by e.g., Böheim et al. (2007). We also find that unemployment spells or periods of parental leave are associated with lower wages. Wages clearly differ by the type of workplace and they are typically higher in larger workplaces, in banks, and in urban areas. We also find evidence for an association

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[7] See Blinder (1973) and Oaxaca (1973).

[8] The coefficients indicate changes in log wages. For small values, they are approximately equal to percent changes, i.e., a coefficient of 0.02 indicates that a 1 unit change in the explanatory variable is associated with a 2 % change in log wages. To calculate percentages from log-points, use $\exp(\hat{\beta}) - 1$.

Table 4 Wage regressions for 2002 and 2007, by gender

	Men, 2002 Coef. (S.E.)	Women, 2002 Coef. (S.E.)	Men, 2007 Coef. (S.E.)	Women, 2007 Coef. (S.E.)
Apprenticeship	0.062	0.019	0.250	0.134
	(0.01)	(0.01)	(0.01)	(0.01)
Secondary school	0.148	0.095	0.304	0.226
	(0.02)	(0.01)	(0.01)	(0.01)
High school	0.220	0.183	0.458	0.343
	(0.01)	(0.02)	(0.01)	(0.01)
Craftsmen diploma	0.215	0.241	0.477	0.414
	(0.03)	(0.03)	(0.02)	(0.02)
University degree	0.456	0.370	0.644	0.521
	(0.02)	(0.02)	(0.02)	(0.02)
Experience	0.035	0.023	0.049	0.037
	(0.00)	(0.00)	(0.00)	(0.00)
Experience squared × 100	-0.078	-0.040	-0.097	-0.070
	(0.01)	(0.01)	(0.00)	(0.00)
Tenure	0.002	0.010	0.009	0.009
	(0.00)	(0.00)	(0.00)	(0.00)
Tenure squared × 100	0.020	–0.002	0.007	–0.000
	(0.00)	(0.01)	(0.00)	(0.01)
Length of interruptions	–0.037	–0.030	0.007	–0.004
	(0.01)	(0.01)	(0.01)	(0.00)
Length of interruptions × 100	0.222	0.391	–0.191	0.041
	(0.20)	(0.15)	(0.09)	(0.07)
Public	–0.057	0.031	–0.151	–0.056
	(0.01)	(0.02)	(0.02)	(0.02)
Part-time	0.015	0.101	0.155	0.106
	(0.02)	(0.01)	(0.02)	(0.01)
Married	0.065	–0.024	0.053	0.007
	(0.01)	(0.01)	(0.01)	(0.01)
Austrian citizenship	0.051	–0.008	–0.058	–0.059
	(0.01)	(0.02)	(0.01)	(0.01)
Medium population density	0.004	0.030	0.000	0.000
	(0.01)	(0.01)	(0.01)	(0.01)
High population density	0.028	0.017	–0.010	–0.019
	(0.01)	(0.01)	(0.01)	(0.01)
Blue collar worker	–0.082	–0.055	–0.096	–0.083
	(0.01)	(0.01)	(0.01)	(0.01)
Civil servants	0.017	0.068	0.091	0.088
	(0.02)	(0.02)	(0.02)	(0.02)
Log Firm size	0.022	0.016	0.038	0.028
	(0.00)	(0.00)	(0.00)	(0.00)

Table 4 continued

	Men, 2002 Coef. (S.E.)	Women, 2002 Coef. (S.E.)	Men, 2007 Coef. (S.E.)	Women, 2007 Coef. (S.E.)
Average age in the firm	0.005	0.004	0.003	0.003
	(0.00)	(0.00)	(0.00)	(0.00)
Ratio female to male workers in the firm	–0.156	–0.209	–0.169	–0.202
	(0.02)	(0.02)	(0.02)	(0.01)
Worker turnover in the firm	–0.000	0.003	–0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	1.851	1.847	1.551	1.702
	(0.04)	(0.05)	(0.03)	(0.03)
Number of observations	7280	5677	12102	10167
Adjusted R-squared	0.51	0.47	0.60	0.54

Regressions include indicator variables for region, industry, and occupation

between wages and the gender composition of the workplace. Both men and women are estimated to have a significantly lower wage the more women are employed in a firm, which is a commonly found result (Bayard et al. 2003).

The estimates also show that returns to characteristics have changed between 2002 and 2007. We see that returns to formal education have, relative to compulsory education, increased. For example, the returns to a university degree increased from 0.456 to 0.644 log points for men and from 0.370 to 0.521 log points for women. In other words, we estimate that in 2007, men with a university degree had an about 58 % higher wage than men who had only compulsory schooling. Women who had a university degree earned a wage that was about 68 % higher than those of women who had only compulsory education. Overall, we also find that the returns to formal education are less for women than for men. They are particularly low for an apprenticeship, i.e., the returns increased from 0.062 to 0.250 log points for men and from 0.019 to 0.134 log points for women.

There are changes regarding the returns to public and part-time work. While the returns in the public sector were negative for men and positive for women in 2002, there were negative for both men and women in 2007. For both men and women, the relative decline in public sector wages is rather large and is about 8.5 %age points. We estimate that men in the public sector earned on average about 14 % lower wages than men in the private sector. Women, on average, earned about 5 % lower wages in the public than in the private sector.

For part-time work, we find a rather large increase in returns for men, they stayed constant for women. This result seems puzzling. It could be explained by men who work part-time having more favorable characteristics than those who work full-time. This is indeed the case, 11.0 (11.5) percent of part-time working men had a university degree in 2002 (2007), compared to 5.6 (7.7) percent in the overall sample. Because this has not changed over time, we conclude that either the composition of unobservable characteristics has changed or, perhaps more likely, that attitudes towards men who work part-time are changing.

Changes in returns to experience, tenure, or interruptions are minor. We find that men received a marriage premium that declined over time; the wages of married women, however, differed little from those of women with different marital statuses. In 2007, foreign workers earned, in contrast to 2002, on average higher wages than Austrian workers. A reason for this change might be the increase in the number of highly educated migrants from EU countries, especially from Germany, to Austria over this period (OECD 2012). In 2002, wages were higher in cities than in rural areas, this difference is no more relevant in 2007. Other changes in returns are minor.

Table 5 tabulates the decompositions of the explained and the unexplained wage gap, using Juhn et al.'s (1991) approach. This approach attributes the change in the explained part of the wage gap into a component that can be attributed to changes in the groups' differences in unobserved characteristics over time; into a component that is due to changes in residual inequality, i.e., changes in unobserved prices; and into a component which is due to simultaneous changes in characteristics and prices. Overall, we estimate that the gender wage gap decreased over time and that this smaller gap was mainly due to a smaller unexplained component of the wage gap.

Using the male-based decomposition, we find that both the explained and the unexplained components decreased, however, the unexplained part is estimated to have decreased more than the explained part. The change in the explained part of the gender wage gap was due to a large shift in the characteristics, which was offset by the simultaneous change in both characteristics and prices.

The change in the unexplained wage gap is –0.020 log points in the male-based and it is –0.051 log points in the female-based decomposition. The smaller unexplained component of the gender wage gap was caused by a change in unobserved characteristics. Such a change is caused by, for example, a stronger attachment to the labor market or less statistical discrimination.

The change in unobserved prices is estimated to have contributed little to the change over time. In fact, using the male-based decomposition we estimate a small *increase* of the unexplained part, whereas the female-based decomposition yields a small *decrease*. Similarly, the simultaneous change in characteristics and prices is estimated to have contributed little towards a lower unexplained component of the gender wage gap.

Table 5 Decomposition of the change of the gender wage gap between 2002 and 2007

	Female-based	Male-based
Overall change	–0.036	–0.036
Change in the explained gap	0.015	–0.016
Quantity effect	–0.020	0.030
Price effect	–0.012	-0.037
Interaction effect	0.030	–0.008
Change in the unexplained gap	–0.051	–0.020
Quantity effect	–0.050	–0.035
Price effect	0.001	0.025
Interaction effect	–0.002	–0.010

Results from Juhn–Murphy–Pierce decompositions. Dependent variable is the logarithm of hourly gross wages. Number of observations: 12,957 in 2002 and 22,269 in 2007

Table 6 Detailed decomposition of the difference in the predicted gap (male-based)

	Difference in predicted gap	Quantity effect	Price effect	Interaction $Q \times P$
Total	–0.0164	0.0296	–0.0374	–0.0086
Education (overall)	0.0086	–0.0006	0.0139	–0.0047
Experience (overall)	0.0053	–0.0098	0.0162	–0.0010
Tenure (overall)	0.0147	0.0081	0.0004	0.0062
Length of interruptions (overall)	–0.0133	0.0072	–0.0146	–0.0059
Industry (overall)	–0.0126	–0.0016	–0.0117	0.0007
Region (overall)	–0.0003	–0.0004	0.0000	0.0001
Occupation (overall)	–0.0001	0.0135	–0.0133	–0.0004
Blue-collar worker	0.0040	0.0058	–0.0044	0.0027
Population density (overall)	0.0013	0.0028	0.0022	–0.0037
Public sector	0.0176	0.0007	0.0158	0.0011
Part-time	–0.0521	–0.0003	–0.0493	–0.0025
Married	0.0015	0.0019	0.0000	–0.0003
Austrian	0.0013	–0.0001	0.0010	0.0003
Firm size	0.0042	0.0022	0.0004	0.0016
Average age in the firm	0.0008	–0.0006	0.0012	0.0002
Ratio female to male workers in the firm	0.0025	–0.0020	0.0046	–0.0002
Worker turnover in the firm	0.0002	0.0031	0.0001	–0.0030

Results from Juhn–Murphy–Pierce decompositions. Dependent variable is the logarithm of hourly gross wages. Number of observations: 12,957 in 2002 and 22,269 in 2007. Overall effects are reported for specific groups of regressors such as education, experience, tenure, industry, occupation, population density and region

Tables 6 and 7 present in detail which characteristics contributed to the aggregate changes presented in Table 5. The quantitatively most important differences in the gender wage gap between 2002 and 2007 were, according to both estimates, the changes in educational attainments and of the occupational structure. Although women gained from more formal eduction and from a convergence of the returns to education to men's, the overall changes in the educational structure led to *an increase* of the gender wage gap. This increase is due to the unfavorable development for the price of unskilled labor in general and the price of unskilled labor of women in particular. The changes in the occupational structure led to an increase in the gender wage gap, which reflects the employment of women in low paying service occupations. The change in returns to characteristics, in contrast, led to a narrower gender wage gap. In addition, the returns to higher education (the prices) of men and women have converged and this also contributed to a narrower gender wage gap. However, a fall in the price of unskilled labor in general and the price of unskilled female labor in particular did prevent an even narrower gender wage gap. Over this period, the relatively high number of women who have only compulsory schooling did not fall and, consequently, as more women obtain more formal education, the distribution is becoming more unequal.

Table 7 Detailed decomposition of the difference in the predicted gap (female-based)

	Difference in Predicted gap	Quantity Effect	Price Effect	Interaction Q × P
Total	0.0148	–0.0023	–0.0124	0.0296
Education (overall)	0.0010	0.0008	0.0037	–0.0035
Experience (overall)	–0.0005	–0.0035	0.0067	–0.0037
Tenure (overall)	0.0120	0.0132	–0.0002	–0.0013
Length of interruptions (overall)	–0.0061	0.0021	–0.0065	–0.0017
Industry (overall)	–0.0076	0.0009	–0.0109	0.0024
Region (overall)	–0.0002	–0.0001	0.0000	–0.0001
Occupation (overall)	0.0070	0.0181	–0.0099	–0.0011
Blue-collar worker	–0.0004	0.0052	–0.0080	0.0023
Population density (overall)	0.0005	0.0021	0.0024	–0.0039
Public sector	0.0152	–0.0004	0.0145	0.0010
Part-time	–0.0035	–0.0018	–0.0016	–0.0001
Married	0.0002	–0.0007	–0.0000	0.0009
Austrian	0.0007	0.0000	0.0005	0.0001
Firm size	0.0031	0.0016	0.0003	0.0012
Average age in the firm	0.0002	–0.0005	0.0005	0.0001
Ratio female to male workers in the firm	–0.0051	–0.0026	–0.0025	0.0000
Worker turnover in the firm	–0.0015	–0.0368	–0.0015	0.0368

Results from Juhn–Murphy–Pierce decompositions. Dependent variable is the logarithm of hourly gross wages. Number of observations: 12,957 in 2002 and 22,269 in 2007. Overall effects are reported for specific groups of regressors such as education, experience, tenure, industry, occupation, population density and region

4.1 Robustness of our results

We investigate the robustness of our results by re-estimating the decompositions using different samples. First, because wages in the public sector are typically more structured than in the private sector, we limit the sample to the private sector. Second, because full-time workers may differ from part-time workers, we limit the sample to full-time workers in the private sector. Third, because for 2002 we could obtain only data from the micro-census of the third quarter, we limit the data for 2007 also to the third quarter. This should avoid biases from seasonal fluctuations. We present Blinder-Oaxaca decomposition results for 2002 and 2007 and the Juhn–Murphy–Pierce decomposition results in Tables 8, 9, and 10.

Table 8 presents the Blinder-Oaxaca decomposition results. We observe that in the private sector the gender wage gap is wider than in the combined sample. The fixed wage schemes of the public sector result in smaller differences between men and women, but qualitatively our results do not change. In particular, the difference in average female and male wages shrank by about 0.056 log points. According to the male-based decomposition, the explained gap shrank by 0.041 log points and the unexplained gap shrank by 0.015 log points. According to the female-based composition, the explained gap increased by 0.004 log points and the unexplained

Table 8 Blinder-Oaxaca decomposition of wage differentials

	Year	Difference	Explained gap	Unexplained gap
Private sector				
Male-based	2002	0.300	0.133	0.167
	2007	0.244	0.092	0.152
	Difference	−0.056	−0.041	−0.015
Female-based	2002	0.300	0.063	0.237
	2007	0.244	0.067	0.177
	Difference	−0.056	0.004	−0.060
Private sector, full-time workers only				
Male-based	2002	0.305	0.121	0.184
	2007	0.256	0.147	0.109
	Difference	−0.050	0.025	−0.075
Female-based	2002	0.305	0.069	0.236
	2007	0.256	0.087	0.168
	Difference	−0.050	0.018	−0.068
Reduced sample				
Male-based	2002	0.237	0.085	0.152
	2007	0.204	0.037	0.168
	Difference	−0.033	−0.048	−0.016
Female-based	2002	0.237	0.026	0.211
	2007	0.204	0.042	0.162
	Difference	−0.033	0.017	−0.049

Results from Blinder-Oaxaca decompositions. Dependent variable is the logarithm of hourly gross wages. Number of observations in the private sector: 5,369 men and 3,249 women in 2002 and 9,806 and 6,415 in 2007; private sector, full-time employees only: 4,991 men and 1,768 women in 2002 and 8,907 men and 3,444 in 2007; reduced sample uses only observations from the third quarters (but both public and private sector workers, and both part-time and full-time workers): 7,280 men and 5,677 women in 2002 and 7,466 men and 6,201 women in 2007

gap shrank by 0.060 log points. The differences between the male-based and the female-based decompositions differ in the relative importance of the convergence of the explained gap. According to the male-based decomposition, the decline in the gender wage gap is due to the convergences of both the explained and the unexplained gaps. When we use the female-based decomposition, the decline in the gender wage gap is estimated to be solely caused by the convergence in the unexplained gap.

Table 9 reports the Juhn–Murphy–Pierce decomposition results of the change of the explained gap between 2002 and 2007. The results do not change our conclusions from the main estimates. If we concentrate on the private sector, the increase of the explained gap of –0.041 log points is, according to the male-based decomposition, due to a quantity effect of 0.027 log points, a price effect of –0.043 log points, and an interaction effect of –0.024 log points. According to the female-based decomposition, the change of the explained gap of 0.004 log points is the result of a quantity effect of 0.032 log points, a negligible price effect of almost zero

Table 9 Decomposition of the change of the explained gap between 2002 and 2007

	Change in the explained gap	Quantity effect	Price effect	Interaction effect
Private sector				
Male-based	−0.041	0.027	−0.043	−0.024
Female-based	0.004	0.032	−0.001	−0.027
Private sector, full-time workers only				
Male-based	0.025	0.057	0.031	−0.062
Female-based	0.018	0.049	0.030	−0.061
Reduced sample				
Male-based	−0.048	0.034	−0.090	0.009
Female-based	0.017	−0.003	−0.017	0.037

Results from Juhn–Murphy–Pierce decompositions. Dependent variable is the logarithm of hourly gross wages. Number of observations in the private sector: 5,369 men and 3,249 women in 2002 and 9,806 and 6,415 in 2007; private sector, full-time employees only: 4,991 men and 1,768 women in 2002 and 8,907 men and 3,444 in 2007; reduced sample uses only observations from the third quarters (but both public and private sector workers, and both part-time and full-time workers): 7,280 men and 5,677 women in 2002 and 7,466 men and 6,201 women in 2007

(−0.001 log points), and an interaction effect of −0.027 log points. The positive quantity effects imply a divergence of the observed characteristics of men and women; the negative price effects translate into a convergence of the returns between men and women. Due to the different magnitudes of the changes, the explained wage gap is negative according to the male-based decomposition and positive, but rather small, according to the female based decomposition.

Table 10 reports the Juhn–Murphy–Pierce decomposition of the change of the unexplained gap between 2002 and 2007. Again, our main results are robust to changes of the sample. We decompose the change of the unexplained gap of −0.015 and −0.060 log points into quantity effects of −0.035 and −0.059 log points, price effects of 0.031 and 0.002 log points, and interaction effects of −0.012 and −0.002 log points. The reduction in the unexplained wage gap is due to a convergence of the unobserved characteristics between men and women, which is partly offset by a divergence of the unobserved prices of the unobserved characteristics. Women became more equal to men in unobserved characteristics, e.g., commitment to work or statistical discrimination, but their returns to unobserved characteristics become relatively worse over time.

If we further restrict our sample to only full-time workers, we find that the uncorrected gender wage gap declined from 35.6 % (0.305 log points) in 2002 to 29.2 % (0.256 log points) in 2007 and the corrected gender wage gap declined from 20.2 to 11.5 % (0.184–0.109 log points). Compared to the other samples, these changes are relatively large, but they imply the same conclusions as our main estimates. The difference in mean wages in 2002, according to the male-based decomposition, indicates that about 40 % of the gap can be attributed to observed characteristics and that the majority of the gap remains unexplained. For 2007, the decomposition indicates that a larger portion of the gap can be attributed to

Table 10 Decomposition of the change of the unexplained gap between 2002 and 2007

	Change in the unexplained gap	Quantity effect	Price effect	Interaction effect
Private sector				
Male-based	–0.015	–0.035	0.031	–0.012
Female-based	–0.060	–0.059	0.002	–0.002
Private sector, full-time workers only				
Male-based	–0.075	–0.081	0.021	–0.014
Female-based	–0.068	–0.065	–0.005	0.002
Reduced sample				
Male-based	–0.016	–0.011	0.033	–0.006
Female-based	–0.049	–0.055	0.011	–0.005

Results from Juhn–Murphy–Pierce decompositions. Dependent variable is the logarithm of hourly gross wages. Number of observations in the private sector: 5,369 men and 3,249 women in 2002 and 9,806 and 6,415 in 2007; private sector, full-time employees only: 4,991 men and 1,768 women in 2002 and 8,907 men and 3,444 in 2007; reduced sample uses only observations from the third quarters (but both public and private sector workers, and both part-time and full-time workers): 7,280 men and 5,677 women in 2002 and 7,466 men and 6,201 women in 2007

observed characteristics, resulting in a smaller unexplained part of the gender wage gap. We further find that the change of the explained part of the gender wage gap of 0.025 log points in the male-based and of 0.018 log points in the female-based decomposition were due to a large shift in the characteristics, which was offset by the simultaneous change in both characteristics and prices. Finally, we find that the change of the unexplained part of the gender wage gap of –0.075 log points in the male-based and of –0.068 log points in the female-based decomposition were due to changes in the unobserved characteristics.

Limiting our sample for 2007 to observations from the third quarter, we obtain nearly identical results to those from the full sample. Overall, we estimate the decline of the gender wage gap over time is due to an increase of the explained part of the gap or, in other words, a decline of the unexplained part of gap.

4.2 Trends over a longer time period

Our empirical analyses compare a rather short time period of five years. To obtain a more detailed picture over a longer time period, we contrast our results with other results for Austria. Table 11 tabulates uncorrected and corrected wages differentials from several studies, including results from our current analyzes, covering 25 years (1983–2007). Overall, these results do not provide a clear pattern, but the studies differ greatly in their used methods, choice of samples, and in their definition of key variables. For example, Zweimüller and Winter-Ebmer (1994), the first of these studies, used net wages from census data and restricted their sample to white-collar workers. These differences might obscure a clear trend over time.

Because the samples and definitions vary, we re-estimated gender wage differentials with our data using sample restrictions and definitions used in those earlier studies. The results are tabulated in Table 12. The uncorrected gender wage

Table 11 Gender wage gap decompositions for Austria

Year	Uncorrected Differential	Corrected Differential
1983	0.368[a]	0.294
	0.255[b]	0.142
1996	0.196[c]	0.184
1997	0.233[a]	0.106
2002	0.188[c]	0.183
	0.300[f]	0.170
2006	0.203[d]	0.104
	0.255[e]	0.181
2007	0.244[f]	0.152

[a] Zweimüller and Winter-Ebmer (1994): Microcensus 1983, survey data, private sector, net wages, full-time and part-time workers, white collar workers only, male based decomposition

[b] Böheim et al. (2007): Microcensus 1983 and 1997, survey data, private sector, net wages, full-time workers, male based decomposition

[c] Pointner and Stiglbauer (2010): Structure of Earnings Surveys 1996 and 2002, register data, private sector, gross wages, full-time and part-time workers, firms with more than 10 employees, corrected wage differential measured by a dummy variable for females

[d] Grünberger and Zulehner (2009): EU-SILC 2004-6, survey data, private sector, gross wages, full-time workers, corrected wage differential measured by a dummy variable for females

[e] Frauenbericht 2010: Structure of Earnings Surveys 2006, register data, private sector, gross wages, firms with more than 10 employees, Reimers (1983) decomposition

[f] This study: Microcensus, tax records and ASSD 2007, register data, private sector, gross wages, full-time and part-time workers, male based decomposition

gap is estimated to be between 26.6 and 18.9 % (0.236 and 0.173 log points) for 2002, and between 22.1 and 13.5 % (0.200 and 0.127 log points) for 2007. The corrected wage gap is between 18.4 and 20.9 % (0.169 and 0.190 log points) for 2002 and between 14.1 and 11.1 % (0.132 and 0.105 log points) for 2007. The results in Table 12 indicate that the gender wage gap is smaller when we analyze only full-time workers or net wages.

If we compare the results presented in Tables 11 and 12, we observe a moderate decline in the gender wage gap over these years. For example, the estimate of the gender wage gap for 1983 of 44.5 percent (0.368 log points) Zweimüller and Winter-Ebmer (1994) was based on net wages; using their sample restriction, we estimate a gender wage gap of 18.9 % (0.173 log points) for 2002 and 13.5 % (0.127 log points) for 2007. Or, as estimated by (Grünberger and Zulehner 2009) the gender wage gap in 2006 was 18.4 % (0.203 log points); using their sample restriction of gross wages of full-time workers, we estimate a gender wage gap of 19.9 % (0.217 log points) for 2002 and 16.6 % (0.181 log points) for 2007. The sample restrictions also indicate that the corrected gender wage gap declined over time.

Similar to results in Weichselbaumer and Winter-Ebmer (2005), the decline of the uncorrected wage differentials is greater than of the corrected wage differentials.

Table 12 Gender wage gap decompositions: Alternative definitions

Year	Uncorrected differential	Corrected differential
Net wages, full + part-time		
2002	0.173	0.130
2007	0.127	0.105
Gross wages, full + part-time		
2002	0.236	0.152
2007	0.200	0.132
Gross wages, full-time		
2002	0.217	0.169
2007	0.181	0.110

Results from Blinder-Oacaxa decompositions. Dependent variable is the logarithm of hourly wages. Number of observations for gross wages and full-time and part-time workers: 7,280 men and 5,677 women in 2002 and 12,102 and 10,167 in 2007; for gross wages and full-time workers only: 7,134 men and 3,565 women in 2002 and 11,702 men and 6,070 in 2007; for net wages and full-time and part-time workers: 7,280 men and 5,677 women in 2002 and 12,102 and 10,167 in 2007

This implies that women became more equal to men in their observable characteristics, for example, human capital, over the last 25 years, and also in their unobserved characteristics.

5 Summary and conclusions

We investigated the extent, persistence, and socio-economic determinants of the gender wage gap in Austria for the years 2002 and 2007. We use the approach suggested by Juhn et al. (1991) to decompose the gender wage gap over time. Analyzing new matched employer-employee data for Austria, our descriptive analyzes confirm earlier results, i.e., women earn on average less than men, they have on average more formal education than men, but have on average less workplace experience, probably due to child bearing. Taking observed differences between women and men into account, we find that, depending on sample restrictions, between 35 and 45 % of the wage gap is due to differences in observable characteristics, i.e., (fair) discrimination. We cannot explain the remaining part of the wage gap between women and men by such differences. While part of the difference might be caused by unobserved characteristics, e.g., attitude or commitment, it is likely that some part of the remaining difference is caused by unfair discrimination against women.

We further find that women became more attached to the labor market between 2002 and 2007 and that their formal education increased over time. In terms of returns to characteristics, we find that premiums for higher formal education have converged between men and women. In consequence, the gender wage gap shrank by three percentage points from 21.1 % in 2002 to 18 % in 2007. The main determinant of this decline is the relative improvement of women's unobserved characteristics. We also observe that women's improved educational attainments

were partly offset by a shift in the demand for skilled workers that disadvantaged unskilled workers.

Our results suggest that there were two main reasons for a narrower gender wage gap. Women had obtained more formal education and improved their unobserved characteristics. Policies which aim to close the gender wage gap should therefore focus on strategies which lead to more formal education and better unobserved characteristics. Policies that aim to increase women's educational attainments are frequently implemented, e.g., efforts to increase the number of female students in the technical sciences.

A large part of the gender wage gap cannot be explained by productive characteristics such as education or experience, which is interpreted by many researchers as evidence for discrimination against women, e.g., Arulampalam et al. (2007). This interpretation is however contested, usually because of methodological arguments. Because it is difficult to pin down the characteristics of workers, their wages, and the association between unobserved characteristics and wages, many researchers are skeptical if the gender wage gap exists at all. Critics include e.g., Kunze (2008), who stresses that the fundamental research question is if, after accounting for differences in work histories and other qualifications, a gender wage differential does exist at all.[9]

The change in unobserved characteristics could have been caused by, for example, women's stronger attachment to the labor market, less statistical discrimination by employers, or by differences in tastes, e.g., stemming from differences in risk aversion.[10] Since we do not know the true reason for the differences in unobserved characteristics, we are cautious to provide policy conclusions. However, it has been shown that if workers know the distribution of wages, they are more likely to bargain more efficiently (Riley-Bowles et al. 2005). In related work (Böheim et al. 2012), we find that the wage gap is narrower at the bottom of the distribution, where collective bargaining is the norm, than at the top of the wage distribution, where individual bargaining is the norm. Policies that provide information on paid wages should thus provide women with better chances in obtaining fair wages. In addition, policies which help workers to more labor market attachment should also improve women's position in the distribution of unobserved characteristics.

Comparing our results with the results of earlier studies on the Austrian gender wage gap, we observe a moderate convergence of men's and women's wages. Although the speed of convergence is low, we conclude *eppur si muove*.

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[9] She identifies the existence of the glass ceiling as another question that warrants empirical research.

[10] For a recent survey on gender differences related to psychological and socio-psychological factors, see (Bertrand 2010).

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