

The gender gap and the sectoral divide, the case of Germany, 1997 – 2003 *

Joan Muysken
Maastricht University
Department of Economics
P.O. Box 616
6200 MD Maastricht
The Netherlands
tel: +31-43-3883818
fax: +31-43-3884864
email: j.muysken@algec.unimaas.nl

Sybrand Schim van der Loeff
Maastricht University
Department of Quantitative Economics
P.O. Box 616
6200 MD Maastricht
The Netherlands
tel: +31-43-3883843
fax: +31-43-3884874
email: s.loeff@ke.unimaas.nl

Abstract

Most findings on the existence of a gender gap in wages are biased because they are based on single-equation estimation of a wage equation, ignoring the simultaneous nature of gender-related job allocation and wage determination. Through the introduction of a latent variable, “femininity”, we tackle the problem of simultaneity while accounting for unobserved heterogeneity. Imposing testable restrictions on the reduced form enables us to identify the factors that determine wages and femininity. Our estimation results using German data from 1997 to 2003, reveal that the determinants of the gender gap differ strongly between services and manufacturing.

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1. Introduction

The gender gap in wages is a subject of extensive research – see Arulampan, Booth and Bryan (2005) for a recent overview. Two widely observed features are the existence of a glass ceiling and a sticky wage floor. The ‘glass ceiling’ means that female wages are stagnating in the higher segment (“less mobile upwards”) where it is inferred from the fact that higher management positions are less often held by women that such occupations are harder to achieve for women. Arulampan et al. (2005) find this in their comparison of the gender gap in 11 European countries, Gang et al. (2002) and Eberharter (2003) observe this for Germany, while Garcia et al. (2001) and Dolado and Llorens (2004) find this for Spain. Dolado and Llorens also observe the phenomenon of a ‘glass floor’ in Spain, which suggests that women are overrepresented in the secondary labour market and hence are much more vulnerable in bad times. A similar observation is made by Eberharter (2003) for Germany – see also O’Reilly and Fagan (1998) for an international comparison. This phenomenon is related to the ‘sticky wage floor’ found by Arulampan et al. (2005). The latter implies a lower upward mobility of wages in the low segment of the labour market. Finally, Blau and Kahn (1992) who present an early international comparison of these gender differences, add an interesting element to the discussion by observing that gender differences are larger in the US compared to Europe, which they attribute to differences in wage setting behaviour. This finding is confirmed by Arulampan et al. (2005) when comparing 11 countries within Europe. In a similar vein one should understand the finding by Arulampan et al. (2005) that the gender gap is lower in the public sector when compared to the private sector in European countries.

Although these stylised facts are widely observed, there is less consensus about the underlying causes. As we elaborate below, we conclude from the literature that part of the gender gap can be explained by a different distribution of women compared to men over wage relevant job characteristics like occupations and sectors. In that context a much larger prevalence of female workers in white collar jobs in service oriented sectors.

A second element is that increasing attention is being paid in the literature to the difference in psychological characteristics between women and men. An important finding of this literature is the more 'competitive nature' of typical male behaviour in contrast to the more 'caring nature' of average female behaviour. In our view this has two implications: First of all, several studies associate the more caring nature of female behaviour with the high incidence of female workers in the service sectors. Second, the 'competitive attitude' of male behaviour as opposed to the 'non-competitive' nature of female behaviour, can explain the presence of a gender gap for wages in otherwise identical situations.

The third conclusion from the literature usually is that the part of the gender gap that cannot be explained otherwise, should be attributed to discrimination. This may be outright male behaviour, but statistical discrimination can also play a role. The latter means that employers are inclined to invest less in women in certain types of occupations because of a perceived risk of drop out from the labour force, at least temporarily.

Last but not least some studies claim that women, because of differences in life-time patterns and different responsibilities in the household, will choose occupations which facilitate this different behaviour. The observed gender gap then is the price they have to pay for this facility.

Interestingly, we found no studies which emphasise the possible interaction between the above four conclusions. In our view, there is intuitively a strong connection between female responsibilities, female psychological characteristics and wage relevant job characteristics. For instance, the less competitive attitude might explain the presence of a glass ceiling. It might also explain the nature of a glass floor, since these characteristics might also make women more vulnerable to exploitation. In both cases statistical discrimination might also play a role, or the preference of women for more flexible jobs. Also women might earn a lower wage within a typical job when compared to men due to a weaker bargaining position which can be explained by either a lower level of assertivity in bargaining and/or discrimination in the bargaining process. Finally, the more caring nature of women, combined with a preference for more flexible jobs, might explain their relatively high representation in the service sector.

These observations lead us to emphasise the importance of the simultaneous nature of the determination of wages and feminine job characteristics, which are to a large extent related to gender. We present a general model based on Heckman (1978) which models this simultaneity explicitly, using femininity as a latent variable. The model also accounts for unobserved heterogeneity. Our estimation results show that simultaneity cannot be rejected for the services sector, in which 75 percent of the women are employed, and for manufacturing. Moreover, the model allows us to identify the gender gap for specific groups.

Turning back to the literature, several explanations of the gender gap can be found. First of all there is a strong tendency to label those parts of the gender gap that cannot be explained as ‘discrimination’ – see for instance Eberharter (2003) and Dolado and Llorens (2004), as well as Blau and Kahn (1992). Polacheck and Kim (1994), who attribute about half of the gender gap to unobserved heterogeneity, are a notable exception in this respect. Manning and Swaffield (2005), who also find a considerable unexplained part, point at the possibility of statistical discrimination, amongst others. Some studies also use information on the perception of being discriminated – see Kuhn (1990) and Hallock et al. (1998); Garcia et al. (2001) use a surrogate measure in their analysis. These studies find a positive correlation between perceived discrimination and an unexplained larger wage gap for women.

A more recent strand of the literature emphasises underlying differences in attitude between men and women which might explain the gender gap. A rather direct theory is presented by Kanazawa (2005) starting from the notion that reproductive success is the ultimate goal of human behaviour. While this success shows up in earnings for men, this does not hold for women: they “have better things to do than to earn money, reproductively speaking”. Kanazawa (2005) sees this hypothesis corroborated by the observation that there is no gender gap for single women under 40 in the US. However, Manning and Swaffield (2005) find for the UK, using a more sophisticated analysis, that “women who have continuous full-time employment, have no children and express no desire to have them, earn about 12 log points less than equivalent men after 10 years in the labour market”. They introduce some psychological characteristics, using self-esteem and locus-of-control

measurements, to try to explain this phenomenon. However, they only find a very small impact of these variables.

Nyhus and Pons (2005) use a much wider range of psychological characteristics next to economic variables for a small Dutch sample of 800 persons. Their analysis shows that psychological variables do matter when explaining earnings differences. Moreover, although they do not focus on the gender gap, they argue that “male and females dominate different occupations that each favour specific personality traits. .. women tend to dominate occupations that involve care for other people [..where..] agreeableness may be an important attribute”.(p. 381-2). This conclusion, which is in line with Bowles et al. (2001), might explain why there is a high incidence of women in the service sector.

Another result from this strand of literature is aptly summarised in the title of Babcock and Laschever (2003): “Women Don’t Ask: Negotiation and the Gender Divide”. Their main contention is that women don’t want to ask for higher wages for various reasons, such as a lack of assertiveness, more inclination to self-doubt and a tendency to be agreeable. A similar result is found in Gneezy, Niederle and Rustichini (2003) who find from experiments that “women may be less effective in competitive environments, even if they are able to perform similarly in non-competitive environments” (p. 1049). Somewhat related results are found by Niederle and Vesterlund (2005) in an experimental setting. They find that a majority of men consistently prefer competitive tournaments, while most women choose a non-competitive piece rate. As a consequence this strand of research suggests that the performance of women in wage negotiations and related situations may lead to a gender gap too. See, however, Pradel et al. (2005) for a much more nuanced interpretation of these findings.

An alternative interpretation, which is less prevalent in the literature, is provided by O’Neill (2003). In line with Becker (1985) she argues: “The expectation of withdrawals from the labor force and the need to work fewer hours during the week are likely to influence the type of occupations that women train for and ultimately pursue. More subtle factors such as the level of stress at work and the ability to take unplanned time off for family emergencies are also likely to influence the choice of occupation and work place. Thus, certain characteristics of jobs may affect women’s occupational choices because they

are particularly compatible or incompatible with women's dual home/market roles. These adaptive occupational choices will tend to lower the market earnings of women relative to men.”(p. 310) Of course these factors can also play a role in statistical discrimination, although that is not mentioned by O'Neill. Both interpretations are consistent with O'Neill's observation of a lower return to various characteristics for women – a result which is also observed by Polacheck and Kim (1994). The latter explain their finding as follows: “... because of differences in lifetime work patterns men's and women's work motivations differ in ways that are difficult to measure directly ...” (p. 24) and also refer to Becker (1985). Finally, O'Neill indicates that her analysis might also provide an explanation why women are much stronger represented in the service sector.

A sectoral and occupational differentiation by genders is widely observed in the literature. For instance O'Neill (2003) reports a strong clustering of women and men in different occupations for the US. Bayard et al. (2003) also find for the US that “a sizable fraction of the sex gap in wages is accounted for by the segregation of women in lower-paying industries, occupations, establishments ...” (p. 918). Gupta and Rothstein (2005) report for Denmark a strong divide between male-dominated manual workers and female-dominated salaried workers. All these divides roughly correspond to a distinction between services and manufacturing. Shin (2000) and Kandil and Woods (2002) also emphasise this distinction when they analyse the cyclical behaviour of the gender gap. They observe a high incidence of women to occupy white collar jobs and work in the service sector.

From the literature reviewed above two causes for a high incidence of women in the service sector can be distinguished. One type of argument is that feminine characteristics like 'care' and 'agreeableness' are much more important in the service sector and hence explain the relatively high employment of women in that sector. The other line of reasoning is that jobs in the service sector generally are “more compatible with women's home responsibilities”. O'Neill (2003: 310)¹ Although we cannot discriminate between both causes, we will emphasise and use the distinction between services and manufacturing in our further analysis.

¹ In this quote O'Neill does not explicitly refer to the services sector, although her description of many characteristics strongly points in that direction.

The structure of our paper is as follows. We describe the GSOEP data set for Germany, 1997 – 2003, which we use in our analysis in section 2. There we also show the differences between the service sector and manufacturing in the average gender gap and underlying variables. In section 3 we apply Heckman (1978) to model the simultaneous determination of wages and feminine nature of jobs. The introduction of a latent variable for “femininity” also allows us to control for unobserved heterogeneity. Using a reduced form of this model, we show that for our data the hypothesis of simultaneity cannot be rejected for the services sector, in which the majority of women are employed, nor for the manufacturing sector. However, the nature of simultaneity is different in both sectors, which emphasises the sectoral divide. We also demonstrate that due to the simultaneous nature of the allocation, the gender gap in wages longer can be represented by a single parameter, but is dependent on person and job characteristics.

The parameters of a structural model for the services sector are estimated in section 4, where we also test the identifying restrictions. We show that indeed there is a strong interaction between “femininity” and wage determination. Moreover, the distinction between “femininity” and wage determination allows us to discriminate between various factors that influence the gender gap. We present some concluding remarks in Section 5.

2. The SOEP-data for Germany, 1997 – 2003

2.1 The data used

The SOEP-data set covers German households and individuals from 1984 onwards. It is an unbalanced panel with data on more than 20,000 individuals in the more recent years. Traditionally questions have been asked, amongst others, about income, personal characteristics that constitute human capital and work related variables. Hence the data set has been used intensively to estimate earnings functions in various forms; see for instance Büchel and Mertens (2000) for an overview.

Table 1 *Number of workers in services and manufacturing, 1997 – 2003*

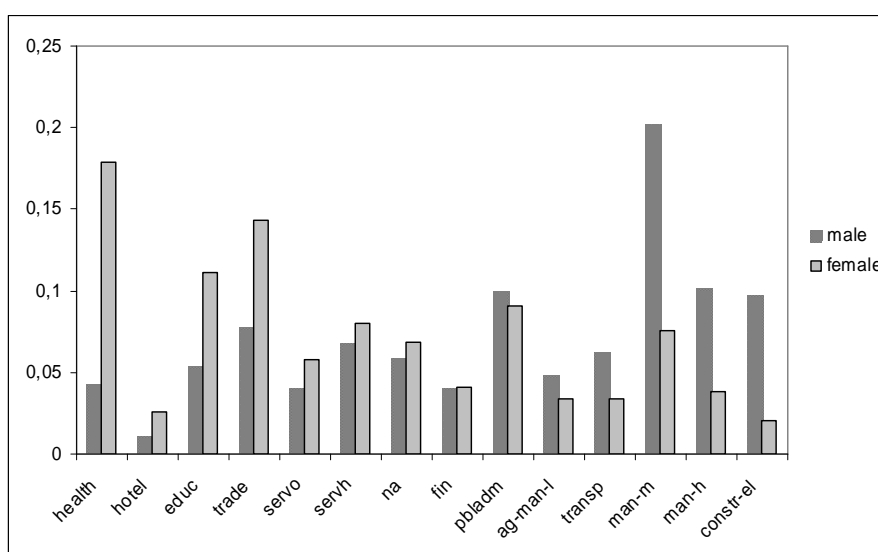
	Services		Manufacturing	
	Total	Proportion females	Total	Proportion females
1997	3115	0.61	2233	0.28
1998	3420	0.60	2390	0.27
1999	3267	0.60	2242	0.28
2000	5782	0.60	3507	0,27
2001	5133	0.61	3085	0.27
2002	6069	0.59	3203	0.29
2003	5327	0.49	2778	0.28

We use the 1997 – 2003 waves of these data pertaining to persons with a job, including part-time workers, in our analysis.² From Table 1 one sees that our sample increases from 5348 to 8105 workers, of which the majority works in services. Although the number of women lies only somewhat below that of men, the majority of women works in services.

² More information can be found on <http://www.diw.de/deutsch/sop/>.

From the table one sees that the majority of workers in the services sector is female.³ The stability of the share of female workers over time in both sectors does not give rise to suspect that the gender gap is due to a competition bias – Park and Shin (2005) use this notion to explain their finding that for the US that the gender gap is procyclical.

Figure 1 *Distribution of male and female workers by sector, 2003*



Preliminary investigations with the data revealed that next to gender differences, sectoral differences are also important for purpose – which is also in line with the findings in the literature as we discussed in the introduction. Figure 1 shows the distribution of male and female workers over 14 sectors in 2003. The ranking in the figure of these sectors is according to the ratio between female and male employment. That is, the health sector has the highest proportion of female employment, whereas the construction sector has the lowest proportion.⁴ The ranking also suggests a typical division between more service oriented sectors, which are relatively dominated by women, and more manufacturing oriented sectors which are dominated by men. Table 2 elaborates the differences between these more service oriented sectors, ranging from health to public administration, and the remaining manufacturing oriented sectors, excluding construction and electricity. The latter

³ The sharp decrease in the proportion of female workers in 2003 in the services sector is remarkable.

⁴ Precise sectoral definitions are given in the Annex.

Table 2 *Differences by gender and sector, 2003*

		services		manufacturing	
		female	male	female	male
nr. of workers		3488	2386	885	2487
hourly wage		26.73	37.89	26.60	35.87
share part-time		0.43	0.08	0.17	0.01
occupation					
nr. of workers	bc ⁵	571	294	524	1478
	wc	2529	562	1322	958
	cs	334	23	495	32
average level	bc	1.93	2.62	2.12	2,83
	wc	3.76	3.91	4.36	4,41
	cs	3.04	3.08	2.52	2,18
region					
share east		0.24	0.22	0.20	0.21
training and experience					
years of education		12.5	13.2	11.9	11.9
age		42.1	43.1	41.5	42.3
tenure		9.8	12.2	10.0	12.2
share overeducation		0.15	0.12	0.19	0.15
firm size		4.2	5.1	5.3	5.6
personal status					
share married		0.38	0.38	0.35	0.46
share children		0.42	0.51	0.53	0.56
perceptions					
job happiness (0-10)		7	7.1	6.9	7
<i>probability (%) of:</i>					
demotion		8.6	9.7	10.6	11.8
promotion		14.6	21.7	14.2	20.4
further training		35.2	41.9	29.8	32.4
pay rise		12.3	19.2	16	20.1

⁵ bc; blue collar, wc; white collar, cs; civil servant

sector is too male dominated to be sensibly included in a sectoral study of the wage gender gap.

From the table one sees that services indeed are dominated by female workers, whereas in manufacturing the opposite is the case: while almost half of the male workers are employed in services, about three quarters of the females is employed in that sector. Both sectors have a higher average hourly wage for men than for women of about 30%.

From the middle part of the table one sees that these differences on average cannot be attributed to living in the Eastern part of Germany, age, education or family status. Actually, the lower share of women with children below the age of 16 in the service sector might favour a somewhat higher wage. Part of the wage gap may be explained that women work in smaller firms on average, in particular in services, and have less tenure in both sectors. In addition, the fact that there is – on average – a larger educational mismatch for women than for men, the observation that women are more overeducated on average might play a role.⁶ This finding is also consistent with the phenomenon of a glass ceiling which has been found for Germany by Gang et al. (2002) and Eberharter (2003).

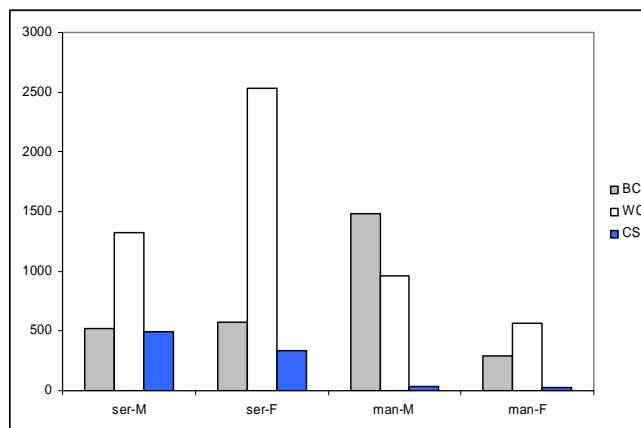
The most striking differences can be observed, however, with respect to the share of part-time work and occupational status. The higher incidence of part-time work amongst women is well known: From our data one sees that in 2003 about 40 percent of the women work less than 30 hours per week, compared to 5 percent of men. However, in manufacturing only 17 percent of the women works part-time, compared to 43 percent in services.

Similarly we distinguish in occupational status between blue collar workers (bc), white collar workers (wc) and civil servants (cs), and within each category between 4 to 6 levels. The sectoral distribution by gender of occupations is summarised in Figure 2 (expressed in number of workers). Several observations can be made from this figure.

First, about 80 percent of female employment is in the service sector, compared to about 50 percent of male employment. Also female employment is dominated by white

⁶ Overeducation was determined by comparing the highest education received with the answer given to the question which type of training was required for the job currently working in. In addition, the worker had to answer the question "Are you working in the occupation trained for?" with "No" to be counted as overeducated.

Figure 2 *Sectoral distribution by gender of occupations, 2003*



collar workers: their share is about 70 percent of female employment, compared to almost 50 percent of male employment. It is therefore hardly surprising that almost 60 percent of total female workers are white collar workers, working in the service sector. While for both males and females service is dominated by white collar workers, blue collar workers in manufacturing dominate male employment in that sector. Over 40 percent of male employment consists of blue collar workers, compared to 20 percent in the case of female employment. Finally, not surprisingly, hardly any civil servants are employed in manufacturing.

With respect to their occupation, women are generally in a lower position when compared to men – this finding is consistent with both the phenomenon of sticky wage floors and that of glass ceilings. Also, manufacturing has on average higher level functions than service does – except for the case of civil servants. The latter is consistent with the findings in Arulampan et al. (2005).

Finally we present some perceived job characteristics in the lower part of the table. A striking result is that job happiness hardly differs between sectors or genders. Also somewhat surprising, women perceive a lower probability of demotion in both sectors. However, the finding of a distinct lower chance to be promoted, receive further training or to receive a pay rise is hardly surprising, given the results found in the literature. They can be seen as an indication of some form of discrimination. However, a further statistical analysis is necessary to draw proper conclusions in this respect.

2.2 Some preliminary findings

Previous findings in the literature using OLS on several specifications of a wage equation indicate significant negative effects of being female on wages. As a check and base-case scenario we reproduce these results for our data. That is, we estimate the following wage equation:

$$w = \delta g + X'\beta + u \quad (1)$$

where w represents the logarithm of the actual wage, and X is the vector of person-related and job-related factors – see the Appendix for the type of controls used – except for gender. To account for the latter we add a dummy, g , which equals unity when a person is female and is zero otherwise. The factor δ then represents the gender gap, which is usually found to be negative. Finally u is a random term which captures random factors and measurement errors.

The estimation results for the gender gap, conditional on all other characteristics, are presented in Table 3 for the whole economy and for services and manufacturing separately. All equations show a remarkably good fit and the estimated values in the order of 15-20 % are in line with other cross-section estimation results.

As pointed out in the previous section, the validity of these estimates may be questioned since there is a strong heterogeneity of tasks performed by men and women within rather broadly defined occupations and job levels. This implies that we should allow for the possibility that workers and tasks have been matched for gender related reasons. Thus wages and gender specificity of tasks might be determined simultaneously. Moreover, unobserved heterogeneity might also play a role.

3. A simultaneous model of wages and femininity

As we argued above, we conclude from the literature that when discussing the gender gap, the simultaneous nature of the determination of wages and at least some wage relevant job characteristics, which are to a large extent related to gender, should be taken into account. We present a general model based on Heckman (1978) which explicitly models this simultaneity. We also estimate a reduced form of our model and show that simultaneity cannot be rejected, albeit it has a different nature for services and manufacturing.

3.1 The model

We assume that workers are matched to a job, taking into account person-related and job-related factors. Some of these factors cannot be directly observed from the data available, although they are often related to gender as we discussed above. Examples are psychological and physical characteristics, leading to more suitability to specific tasks; a higher incidence of female workers to job termination or spells of absence, leading to statistical discrimination; and being female or a feminine type, leading to outright discrimination. As a consequence gender might have an impact of the assignment to various tasks – which cannot be directly observed. Moreover, apart from matching specific elements, women might earn a lower wage within a typical job when compared to men due to a weaker bargaining position which can be explained by either a lower level of assertiveness in bargaining and/or discrimination in the bargaining process.

The observed gender in a job then provides an indication of the presence of these unobserved factors. To that aim we introduce a latent variable g^* representing “femininity”, indicating that a certain observed person-job combination has a lower wage due to the unobserved nature of the tasks and/or bargaining position. For the latent variable holds $g^* > 0$ when $g = 1$ and $g^* \leq 0$ when $g = 0$.⁷ The use of this latent variable also partly controls for unobserved heterogeneity. It does not have a one-to-one relationship with gender

⁷ The boundary of zero for the variable g^* is an arbitrary choice – taking another cut-off point will not affect the analysis and the estimation results.

because some male persons will have typical “feminine” characteristics, while some females will have typical “male” characteristics.

Let the person-related and job-related factors that can be directly observed from the available data, except gender, be represented by the vector X . Then wage equation (1) should be amended as follows:

$$w = \gamma_1 g^* + \delta_1 g + X'\beta_1 + u_1 \quad \gamma_1 < 0 \quad (2)$$

That is, we augment that specification with the latent variable “femininity”, g^* . The presence of g^* next to gender g in equation (2) allows us to differentiate between the impact of the characteristic femininity and being a female person.⁸

For simplicity we assume that gender-feasibility is also determined by variables included in the vector X . We also allow for the possibility that wages play a role in matching gender to specific tasks. Also, since the observed gender at work provides an indication of the presence of femininity, we include this as an additional variable. Then femininity is explained by:

$$g^* = \gamma_2 w + \delta_2 g + X'\beta_2 + u_2 \quad \delta_2 \geq 0 \quad (3)$$

$$\begin{aligned} \text{with } g &= 1 && \text{if } g^* > 0 \\ &= 0 && \text{if } g^* \leq 0 \end{aligned}$$

Since g should have a positive impact on g^* , if any, we should find $\delta_2 \geq 0$. The simultaneous nature of the determination of wages and feminine tasks implies that the error terms u_1 and u_2 are correlated. We expect this correlation to be negative, since a person with relatively strong feminine characteristics, hence a high value of g^* , might be expected to have a relatively lower wage.

⁸ See also the discussion on the gender gap in equation (6) below.

Our model of equations (2) and (3) essentially is the model developed by Heckman (1978) in its most general form. Because of logical consistency, the restriction $\gamma_2\delta_1 + \delta_2 = 0$ must be imposed.⁹ Imposing this restriction, but no other structural form restriction, the reduced form – or, more appropriately, the semi-reduced form – of the model composed of equations (2) and (3) can be expressed as

$$w = \delta_1 g + X' \pi_1 + v_1 \quad (4)$$

$$g^* = X' \pi_2 + v_2 \quad (5)$$

$$\text{with } \begin{array}{ll} g = 1 & \text{if } g^* > 0 \\ = 0 & \text{if } g^* \leq 0 \end{array}$$

where π_1 and π_2 denote reduced form coefficients and v_1 and v_2 are reduced form disturbances. An interesting feature of the reduced form model is that the structural parameter δ_1 can be identified directly. The other structural parameters can only be identified by imposing further restrictions on the parameters, as we elaborate in the next section.

Heckman (1978) shows that under the assumption that v_1 and v_2 are normally distributed with a variance-covariance matrix

$$\Sigma = \begin{pmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{pmatrix}$$

the parameters of the model composed of equations (4) and (5) can be estimated by means of maximum likelihood.

Since wages and gender specific tasks are decided upon simultaneously the gender gap is no longer represented by a single parameter in the model. We find for the expected gap:

⁹ This follows from the restriction $Prob(g^* > 0) + Prob(g^* \leq 0) = 1$ (Maddala, 1983, p. 118).

$$E(w|g=1) - E(w|g=0) = \delta_l + \rho \sigma Y \quad \sigma Y > 0 \quad (6)$$

where $\rho \sigma Y$ is a term resulting from the simultaneity bias.¹⁰

3.2 Estimation results for the reduced form: the sectoral divide revealed

We estimated the model for our data, using the same controls as presented in section 2. First some detailed results are presented in Table 3 for 2003 only. For the whole economy we found that the presence of simultaneity was rejected, as is indicated by the large standard deviation of ρ . We interpret that as an indication of the misspecification of our model due to the heterogeneous nature of services and manufacturing with respect to the treatment of femininity, moreover the whole economy includes the sector construction and electricity.

Table 3 *Estimation results for 2003 of the gender gaps and simultaneity^{***}*

<i>Sector</i> <i>(sample size)</i>	<i>Whole economy</i> <i>(N=8664)</i>	<i>Services</i> <i>(N=5327)</i>	<i>Manufacturing</i> <i>(N=2778)</i>
Gender gap according to equation (1)	-0.158 (0.010)	-0.144 (0.013)	-0.198 (0.016)
Gender gap according to equation (6)	-	-0.142 [0.000]	-0.212 [0.000]
ρ	-0.0173 (0.066)	-0.511 (0.057)	0.181 (0.086)

* Asymptotic standard errors in parentheses.

** p-values, for the test of the hypothesis that the premium is equal to zero, in square brackets.

¹⁰ Actually $Y = \frac{\phi(X' \pi_2)}{\Phi(X' \pi_2)[1 - \Phi(X' \pi_2)]}$ where ϕ is the standard normal density function and Φ represents its cumulative distribution.

This intuition is confirmed when we estimate the model for both sectors separately. From the results presented in Table 3, one sees that for the service sector indeed a clear indication was found that wages and femininity are interdependent, as we expected from the results found in the literature, with a negative correlation in the disturbance terms. For manufacturing this interdependence is found too, however the value of ρ then turns out to be positive and significantly different from zero.

Table 4 *Estimation results for 1997 – 2003 of simultaneity (ρ)**

	services	manufacturing
1997**	-0.557 (0.069)	0.172 (0.114)
1998	-0.465 (0.086)	0.104 (0.081)
1999	-0.068 (0.170)	0.280 (0.077)
2000**	-0.010 (0.077)	0.233 (0.063)
2001	-0.129 (0.103)	0.077 (0.084)
2002	-0.337 (0.075)	0.219 (0.077)
2003	-0.511 (0.057)	0.181 (0.086)

* Standard errors in parentheses

** There are no control variables for three job perception variables

These results are confirmed for the years 1997 – 2003, as we show in Table 4. Rho is always negative and significantly different from zero for most years in the services sector – closer inspection shows that it is significantly different from zero for all years in the non-profit sector, which employs about half of the workers in the services sector. It is always positive in manufacturing and significantly different from zero for most years – closer inspection reveals no systematic pattern over sub-sectors.

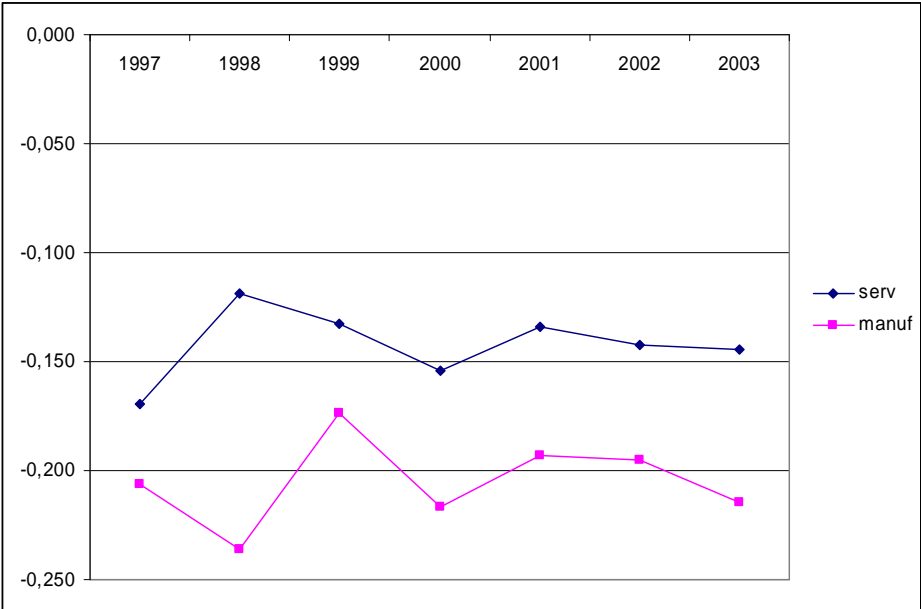
We interpret these results as follows: Women have a strong tendency to work in the service sector, which is related to their high incidence of femininity. In a similar vein, men who have a relatively high incidence of femininity will have a tendency to work in the

service sector. Moreover, those women who choose to work in manufacturing instead, on average will have positive impact of unobserved on wages compared to females working in the service sector. We elaborate that notion in section 4.1. For the moment we will focus on a further analysis of the gender gap.

3.3 A further analysis of the gender gap

Due to the nature of the simultaneity bias, the gender gap can only be calculated for a specific set of person-related and job-related characteristics X as equation (6) shows. The average gender gap for both the service and the manufacturing sectors, i.e. calculated for the average set of characteristics of that sector in 2003, is reported in Table 3, together with an indication of its significance. It should be no surprise that the calculated values of the gender gap are remarkably close to those found from the OLS results from equation (1).

Figure 3 *The gender gap for services and manufacturing, 1997 – 2003*



The average gender gaps for all years in the period 1997 – 2003 are depicted in Figure 3. On sees that the gap is quite stable over time and that the gap in manufacturing is systematically larger than that in services.

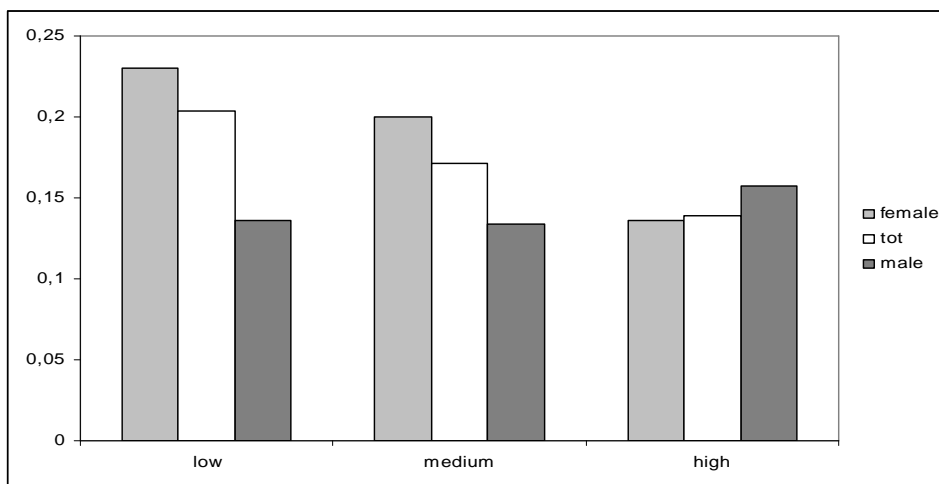
Table 5 *Gender gap for different occupational levels, 2003*

		Services	Manufacturing
Blue Collar	Low		0.218
	Medium	0.169	0.186
	High		0.165
White Collar	Low	0.204	0.22
	Medium	0.172	0.22
	High	0.139	0.202
Civil Servant	Low	0.141	
	Medium	0.134	0.211
	High	0.146	

To get an impression of the impact of personal and job characteristics on the gender premium, the gap for women in different positions can also be calculated. We show this in Table 5, where we present the gender gaps for different occupations, distinguishing between services and manufacturing. The table illustrates, as we already observed in Table 4 and Figure 3, that on average the wage gap is larger in manufacturing. One also sees a pronounced decrease in the gap with the functional level for blue collar workers in manufacturing and white collar workers in services. This observation is not consistent with the notion of a glass ceiling. On the other hand the absence of differentials within civil service occupational levels is in line with the literature.

One should realise that the gaps presented in Table 5 are calculated for average persons working in the indicated occupational levels. This ignores the possibility that women on average have different characteristics within these levels than men do. To illustrate this point, Figure 4 shows how different gender gaps, represented by the left-hand and right-hand columns in the figure, respectively, are calculated for female and male characteristics. The middle column is the average gender gap from Table 5. From Figure 4 one sees that the apparent absence of a glass-ceiling effect does indeed hold on average as we noted before. This is accentuated when one concentrates on female characteristics only. The opposite is true when concentrating on male characteristics. This, to our mind, illustrates that the gender gap is in part a consequence of the composition of the different occupational levels, which is emphasised in the literature.

Figure 4 *The gender gap for white collar workers in services, 2003*



4. The gender gap and femininity

Having estimated the model in its reduced form, we now present the estimation results for the structural model of equations (2) and (3). Next we use our estimation results to analyse the factors which determine femininity.

4.1 Estimation results

The structural model of equations (2) and (3) can be estimated by means of maximum likelihood or various two-stage methods, detailed in Maddala (1983). The structural parameter δ_l is always identified. To identify the other structural parameters, we have to impose further restrictions on the structural model. For that purpose it is useful to distinguish between X_0 , X_1 and X_2 , where X_1 represents those variables which are relevant in explaining wages, but do not contribute directly to an explanation of femininity, and X_2 represents the variables with an opposite function. The variables in X_0 are relevant for the explanation of both wages and femininity. Thus we specify:

$$w = \gamma_1 g^* + \delta_1 g + X'_0 \beta_{11} + X'_1 \beta_{12} + u_1 \quad (7)$$

$$g^* = \gamma_2 (w - \delta_1 g) + X'_0 \beta_{21} + X'_2 \beta_{22} + u_2 \quad (8)$$

When at least one exogenous variable that is excluded from equation (8) is included in equation (7), i.e. $\beta_{12} \neq 0$, the parameters of equation (8) can be identified up to a constant. This enables us to test whether $\gamma_2 \neq 0$ does hold. And when $\beta_{22} \neq 0$, the same holds for the parameters of equation (7) – β_{11} and β_{12} can even be determined exactly. Since the parameter δ_j always is identified, we then can test indirectly whether $\delta_2 \neq 0$ does hold.¹¹ As in the case of the reduced form the estimation procedure also allows us to test whether simultaneity is rejected or not, depending on whether ρ is significantly different from zero or not.

To identify the structural model we assume that femininity is not influenced by educational variables. Many studies report that there are no significant gender differences in the educational composition of the workforce in the last decade. However, it is well-documented that education has a large impact on wages.

We have also found a variable which indicates the number of hours per day spent on household-related activities. It seems reasonable to assume that this variable does not affect wages, since we already control for hours worked, marriage and the presence of children below age 16. However, this variable might be a nice indicator of femininity: it turns out that about 92 percent of the male workers work 1 hour per day or less in the household, compared to 40 percent of the female workers. We use a dummy of this variable which equals zero if the number of hours in household-related activities per day is less than or equal to one hour, and the dummy equals unity otherwise.

As we mentioned earlier, we expect ρ to be negative, since a person with relatively strong feminine characteristics, hence a high value of g^* , might be expected to have a relatively lower wage. This can be elaborated with the example of two males, Terry and Simon, who

¹¹ The logical constraint $\gamma_2 \delta_1 + \delta_2 = 0$ implies that when both $\delta_1 \neq 0$ and $\gamma_2 \neq 0$ hold, we also have $\delta_2 \neq 0$.

in terms of the control variables X are identical – compare equations (2) and (3). However, Terry has feminine characteristics, while Simon doesn't.¹² As a consequence Terry will have a positive score on g^* , that is, Terry's u_2 will be positive, while Simon will have a negative score on g^* and his u_2 will be negative. In our brief survey of the literature we found that due to discrimination, attitude or preferences, it seems plausible that Terry will have a lower wage than Simon. On the one hand this suggests a negative impact of g^* , i.e. a negative value of γ_1 , since Terry and Simon have the same gender. One might also expect that those unobserved features of Terry which contribute to his higher femininity, also contribute to a lower wage irrespective of g^* . Hence Terry's u_1 will be negative, while analogous reasoning leads to a positive u_1 for Simon. The implication is that u_1 and u_2 are negatively correlated, which explains why we expect a negative value of ρ .

Table 6 *Estimation results of the structural form for 2003, selected parameters*

<i>Sector (sample size)</i>	<i>Services (N= 5327)</i>	<i>Manufacturing (N=2778)</i>
γ_1	-0.129 (0.016)	-0.006 (0.018)
δ_1	0.177 (0.046)	-0.307 (0.049)
γ_2	0.923 (0.421)	2.983 (1.899)
δ_2	0.119	
ρ	-0.511 (0.057)	0.175 (0.088)
Test of structural restrictions *	7.23 [0.124]	13.07 [0.011]

*Chi-squared values of likelihood ratio test, p-values in square brackets.

While the results for services are consistent with our expectations, as one can see from Table 6, those for manufacturing are not. The structural restrictions, that are not rejected at any reasonable level of significance for the services sector, are rejected at the 5%-level of

¹² Figlio (2003) did show that in case of female siblings, that the sister with a typical female name did behave significantly more feminine than the sister with a boyish name. A similar reasoning may apply to men, as exemplified in the Johnny Cash song "A boy named Sue".

significance for the manufacturing sector, but not at the 1% -level. Interpreting the sign of ρ in the case of manufacturing, one has to bear in mind that the “transmission” parameters γ_1 and γ_2 are insignificantly different from zero.¹³ This means that a higher, unexplained, score on femininity cannot be compensated for by the femininity effect in wages (γ_1) and translates directly into a higher than expected wage rate in the male-dominated manufacturing sector, resulting in a positive sign for ρ . It is tempting to interpret this observation that assertiveness is relatively more advantageous for women seeking employment in manufacturing.

4.2 The determinants of femininity in services

The estimation results for the structural form of services are presented in Table 7. The estimation results for the wage equation are consistent with those found in the literature – c.f. Muysken et al. (2003). We concentrate on the estimation results for the “femininity” equation. As may be expected from the discussion above, wage rate plays no significant role in determining femininity. Being married and having small children lowers the chances that the job is filled by a woman controlling for the time spent in the household (*hourshh*). Somewhat surprisingly, hours worked has a positive effect on femininity, whereas the positive effect of age up to the age of approximately 35 years and decreasing thereafter is as expected. Low- and medium-level white collar jobs are more likely to be filled by women than blue-collar jobs (the reference category), which is in line with our a priori ideas, but the fact that high level white collar jobs are less likely to be filled by women may be interpreted as an indication of a glass ceiling. Jobs in smaller firms and in the healthcare, educational and hotel branches of the services industry are more likely to be filled by women. Interestingly, of the perceptions that employees have of their job, only the probability to receive further training has a significant role in femininity. The negative sign may signify that the question is interpreted as the existence of ‘job pressure’.

¹³ The estimates for γ_1 and γ_2 are only determined up to a normalisation constant (the product of γ_1 and γ_2 is exact).

Table 7 *ML estimation results of the structural form equations (7) and (8) for services*

Variable	Equation (7)		Equation (8)	
	Coefficient	Standard error	Coefficient	Standard error
Female (δ_1)	0.177	0.046		
Wage (log) (γ_2)			0.923	0.421
Femininity (γ_i)	-0.129	0.016		
Constant	1.686	0.154	-5.867	1.136
Married	0.014	0.013	-0.172	0.057
Child below 16	0.036	0.013	-0.546	0.069
Hours (log)	0.010	0.087	2.842	0.395
Hours (log) squared	-0.014	0.016	-0.637	0.068
Age	3.979	0.461	7.172	2.335
Age squared	-0.042	0.005	-0.109	0.026
Tenure	1.526	0.180	-1.437	1.025
Tenure squared	-0.021	0.005	0.011	0.025
East	-0.201	0.013	0.444	0.103
Hours househ.			1.560	0.100
Education				
	apprentice low	0.104	0.022	
	apprent. med.	0.139	0.022	
	apprent. high	0.201	0.029	
	voc. training	0.143	0.021	
	university	0.261	0.022	
Functional level				
(white collar)	low skilled	0.150	0.020	0.624
	med. skilled	0.322	0.019	0.618
	high skilled	0.607	0.021	-0.395
(civil servant)	low/med.	0.188	0.034	-0.069
	high skilled	0.422	0.029	-0.105
	executive	0.550	0.034	-0.620
Firm size				
	20 – 200	0.133	0.015	-0.350
	> 200	0.197	0.015	-0.562
Sector				
	health	-0.011	0.033	0.553
	trade	-0.050	0.032	0.134
	educ	0.094	0.035	0.428
	pbladm	-0.035	0.033	0.142
	servh	0.020	0.033	-0.049
	hotel	-0.079	0.042	0.372
	servoth	-0.090	0.035	0.206
	finance	0.087	0.036	0.054
Percieved				
(probability of:)	Job happiness	0.015	0.003	0.017
	Job demotion	0.052	0.029	-0.167
	Job promotion	-0.090	0.025	-0.132
	Job furth train.	0.038	0.017	-0.241
	Job payrise	0.144	0.024	-0.328

5. Concluding remarks

Our analysis focuses on the simultaneous nature of the determination of wages and feminine job characteristics, which are to a large extent related to gender. We present a general model based on Heckman (1978) which models this simultaneity explicitly, using femininity as a latent variable. The model also accounts for unobserved heterogeneity. Using SOEP-data for Germany 1997 – 2003, we show that simultaneity cannot be rejected for the services sector, in which 75 percent of the women are employed. Neither can simultaneity be rejected for manufacturing, although we find that the mechanism leading to a gender gap is totally different there, compared to services.

In services our results suggest that either women choose for jobs that facilitate their differences in life-time patterns and different responsibilities in the household, or statistical discrimination anticipates this. In manufacturing, however, women do not choose such jobs. Moreover in that sector they try to bargain much more assertive for a higher wage. Nonetheless, even in that sector they loose the bargain when compared to men: a gender gap remains.

References:

- Allen, S. G. (2001). "Technology and the Wage Structure." Journal of Labor Economics **19**(2): 440-483.
- Antecol, H. and P. Kuhn (2000). "Gender as an Impediment to Labor Market Success: Why Do Young Women Report Greater Harm?" Journal of Labor Economics **18**(4): 702-728.
- Arulampalam, W., A. L. Booth, et al. (2005). "Is there a glass ceiling over Europe? Exploring the gender pay gap across the wages distribution." ISER Working Paper 2005-25.
- Azmat, G., M. Güell, et al. (2006). "Gender Gaps in Unemployment Rates in OECD Countries." Journal of Labor Economics **24**(1): 1-37.
- Babcock, L. and S. Laschever (2003). "Women don't ask: Negotiation and the gender divide." Princeton University Press
- Bayard, K., J. Hellerstein, et al. (2003). "New Evidence on Sex Segregation and Sex Differences in Wages from Matched Employee-Employer Data." Journal of Labor Economics **21**(4): 887-922.
- Becker, G. S. (1985). "Human Capital, Effort and the Sexual Division of Labor." Journal of Labor Economics, **3**: S33-S58.
- Blau, F. D. and L. M. Kahn (1992). "The gender earnings gap: Learning from international comparisons." American Economic Review **82**(2): 533-538.
- Blau, F. D. and L. M. Kahn (1996). "International differences in male wage inequality: Institutions versus market forces." The Journal of Political Economy **104**(4): 791-837.
- Booth, A. L., M. Francesconi, et al. (1998). "Glass Ceilings or Sticky Floors?" CEPR Discussion Paper(1965).
- Buchel, F. and A. Mertens (2004). "Overeducation, Undereducation, and the Theory of Career Mobility." Applied Economics **36**(8): 803-816.
- Card, D. and J. E. DiNardo (2002). "Skill-Biased Technological Change and Rising Wage Inequality: Some Problems and Puzzles." Journal of Labor Economics **20**(4): 733-783.
- Dolado, J. J. and V. Llorens (2004). "Gender Wage Gaps by Education in Spain: Glass Floors versus Glass Ceilings." CEPR Discussion Paper(4203).
- Eberharter, V. (2001). "Gender Roles, Labour Market Participation and Household Income Position." Structural Change and Economic Dynamics **12**(3): 235-246.
- Eberharter, V. (2003). "Structural Features of Female Employment Status and Earnings Mobility: The Experience in Germany." Review of Social Economy **61**(4): 511-533.
- Figlio, D (2005) "Why Barbie Says "Math is Hard", University of Florida and NBER, 1-26.
- Filippin, A. and A. Ichino (2005). "Gender Wage Gap in Expectations and Realizations." Labour Economics **12**(1): 125-45.
- Gang, I. N., J. Landon-Lane, et al. (2003). "Gender Differences in German Upward Income Mobility." Schmollers Jahrbuch: Zeitschrift für Wirtschafts- und Sozialwissenschaften/Journal of Applied Social Science Studies **123**(1): 3-13.

- Garcia, J., P. J. Hernandez, et al. (2001). "How Wide Is the Gap? An Investigation of Gender Wage Differences Using Quantile Regression." Empirical Economics **26**(1): 149-167.
- Gneezy, U., M. Niederle, et al. (2003). "Performance in Competitive Environments: Gender Differences." The Quarterly Journal of Economics **118**(3): 1049-1074.
- Gupta, N. and D. Rothstein (2005). "The Impact of Worker and Establishment-level Characteristics on Male-Female Wage Differentials: Evidence from Danish Matched Employee-Employer Data." Review of Labour Economics & Industrial Relations **19**(1): 1-34.
- Hallock, K. F. and W. Hendricks (1998). "Discrimination by Gender and Disability Status: Do Worker Perceptions Match Statistical Measures?" Southern Economic Journal **65**(2): 245-263.
- Heckman, J.J. (1978), "Dummy Endogenous Variables in a Simultaneous Equation System", Econometrica, **46** (4), 931 – 959.
- Hunt, J. (2002). "The Transition in East Germany: When Is a Ten-Point Fall in the Gender Wage Gap Bad News?" Journal of Labor Economics **20**(1): 148-169.
- Hunt, J. (2004). "Convergence and determinants of non-employment durations in Eastern and Western Germany." Journal of Population Economics **17**: 249-266.
- Kanazawa, S. (2005). "Is "discrimination" necessary to explain the sex gap in earnings?" Journal of Economic Psychology **26**: 269-287.
- Kandil, M. and J. G. Woods (2002). "Convergence of the gender gap over the business cycle: a sectoral investigation." Journal of Economics & Business **54**: 271-292.
- Kuhn, P. J. (1990). "Sex discrimination in labor markets: The role." American Economic Review **80**(1): 290-297.
- Maddala, G.S., (1983), "Limited Dependent and Qualitative Variables in Econometrics", Cambridge University Press.
- Manning, A. and J. Swaffield (2005). "The Gender Gap in Early Career Wage Growth." CEP Discussion Paper(No 700): 1-62.
- Muysken, J., H. Kiiver and M.M. Hoppe (2003), "The impact of education and mismatch on wages: Germany, 1984-2000", in: F. Büchel, A. de Grip and A. Mertens (eds.), "Overeducation in Europe: What do we know?", Cheltenham: Edward Elgar Publishing Ltd., pp. 109-132
- Niederle, M. and L. Vesterlund (2005). "Do Women Shy Away From Competition? Do Men Compete Too Much?" NBER Working Paper Series(w11474).
- Nyhus, E. K. and E. Pons (2005). "The effects of personality on earnings." Journal of Economic Psychology **26**(3): 363-384.
- O'Neill, J. (2003). "The Gender Gap in Wages, circa 2000." American Economic Review **93**(2): 309-314.
- O'Reilly, J. and C. Fagan eds. (1998). "Part-Time Prospects: An International Comparison of Part-time Work in Europe, North America and the Pacific Rim." London and New York, Routledge.
- Park, S. and D. Shin (2005), "Explaining procyclical male-female wage gaps", Economics Letters **88**(2005): 231 - 235.

- Polachek, S. W. and S. W. Moon-Kak Kim (1994). "Panel estimates of the gender earnings gap: Individual-specific intercept and individual-specific slope models." Journal of Econometrics **61**: 23-42.
- Pradel, D. W., H. R. Bowles, et al. (2005). "When Does Gender Matter in Negotiation?" Harvard Business School Publication Corp.300 North Beacon Street Watertown Massachusetts 02472 United States of America: 3-5.
- Shin, D. (2000). "Gender and Industry Differences in Employment Cyclicalilty: Evidence over the Postwar Period." Economic Inquiry **38**(4): 641-650.
- Stanley, T. D. and S. B. Jarrell (1998). "Gender Wage Discrimination Bias? A Meta-regression Analysis." Journal of Human Resources **33**(4): 947-973.
- Waldfogel, J. (1995). "The price of motherhood: Family status and women's pay in a young British cohort." Oxford Economic Papers **47**(4): 584-610.

APPENDIX: The data used

<i>Wage</i>	
lwage:	Natural logarithm of gross monthly earnings.
<i>Age</i>	
age:	Years of age.
<i>Gender</i>	
female:	Dummy equal to one if person is female.
<i>Marital status, Children and Household Hours</i>	
married:	Dummy equal to one if person is married.
chb16:	Dummy equal to one if children below age 16
dumhh:	Dummy equal to one if work in household more than 1 hour per day
<i>Working time</i>	
lnhours:	Natural logarithm of hours worked per month.
<i>Region</i>	
east:	Dummy equal to one if place of work is in the former East-Germany (1997 and 1998).
<i>Experience</i>	
currexp:	Years (and months) a person has worked in her current job.
<i>Education</i>	
noed:	Dummy equal to one if person has not finished school or who have finished school but have no further education.
dualh:	Dummy equal to one if person has finished school (low) and apprenticeship.
dualr:	Dummy equal to one if person has finished school (medium) and apprenticeship
duala:	Dummy equal to one if person has finished school (high) and apprenticeship
vocs:	Dummy equal to one if person has finished school and vocational training other than apprenticeship.
univ:	Educational level dummy equal to one if person has finished school and university.
<i>Function</i>	
bc:	Dummy equal to one if person has blue collar job.
wc1-3:	Dummy equal to one if person is industrial foreman, or does unskilled and semi-skilled white collar labour with high level job
wc4:	Dummy equal to one if person is a semi-skilled professional with executive job
wc5-6:	Dummy equal to one if person has a professional or managerial job.
cs1-2:	Dummy equal to one if person is a civil servant with low/medium level job
cs3	Dummy equal to one if person is a civil servant with high level job
cs4	Dummy equal to one if person is a civil servant with executive job
<i>Branches of industry*</i>	
agr:	Dummy equal to one if NACE equals 1-10.
man low:	Dummy equal to one if NACE equals 15-19.
man med:	Dummy equal to one if NACE equals 20-29.
man high:	Dummy equal to one if NACE equals 30-36.
constr:	Dummy equal to one if NACE equals 40-45
trade:	Dummy equal to one if NACE equals 50-52.
hotel:	Dummy equal to one if NACE equals 55.
transp:	Dummy equal to one if NACE equals 60-64.
fin:	Dummy equal to one if NACE equals 65-67.
servhigh:	Dummy equal to one if NACE equals 70-74.
pbladm:	Dummy equal to one if NACE equals 75
educ:	Dummy equal to one if NACE equals 80
health:	Dummy equal to one if NACE equals 85
servoth:	Dummy equal to one if NACE equals 90-95
<i>Firm size</i>	
Small:	Dummy equal to one if firm has less than 20 employees.
Medium:	Dummy equal to one if firm has between 20 and 200 employees.
Large:	Dummy equal to one if firm has more than 200 employees

Job perceptions

jobhappy:	Indication of happiness on job om scale 1-10
jobdemot:	Probability of being demoted (%)
jobpromo:	Probability of being promoted (%)
jobfurtr:	Probability of receiving further training (%)
jobgpayr:	Probability of receiving a pay-rise (%)
