

Gender differences in job assignment and promotion on a complexity ladder of jobs*

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Abstract

This paper studies gender differences in the allocation of workers across tasks of different complexity using panel data from a representative sample of Finnish metalworkers during 1990-2000. Finnish metal industry data provide a continuous measure of the complexity of the workers' tasks that can be used to construct a complexity ladder of jobs. We study whether women have to meet higher productivity requirements than men in order to be assigned to more complex tasks. Gender differences in the initial tasks assignments, promotion rates and duration to promotion are examined. Furthermore, we use individual productivity measures that are based on the supervisors' performance evaluations and examine gender differences in the productivity of promoted and non-promoted workers. It is found that women start their careers in less complex tasks than men and that they are also less likely to get promoted than men who start in similar tasks. We also find that women are on average more productive than men in the groups of both promoted and non-promoted workers. We interpret these results as evidence on higher female assignment thresholds.

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1 Introduction

The gender wage gap is a persistent phenomenon. Despite the fact that in many countries the female participation rates have been high for decades and the experience on anti-discriminatory legislation is long, women tend to earn lower wages than men. An important part of this wage gap is explained by occupational segregation. It is common to find, that when sufficiently narrow occupational categories are controlled for, the gender wage gap is considerably reduced.¹ Hence, one of the key elements in understanding the gender wage gap is the asymmetric allocation of men and women across occupations.

This paper uses panel data on Finnish metalworkers to study gender differences in the allocation of workers across jobs of different complexity. In the Finnish metal industry, as in many other industries, women typically work on less complex jobs than men. Our aim is to find out, whether this happens because women need to meet higher productivity requirements than men to be assigned to more complex jobs. We address this question by examining gender differences in the initial job assignments and in the probability of promotions from the initial jobs. Furthermore, we use a measure of individual productivity that is based on supervisors' performance evaluations to study how promoted and non-promoted women perform with respect to their male counterparts. We then use this information to infer whether the male and female productivity thresholds of assignment are different.

Very common explanation for gender differences in the assignment thresholds is taste-based discrimination. But there are also theoretical arguments that do not rely on discriminatory behavior on the part of the employers. Most notably, in the model by Lazear and Rosen (1990), the comparative advantage of women in non-market activities makes them more likely to quit than men. Consequently, women have to be more productive than men to be assigned to complex jobs.

Previous empirical literature on gender differences in job allocation has almost exclusively concentrated on estimating gender differences in the probability of promotion.² There are studies that use data from large surveys such as Winter-Ebmer and Zweimüller (1997) using Austrian census data, McCue (1996) using the PSID, and Booth et al (2001) using the BHPS. Other studies have used data from a single industry or firm: Granqvist and Persson (2002) analyze gender differences in the career mobility of workers in the Swedish retail trade industry, Hersch and Viscusi (1996) focus on one US public utility, and Jones and Makepeace (1996) look at workers in a British financial institution. A special branch of the literature are the studies on the career advancement of academics like Ginther and Hayes (1999, 2003) and McDowell et al (1999). The common finding is that women are less likely to get promoted than men.

But gender differences in the assignment thresholds have implications that go beyond promotion probabilities. The promotion process will also improve the relative productivity of women within jobs. Since the promoted women have passed a higher threshold than promoted men, they will be on average more productive than men who are promoted to the new job. On the other hand, the men that remain in the less complex jobs have failed to meet a lower productivity threshold and are therefore less productive than women who remain in the same job.

Here, we will directly address the question of whether women have to be more productive than men to be assigned to complex jobs. We focus on the early careers of workers who are initially assigned to jobs of similar complexity. The idea is that there shouldn't be significant productivity differences between men and women within jobs, unless the

¹See for example Blau and Ferber (1987) or Groshen (1991).

²Exceptions are Booth et al (2001) and Hersch and Viscusi (1996) who also estimate gender differences in the wage growth upon promotion. Both find that women gain less from promotions than men.

assignment thresholds are different for men and women. We then study how the gender differences in the productivity of these workers are affected by the promotion process by comparing the productivity of men and women among the promoted and non-promoted workers. If the productivity threshold of promotion is higher for women than for men, the relative productivity of women should improve in both groups as a result of the promotion process. Finally, we use the estimated male and female quit rates to assess whether the gender differences in reservation wages could plausibly explain the asymmetry in the job assignment.

We believe that the Finnish metal industry data are suitable for this kind of analysis. First of all, they provide a measure for the complexity of the jobs. This complexity measure is valid for both within- and between-firm comparisons. In this industry, all the jobs are evaluated according to their complexity, and on the basis of this evaluation a minimum wage is attached to each job. We use these minimum wages to construct a complexity ladder of jobs. Second, the panel nature of the data allows us to distinguish between the initial job assignments and subsequent promotions. We can therefore compare the careers of men and women who start in jobs of similar complexity. Finally, the data provide information on bonuses that are based on individual performance evaluations, so that we do not have to rely on final wages when measuring individual productivity.

Using these features of the data, we find that women are initially assigned to less complex jobs than men and that they are also less likely to get promoted than men who start in the same jobs. When we measure individual productivity with bonuses, we find that there are no clear gender differences in productivity at the initial job assignment. However, gender differences in productivity become clear as some of the workers are selected for promotion. Women are consistently more productive in the groups of promoted and non-promoted workers. We interpret these results as supportive of the asymmetric threshold hypothesis. In this industry, women are also more likely to quit than men. These differences in quit rates are especially significant among younger workers, who are the most likely candidates for promotion. However, as the differences in quit rates may also be a result of the different promotion prospects, we can only say that the quit behaviour of men and women in this industry is consistent with, but not necessarily supportive of, the reservation wage explanation of gender differences in assignment thresholds.

The rest of the paper is organized as follows. In the following section, we summarize the familiar Lazear and Rosen (1990) model and discuss the implications regarding the job assignments and gender productivity differences within jobs. We also point out what different assumptions about the underlying male and female productivity distributions imply for the inference on the assignment thresholds. In the third section, we discuss the data and the fourth section explains the construction of the complexity ladder of jobs. We then study the movement of workers on the complexity ladder. In the fifth section, we examine the allocation of workers across levels of complexity at the initial job assignment and replicate the standard analysis of gender differences in the probability of promotion. The most original analysis is reported in section 6, in which we use our productivity proxies to evaluate the relative performance of a given group of newly recruited men and women, both before and after the first promotion decisions have taken place. In section 7, we briefly examine the quit behavior of the workers and discuss whether the gender differences are large enough to explain the differences in the job allocation. Section 8 concludes.

2 Theoretical background

The model by Lazear and Rosen (1990) is a popular framework in which to think about gender differences in job assignment. In this model, the workers who are assigned to more

demanding jobs undergo costly training to learn the tasks involved. Once the training is finished, the workers cannot commit to staying with the employer but leave the firm, if the value of their reservation wage exceeds the wage paid by the firm.

Women are assumed to have higher reservation wages than men because of their comparative advantage in non-market activities. Hence, women are more likely to leave the firm and the risk of losing the training investment is higher when a woman is assigned to the demanding job. Thus, the productivity threshold that decides whether the worker is assigned to the demanding job is higher for women than for men.

2.1 Job assignments

Consider workers who enter the firm with some level of innate ability and who gradually acquire seniority that increases their effective ability. Denote the innate ability of worker i with δ_i and his/her seniority prior to period t with x_{it} . Following Gibbons and Waldman (1999), assume that the effective ability of the worker, η_{it} , is a function of the innate ability and seniority: $\eta_{it} = \delta_i f(x_{it})$, where $f' > 0$, $f'' \leq 0$. The innate ability of the worker is assumed to be common knowledge at the beginning of the worker's career.

There are two jobs, the more demanding job A and the less demanding job B . Consider the employer's job assignment decisions at time t . If the worker is assigned to job A , he/she will undergo costly training during the fraction τ of the period t and reaches the full productive capacity for the fraction $(1 - \tau)$ of the period. One way to interpret τ is to view it as the time spent in job specific monitoring, as in Lazear (1986). There is no training in task B .

The output per worker in job B during the whole period t is equal to his/her effective ability $\eta_{it} = \delta_i f(x_{it})$. If the worker is assigned to job A , his/her output is reduced to $\gamma_1 \eta_{it} = \gamma_1 \delta_i f(x_{it})$ during τ , where $0 < \gamma_1 < 1$. During $(1 - \tau)$, the output of the worker in job A reaches $\gamma_2 \eta_{it} = \gamma_2 \delta_i f(x_{it})$, where $\gamma_2 > 1$.

Assume that the workers are certain to stay in the firm during τ but that they cannot commit to staying during $(1 - \tau)$. Workers will leave the firm if the value of their reservation wage is higher than the wage paid by the firm. Lazear and Rosen assume that the worker's reservation wage is a random variable ω and that at the beginning of period t only the the cdf, $F(\omega)$, of this variable is known.

An efficient assignment rule should induce the workers to stay in the firm, if the market value of their output exceeds their reservation wage. Furthermore, the rule should assign only those workers to job A , whose social output is higher in job A than in job B .

Social output of the workers who are assigned to job A is equal to:

$$\tau \gamma_1 \eta_{it} + (1 - \tau) \left(\gamma_2 \eta_{it} \int_0^{\gamma_2 \eta_{it}} dF + \int_{\gamma_2 \eta_{it}}^{\infty} \omega dF \right) \quad (1)$$

Correspondingly, the social output of the workers in job B is:

$$\tau \eta_{it} + (1 - \tau) \left(\eta_{it} \int_0^{\eta_{it}} dF + \int_{\eta_{it}}^{\infty} \omega dF \right) \quad (2)$$

The difference between (1) and (2) can be written as:

$$D = -\tau \eta_{it} (1 - \gamma_1) + (1 - \tau) \int_{\eta_{it}}^{\gamma_2 \eta_{it}} F(\omega) d\omega \quad (3)$$

Workers are assigned to task A if $D > 0$ and to task B if $D < 0$. Hence, there is an assignment threshold $D(\eta^*) = 0$.

The initial job assignment will be decided solely on the basis of innate ability. Thus, there will be a threshold level of innate ability, δ^* , that decides to which job the worker is initially assigned. Similarly, for workers that were initially assigned to job B there exists a threshold level of seniority, x_t^* , after which they will be promoted to job B . Naturally, the higher is the innate ability of the worker in job B , the faster he/she will get promoted.

2.2 Gender differences in reservation wages

Lazear and Rosen assume that men and women have different outside options. More specifically, female distribution of reservation wages, $F_f(\omega)$, first-order stochastically dominates that of men, $F_m(\omega)$. To introduce this assumption in the setting above, write the distribution of reservation wages as $F(\omega; \alpha)$, where α is a shifter, such that $\partial F/\partial \alpha > 0$. Define $F_f(\omega) \equiv F(\omega; \alpha_f)$ and $F_m(\omega) \equiv F(\omega; \alpha_m)$ so that $\alpha_m > \alpha_f$, which implies that $F_f(\omega) < F_m(\omega)$.

Differentiating $D(\eta^*) = 0$ with respect to α yields:

$$\frac{d\eta^*}{d\alpha} = \frac{\int_{\eta^*}^{\gamma_2 \eta^*} \frac{\partial F(\omega; \alpha)}{\partial \alpha} d\omega}{-\partial D(\eta^*)/\partial \eta_{it}}$$

which is negative since $\partial D(\eta^*)/\partial \eta_{it} > 0$. Hence, α decreases the threshold value of effective ability η^* and because $\alpha_m > \alpha_f$ we have that $\eta_m^* < \eta_f^*$. This means that in order to be assigned to the complex job women need to have a higher innate ability than men with the same level of seniority. Similarly, women need to acquire more seniority than men of equal innate ability to get promoted to the complex job.

2.3 Implications of the gender differences in reservation wages

Gender differences in the assignment thresholds have implications for the job assignments and productivity differences within jobs. The direction in which these impacts work depends on the underlying ability distributions of men and women.

Denote the male ability distribution with $G_m(\eta)$ and the female distribution with $G_f(\eta)$. Women will be less likely to be assigned to complex job, if:

$$\Pr(\eta \geq \eta_m^*) = 1 - G_m(\eta_m^*) \geq 1 - G_f(\eta_f^*) = \Pr(\eta \geq \eta_f^*) \quad (4)$$

Furthermore, women will be on average more productive within jobs if:

$$E[\eta \mid \eta \geq \eta_m^*] = \int_{\eta_m^*}^{\infty} \eta dG_m(\eta \mid \eta > \eta_m^*) \leq \int_{\eta_f^*}^{\infty} \eta dG_f(\eta \mid \eta > \eta_f^*) = E[\eta \mid \eta \geq \eta_f^*] \quad (5)$$

Below, we will use gender differences in promotion rates and productivity within groups of promoted and non-promoted workers to infer whether the assignment thresholds are different for men and women. In order to do this, we need to know under which assumptions (4) and (5) can hold simultaneously only, if $\eta_m^* \leq \eta_f^*$. If we rule out intersecting male and female ability distributions, this turns out to be straightforward. It is easy to see that if $G_m(\eta)$ and $G_f(\eta)$ are identical, both (4) and (5) can only hold if $\eta_m^* \leq \eta_f^*$. When the male ability distribution first-order stochastically dominates the female distribution, $1 - G_m(\eta_m) \geq 1 - G_f(\eta_f)$, the condition (4) can also hold for some values $\eta_m^* > \eta_f^*$ but the condition (5) holds only when $\eta_m^* \leq \eta_f^*$. On the other hand, if the female distribution dominates, $1 - G_m(\eta_m) \leq 1 - G_f(\eta_f)$, the condition (4) can only hold if $\eta_m^* \leq \eta_f^*$, whereas the condition (5) also holds for some values such that $\eta_m^* > \eta_f^*$. Thus, women can be *simultaneously* less likely to be assigned to the complex job and more productive within jobs only if the female assignment threshold is higher than the male assignment threshold.

3 The data

The data used in this paper come from the wage records of the Confederation of Finnish Industry and Employers (*Teollisuus ja työnantajat*). The wage records contain detailed information on the wages and working hours of all the workers who are affiliated with the confederation. In the Finnish metal industry, this covers practically 100% of the firms.

The wage records' data on wages and working hours can be considered as exceptionally reliable since the information comes directly from the firms' wage accounts. However, the information on the individual characteristics is rather scarce. Basically only age, gender, and seniority can be identified from the raw data. For the objectives of this paper, the most disturbing piece of missing information are the variables concerning marital status of the worker and the number of dependent children.

In this paper, we use all the workers who start their careers in the Finnish metal industry between 1990-1995 and who we can follow for at least five years up to year 2000 when our data end. We chose to restrict the sample like this because for our purposes it is essential to observe the workers at their initial job assignments and follow them for a reasonable number of years. Furthermore, restricting to workers who stay for more than four years selects the workers with a strong labour market attachment.

This panel of newcomers to the metal industry has 83 474 employee/year observations on 11 661 workers of whom 2 705 (23 %) are women. We have 64 198 episodes where the both current and next year's jobs are observed and the worker stays within the same firm.

In table 1, we present the descriptive statistics on this sample at the first year of seniority and compare them with the full cross-section of workers in the metal industry in 1990. It is clear that this is a strongly male-dominated industry. This fact should be taken into account, when interpreting the results reported below.

3.1 Wage determination in the Finnish metal industry

The sample was restricted to include only workers from the metal industry because the peculiar wage determination process in this industry provides particularly interesting information on the complexity of the jobs. According to the industry's collective agreement, wages should be determined by the complexity of the job, the individual performance of the worker, and by various individual and firm-specific factors.

The complexity of the job specifies a minimum wage for each job. This minimum wage is called the *occupation-related wage*. Worker's individual performance on the job affects the wage outcome through a *personal bonus* of 2 to 17% of the occupation-related wage. In this paper, we will use the occupation-related wages as a measure of the complexity of the job and personal bonuses as a proxy for the productivity of the individual.

3.2 Job complexity

The complexity of the job is evaluated with a grading system that is similar to the ones used in some large establishments in the US. The evaluation is carried out by a group of experts, that considers various aspects of the jobs and assigns them points according to their complexity. The complexity level is based on three criteria: 1) how long does it take to learn the tasks, 2) the degree of responsibility, and 3) the working conditions. The evaluation should be independent of the workers performing the job and it should make jobs comparable both between and within firms.

Based on the evaluation of jobs, an occupation-related wage is determined for each job in the collective agreement. The more demanding the job, that is the more complexity points it gets, the higher is the corresponding occupation-related wage. Basically, there

should be a one-to-one mapping from the occupation-related wages to the complexity points. The occupation-related wages can therefore be interpreted as a continuous variable that measures the complexity of the job. There are typically around 50 different levels of occupation-related wages per year.

3.3 Individual performance

The individual performance of the worker is evaluated by his/her immediate supervisor. The performance evaluation is based on three criteria: 1) how well the tasks are carried out, 2) the worker's output relative to what is considered normal in the job, and 3) how well the worker follows the instructions and regulations. The performance of the worker is always evaluated relative to what is considered normal on the job in question. Hence, if, for example, the output of all the workers in the firm increases, the performance evaluations of the individual workers should not be affected.

Based on the supervisor's evaluation each worker is paid a personal bonus that should amount to 2-17% of the worker's occupation-related wage. The collective agreement states, that the bonuses should be symmetrically distributed around the mean of 9.5% within each complexity tercile in the firm.

In order to check whether these principles of the collective agreement are also followed in practice, we examined the variation of bonuses across complexity levels for groups of workers with a given level of seniority. There was some indication that bonuses were increasing in the level of complexity. Furthermore, straightforward analysis of variance revealed that firm dummies explain approximately 5% of the variation in bonuses. In order to account for this variation across complexity levels and firms, we measure individual performance with the deviation of the worker's personal bonus from the firm - complexity level cell mean. In the following, this productivity measure will be called *personal bonus deviation*.

4 Complexity ladder of jobs

As was explained above, the occupation-related wages order the jobs according to their complexity. In this paper, we use this ordering of jobs as a job ladder where the within-firm upwards movement on the ladder is interpreted as a promotion and downwards movement as a demotion.

The fact that the occupation-related wages are a component of the final wages makes their use as a complexity measure problematic. There is some year-to-year variation in the occupation-related wages that is not related to changes in the complexity of the jobs. For example, in certain years all the occupation-related wages are increased to account for the effects of inflation. This means that the scale with which the complexity of the jobs is measured is not constant in time.

We corrected for these changes by descaling the occupation-related wages in the following way. We first grouped the workers according to their occupation-related wages within each year and examined the within group distributions of changes in the occupation-related wages. This analysis revealed that for most of the workers in these groups the year-to-year changes in occupation-related wages were identical. We interpreted the group mode changes of the occupation-related wages as increases that were not related to changes in the complexity of the jobs. The occupation-related wages were then corrected by subtracting the annual mode changes from occupation-related wages. After this correction, the occupation-related wages form a consistent ladder for all the years 1990-2000.

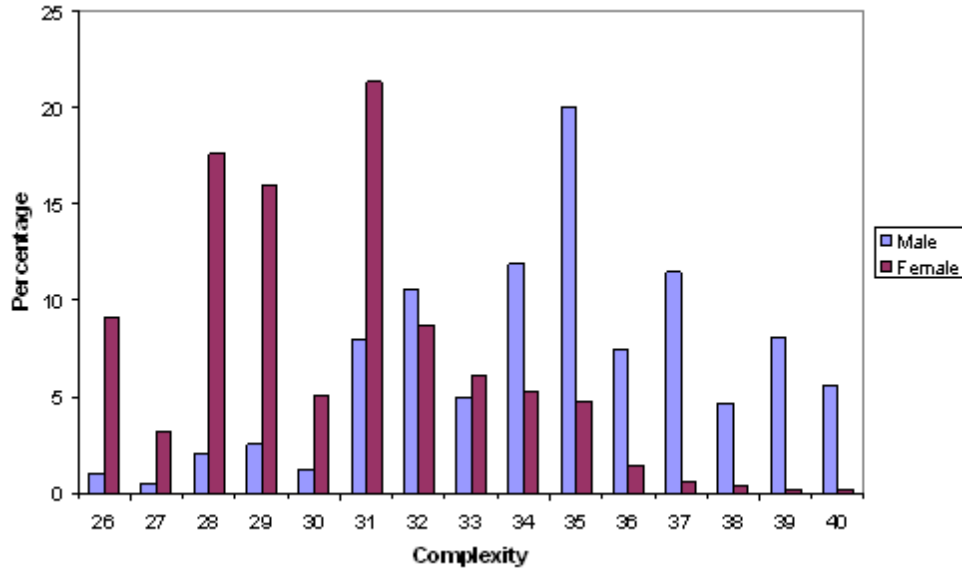


Figure 1: Percentages of male and female workers across tasks of different complexity, 1990 cross-section

Table 2 is a transition matrix of movements between complexity levels in 1990-1991. It shows all the within-firms movement between complexity levels, including entries, exits and stays as percentages of the number of workers on each level. The table can be interpreted in the same way as the job-to-job transition matrices in Baker et al (1994) or Treble et al (2001). For the purposes of this table, the complexity levels were aggregated into integers.

If complexity levels really are a true job ladder, the movements on this ladder should resemble the stylized facts about promotions and demotions. Basically, there should be more movement upwards than downwards. In table 2, there are 62 304 workers who stayed with the same employer between 1990-1991. Approximately 9% of these workers worked in a more complex and about 5% in a less complex job in 1991 than in 1990. Shaded areas in the table indicate the levels that were the most frequent destinations of movement between complexity levels. There is a considerable amount of movement, most of which is upwards and rarely leaping over many levels. In our view, the information in table 2 is in line with the stylized facts about promotions and demotions. It seems appropriate to interpret the complexity axis as a job ladder.

5 Gender differences in job assignments

How are men and women then allocated on this ladder? Figure 1 plots the percentages of male and female workers across the same complexity levels as in table 2 in the 1990 cross-section. The figure reveals that women are concentrated in the low end of the complexity axis while the most men work on more complex jobs. This pattern is repeated throughout the years 1990-2000.

Why are women concentrated in the low-end of the complexity axis as in figure 1? Perhaps the most common approach to studying gender differences in job allocation, is

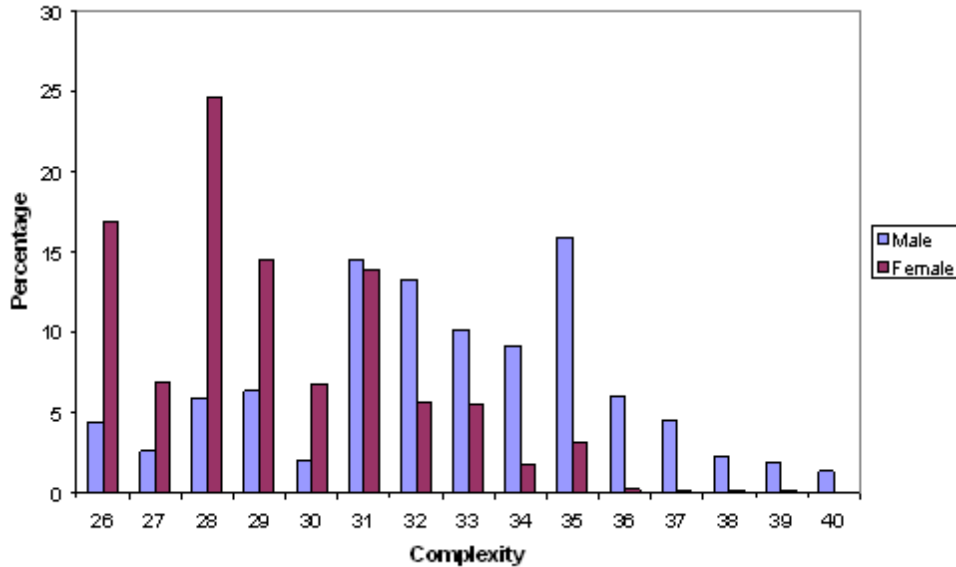


Figure 2: Percentages of male and female workers across jobs of different complexity at the initial job assignment

to examine movement of workers between jobs. If the assignment thresholds are identical for men and women, we shouldn't see any differences in the movement of men and women once the productive characteristics are controlled for. In this section, we study the gender differences in the allocation of workers across jobs of different complexity at the initial job assignment and in the promotion process.

5.1 Initial job assignments

In our sample, we observe the jobs where the workers started their careers and their subsequent promotions and demotions. In figure 2, we have plotted the distributions of the first job assignments of the men and women in our sample.

The asymmetry in figure 2 is striking. Women seem to start their careers in clearly less complex jobs than men. The Duncan and Duncan index of dissimilarity for the initial job assignments gives a value 49.3. That is, nearly half of the women in our sample should change their initial job assignment to arrive to the male allocation of jobs.

However, figure 2 should not be interpreted as evidence on gender differences in the assignment thresholds. After all, it is possible that the asymmetry in figure 2 only reflects the differences in the ability distributions of men and women who choose to work in the metal industry. If the underlying productivity of women in this industry is lower than that of men, it is not surprising that women start their careers in less complex jobs than men. Still, whatever the reason for the asymmetry in figure 2, it is clear that the initial job assignment has to be taken into account in the analysis of gender differences of promotion and productivity.

5.2 Promotions

Are women then less likely to move upwards on the complexity ladder than men? In table 3, we report the gender differences in the change of complexity. We take advantage of the fact that the occupation-related wage is a continuous variable. Thus, the changes of occupation-related wages conveniently summarize both the extent and the direction of the change in the complexity of the jobs that workers are performing.

The first row of table 3 reports the sample means of changes in log occupation-related wages for men and women in our sample. The male and female sample mean of changes in the complexity of the jobs are virtually identical. If anything, the female mean is slightly higher than the male mean, although the difference is not statistically significant. However, once we split the workers according to the complexity of their initial job assignments, the gender differences become clear. In the following rows of table 3, we report the male and female means of changes in log occupation-related wages in the complexity groups of initial job assignment. In most groups, the mean change in log complexity is clearly lower for women than for men.

The numbers in table 3 are just cell means which do not control for anything else than the complexity of the initial job assignment. In order to control for observable productive characteristics, we ran a following regression on the pooled data:

$$\Delta c_{it} = \beta F_i + X'_{it}\gamma + \delta I_{it} + \varepsilon_{it} \quad (6)$$

where $\Delta c_{it} = c_{i,t+1} - c_{it}$ is the difference in log occupation related wages, F_i is the female dummy, and X_{it} is a set of productive characteristics including age and seniority and their squares. In I_{it} we include a full (15) set of initial job complexity dummies to control for the initial job assignment.

The regression results are reported in table 4. The coefficient on the female dummy is again negative, -0.008 , and clearly significant. Thus, the results in tables 3 and 4 clearly indicate that women take smaller steps on the complexity ladder than men who start in jobs of similar complexity.

Another way of looking at gender differences in the promotion patterns is to examine duration to promotion. In order to do this, we defined a promotion indicator that takes value one if the individual experienced a positive change in the occupation-related wage within the same firm and zero otherwise. In table 5, we report the Kaplan-Meier estimates of the survivor function for men and women. The first column shows the estimates for the whole sample. Although the female survivor function is consistently above the male one, the differences are relatively small.

However, the gender differences become clear once we focus on workers who start their careers in jobs of more or less similar complexity. This is done in columns 2-4 of table 5, where we report the estimates of the survivor function within subsamples of workers. The groups were formed by dividing the workers into "low-complexity", "medium-complexity", and "high-complexity" groups according to the complexity of the initial job assignment. Female survivor functions are clearly above the male ones in the low and medium groups of initial job complexity. A straightforward log-rank test for the equality of the Kaplan-Meier estimates, results of which are reported in the last row of table 5, rejects the null in all the cases except the high complexity jobs.

In order to control for observable productive characteristics in the duration analysis, we ran a discrete-time proportional hazards model of promotion, using the log-likelihood suggested by Jenkins (1995):

$$\log \mathcal{L} = \sum_{i=1}^N \sum_{t=1}^T y_{it} \left[\frac{h_{it}}{(1 - h_{it})} \right] + \sum_{i=1}^N \sum_{t=1}^T \log(1 - h_{i,t}) \quad (7)$$

where N is the number of individuals in our sample, T is the number of years, and y_{it} is a dummy that takes the value 1 for individual i at t if he/she is promoted at that period and zero otherwise. We use a complementary loglog specification for the hazard rate:

$$h_{it} = 1 - \exp \{- \exp [\theta(t) + F_i + X'_{it}\gamma + \delta I_{it}]\} \quad (8)$$

where the baseline hazard $\theta(t)$ is left unspecified and the rest of the variables are as in (6). The results are presented in table 6. The estimated coefficient of the female dummy is negative (-0.4) and clearly significant.

We interpret the results in tables 3-6 as implying that women are initially assigned to jobs that are less complex but where the promotions are also more frequent. However, compared to the male workers who start their careers on those same jobs, women are much less likely to move to more complex tasks. Thus, women tend to "get stuck" in the initial jobs of low complexity whereas men are more successful in advancing to more complex jobs.

6 Gender differences in productivity

The regressions in the previous section controlled for productive characteristics in a very crude way. An alternative approach to study gender differences in the assignment thresholds is to compare the relative productivity of men and women before and after the promotion decisions have taken place. If the threshold of promotion is higher for women than for men, the promoted and non-promoted women should be, on average, more productive than their male counterparts.

We now use personal bonus deviations to measure individual productivity and examine the productivity of the workers in our newcomer sample. We first measure the productivity of each worker at the initial job assignment and then partition the workers into two sets of workers: those who have got promoted up to some specific year (the "promoted" group) and those who have stayed at the initial assignment until that year (the "stagnant" group).

In table 7, we report the median personal bonus deviations for workers in each of these groups. In the first row, we display the personal bonus deviations of the new entrants during their first year in the industry. The next row depicts the personal bonus deviations of men and women as measured in the second year of the career, separately for those who were promoted after the initial year and those who were not. The following row depicts the median personal bonus deviations two years after the initial assignment, similarly differentiated between those who had been promoted up to their third year of the career and those who were not; and analogously for the fourth and the fifth row.

The medians reported in table 7 indicate that there are hardly any gender differences in productivity at the initial task assignments. However, once the workers are split into promoted and non-promoted groups, the gender differences become clear. Women tend to dominate in both groups. Among the non-promoted workers the gender difference reaches 0.009 and among the promoted workers 0.011 in favour of women.

Table 7 only reports the differences in medians. In order to have a better view of what happens to the productivity distributions, we have plotted the kernel estimators of the cumulative distributions of personal bonus deviations for men and women separately for stagnant and promoted workers in the first four years of seniority in figure 3.³ The male and female distributions of personal bonus deviations are almost indistinguishable at the initial job assignment. After the first year, the workers are split into stagnant and

³The estimation was done using the Epanechnikov kernel with a bandwidth of .005. Different bandwidths were tried out without relevant changes in the qualitative results.

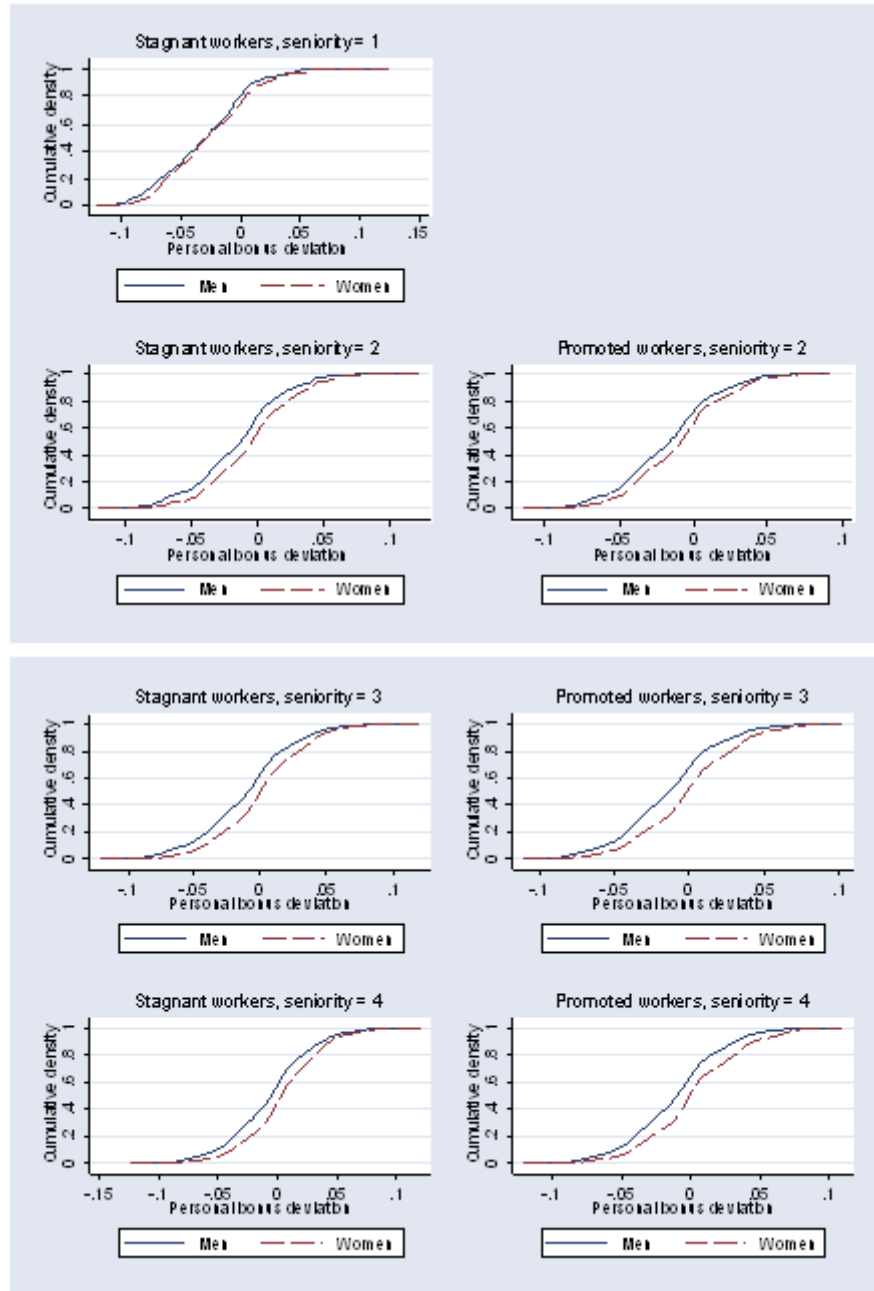


Figure 3: Kernel density estimates of the cumulative distributions of personal bonus deviations

promoted groups. In both groups, the female distributions clearly dominate the male distributions and the differences seem to become clearer with seniority.

Whether the results presented above, together with the results on gender differences in promotion probabilities, imply that the female assignment thresholds are higher than the male ones depends on the underlying productivity distributions of men and women who choose to work in the metal industry. As was discussed in the second section, this is correct in the cases where the male and female distributions of productivity distributions do not intersect. Since in our analysis we focus on men and women who start their careers within jobs of similar complexity, any differences in the underlying distributions of productivity should be small. Finally, the results in table 7 and in figure 3 indicate that there are no visible gender differences in the personal bonus deviations within initial jobs. Hence, in our view, these results indicate that women need to be more productive than men to be assigned to complex jobs.

Finally, personal bonus deviation comparisons also tell us something about the behaviour of the employers. First of all, it is clear that the workers that the employers choose to promote tend to be more productive already in their initial jobs. In terms of Lazear and Rosen story, this implies that training costs do play a role in these firms. After all, if the assignment to more complex jobs was costless, the employer would assign all the workers to more complex tasks. However, it seems that women need to be more productive at their initial job than men to get promoted. For promoted women, the average personal bonus deviation in the initial job is $-.021$ while for promoted men it is only $-.025$. Thus, promoted women are approximately 18% more productive at the initial job than promoted men in the initial job. Since the Lazear and Rosen model does not assume any differences in the training costs of men and women, the only way to explain these differences in terms of their model are gender differences in the quit behaviour.

7 Gender differences in quit behavior

According to the Lazear and Rosen model, gender differences in reservation wages give rise to differences in the assignment thresholds. We will now examine whether the observed quit behaviour of men and women in the Finnish metal industry is consistent with the Lazear and Rosen argument. However, we would like to stress that, in our view, these data do not really allow for "testing" the Lazear and Rosen argument. After all, the quit behaviour of the workers may well be endogenous. That is, any gender differences in the quit behaviour that we observe may be a result of the gender differences in the assignment thresholds. Hence, this exercise should be seen more as a simple check of whether gender differences in quit behaviour could be the underlying cause for the differences in the assignment thresholds in the most favourable case where the quit rates are exogenous.

We do not observe the actual reasons of job separations in our data. Hence, it is not possible to distinguish layoffs and voluntary quits directly. However, since voluntary quits are what we are interested in, we tried to tackle this problem by defining as a "quit" those separations, where more than 75% of the employees remain in the departure firm. This definition rules out the situations where a large proportion of the firm's workforce is laid off at the same time, and it is likely to catch more truly voluntary separations. We do not distinguish between job-to-job turnover and job-to-nonemployment turnover, since from the point of the view of the employer these are equivalent.

In the whole metalworker population, the average quit rate of men was 7.8% and that of women 9.6%. Figure 4 plots the average quit rates for men and women by age in the whole metalworker population. As is clear from the figure, the male and female quit rates differ significantly among younger workers, but tend to converge among older workers

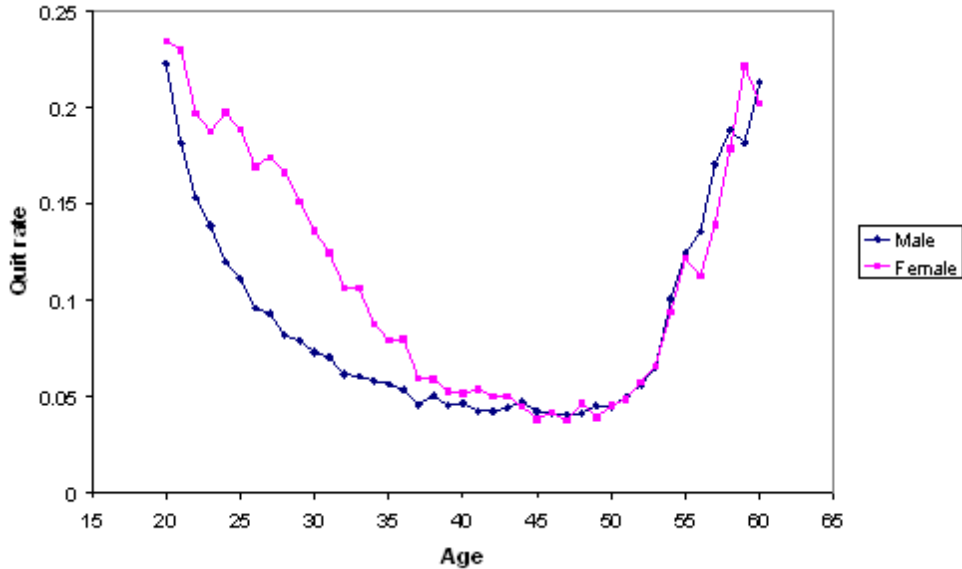


Figure 4: Average quit rates by age and gender in the whole metal industry population, 1990-2000

Table 8 reports the marginal effects from a probit model of quits that uses the whole population of metalworkers. In this model, we allow for different intercepts and age profiles for men and women. The effects are calculated at the mean values of the independent variables. According to these results, women are five percentage points more likely to leave the firm.

However, from the point of view of the employer who is considering whether to promote one of the workers in our newcomer sample, the most relevant differences are the differences in the quit rates of the younger workers. In table 9, we report the predicted quit rates of men and women in different age groups. The predicted quit rates of men and women are substantially different among workers who are younger than 30 years old. In fact, in both groups 25 and below as well 25-30 years old, the female quit rate is approximately 40% higher than the male quit rate. In our newcomer sample, nearly 50% of the observations come from these two age groups.

If one is willing to take these gender differences in the quit behaviour as exogenous, they could just as well cause the observed differences in the assignment thresholds. However, there are plenty of reasons to expect the quit behaviour not to be exogenous. Women may simply respond to the adverse promotion prospects by leaving the firm. This is why these results should only be seen as consistent with, but not necessarily supportive of, the Lazear and Rosen story.

8 Conclusions

The asymmetric allocation of men and women across jobs is one of the most common explanations for the persistence of gender wage gaps. It is often argued that women have to meet higher productivity requirements than men to be assigned to demanding jobs. Because of these differences in the assignment thresholds women tend to start their

careers in less demanding jobs than men and find it more difficult to get promoted than men.

In this paper, we examine gender differences in the job allocations using panel data on Finnish metalworkers. These data are exceptionally suitable for the analysis of the assignment thresholds. They provide a measure for the job complexity that can be used to construct a complexity ladder of jobs. Thus, we are able to compare men and women, who start their careers in similar jobs. Furthermore, the data contain information on personal bonuses that can be used to study the productivity implications of the gender differences in the assignment thresholds.

In the Finnish metal industry, women work on clearly less complex jobs than men. This gender difference in the job allocation is already visible at the initial job assignment. Nearly 50% of the women would have to change their initial jobs to arrive at the male allocation of initial jobs. Furthermore, women find it more difficult to move to more complex tasks than men: Women are clearly less likely to get promoted than men who start their careers in the same jobs, even after controlling for observable productive characteristics.

Using personal bonuses as a measure of individual productivity, we also find that there are no clear productivity differences between men and women within the jobs where the workers are initially assigned to. However, when the workers are split into groups of promoted and non-promoted workers, the gender differences in productivity become clear. Promoted and non-promoted women are consistently more productive than their male counterparts.

Whether one can interpret these results as evidence on gender differences in the assignment thresholds, depends on the underlying productivity distributions of male and female workers in this industry. We argue that since we do not observe any productivity differences within the initial jobs, we can interpret the combination of the results that women are less likely to be promoted and that women are more productive among the promoted and non-promoted workers as evidence on higher female thresholds. Whereas the result that women are less likely to get promoted than men has been reported often, it hasn't been combined with the results on gender differences in productivity that would match the asymmetric assignment threshold hypothesis before.

Finally, the observed quit behaviour of men and women in this industry is broadly consistent with the Lazear-Rosen explanation of the gender differences in the promotion thresholds. Namely, the fact that women are more likely to quit the firm than men, may imply that women face higher thresholds because their promotion is more costly to the employer. However, since the quit behaviour may be a result of the differences in the promotion thresholds, it is not possible to draw definite conclusions on the causes of these threshold differences with these data.

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Table 1 Descriptive statistics

| Variable | Men in our sample | | Women in our sample | | Men in 1990 cross-section | | Women in 1990 cross-section | |
|-------------------------|-------------------|--------------------|---------------------|--------------------|---------------------------|--------------------|-----------------------------|--------------------|
| | Mean | Standard deviation | Mean | Standard deviation | Mean | Standard deviation | Mean | Standard deviation |
| Age | 28.43 | 8.35 | 31.43 | 9.22 | 37.23 | 10.40 | 40.19 | 10.37 |
| Complexity | 33.03 | 3.24 | 29.55 | 2.35 | 35.21 | 3.17 | 30.62 | 2.62 |
| Bonus | .05 | .04 | .06 | .04 | .09 | .04 | .09 | .04 |
| Average hourly earnings | 41.35 | 8.23 | 34.92 | 4.61 | 46.79 | 7.64 | 38.48 | 5.07 |
| Individuals | 8 956 | | 2 705 (23%) | | 52377 | | 14 607 (22%) | |
| Ind/year observations | 83474 | | | | | | | |

Our sample consists of all the observations during 1990-2000 on workers who enters the metal industry during 1990-1995 and stays for at least five years. The descriptive statistics are 1990 means and standard deviations. 1990 cross-section consists of all the workers in the metal industry population in 1990. Complexity refers to the occupation-related wage in FIM 1990. Bonus is reported as a proportion of occupation-related wage. Average hourly earnings consist of worker's earnings in different hourly wage schemes in FIM 1990.

Table2 Transition matrix between jobs for newcomers in the metal industry, 1990-1991

| | Exit | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | Total | N |
|--------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|-------|-------|
| Entry | | 36.5 | 45.1 | 18.2 | 19.5 | 18.4 | 14.3 | 12.8 | 15.4 | 8.1 | 7.7 | 6.3 | 4.3 | 4.9 | 2.8 | 3.7 | | 7405 |
| 26 | 38.9 | 44.3 | 0.1 | 9.4 | 2.9 | . | 1.1 | 1.3 | 0.1 | 1.6 | 0.3 | . | . | 0.1 | . | . | 100 | 1762 |
| 27 | 39.9 | 0.1 | 45.3 | 3.0 | 0.1 | 4.6 | 3.4 | . | 1.4 | 0.3 | 1.3 | 0.4 | . | 0.1 | . | . | 100 | 704 |
| 28 | 30.0 | 1.2 | 0.4 | 59.9 | 2.9 | 1.0 | 2.3 | 0.9 | 0.5 | 0.4 | 0.5 | 0.2 | . | . | . | . | 100 | 3358 |
| 29 | 28.6 | 0.6 | . | 2.0 | 60.1 | 0.1 | 5.5 | 2.2 | . | 0.7 | 0.1 | . | 0.1 | . | . | . | 100 | 3475 |
| 30 | 28.6 | . | 0.7 | 1.6 | . | 56.3 | 5.5 | 0.2 | 3.1 | 0.4 | 2.1 | 0.6 | 0.9 | 0.1 | . | . | 100 | 1344 |
| 31 | 24.9 | 0.1 | . | 0.8 | 1.0 | 0.4 | 62.0 | 4.8 | 2.2 | 1.3 | 1.4 | 0.7 | 0.1 | 0.1 | 0.1 | . | 100 | 6796 |
| 32 | 25.7 | 0.1 | . | 0.3 | 0.5 | . | 2.3 | 62.2 | 0.1 | 6.0 | 2.1 | . | 0.5 | . | 0.2 | . | 100 | 6457 |
| 33 | 22.6 | . | 0.1 | 0.3 | . | 0.5 | 1.5 | . | 64.6 | 0.2 | 5.5 | 3.5 | . | 0.9 | . | 0.3 | 100 | 3303 |
| 34 | 20.9 | . | . | 0.1 | 0.2 | . | 0.7 | 3.3 | . | 63.8 | 9.1 | 0.3 | 1.3 | . | 0.4 | . | 100 | 6529 |
| 35 | 16.6 | . | . | 0.1 | . | 0.1 | 0.3 | 0.7 | 0.9 | 2.5 | 68.9 | 2.9 | 5.7 | 0.5 | 0.6 | 0.2 | 100 | 10382 |
| 36 | 13.8 | . | . | . | . | 0.1 | 0.2 | . | 0.7 | . | 4.3 | 74.0 | 0.1 | 5.3 | 0.1 | 1.6 | 100 | 3754 |
| 37 | 12.5 | . | . | . | 0.1 | . | 0.2 | 0.4 | . | 1.2 | 6.5 | . | 74.3 | 0.1 | 4.8 | . | 100 | 5677 |
| 38 | 13.1 | . | . | . | . | . | 0.1 | . | 0.3 | . | 0.9 | 4.0 | 0.7 | 76.7 | 0.1 | 4.1 | 100 | 2199 |
| 39 | 11.8 | . | . | . | . | . | . | 0.3 | . | 0.4 | 1.5 | . | 4.3 | 0.1 | 81.6 | 0.2 | 100 | 3964 |
| 40 | 12.2 | . | . | . | . | . | . | 0.3 | . | 0.5 | 2.4 | . | 2.7 | 1.7 | 80.1 | | 100 | 2600 |
| Total | 20.6 | 1.4 | 0.6 | 3.8 | 3.8 | 1.4 | 7.9 | 7.7 | 4.0 | 8.1 | 14.2 | 5.5 | 8.3 | 3.3 | 5.9 | 3.6 | 100 | 69709 |

Shows all transitions between complexity levels, including entry, exit, and stays from 1990 to 1991, as percentage of movements from a complexity level to another. Aggregating occupation-related wages into integers creates complexity levels. Shaded cells indicate the level that was the most frequent destination of the complexity level moves. Numbers in boxed cells indicate stays within a complexity level. Zeros denote nonempty cells that round up to zero and “.”s denote empty cells.

Table 3 Change in complexity – Gender differences

| | Male | Female | Difference |
|---------------------|----------------|-----------------|-------------------|
| Total | .010 (.000) | .011 (.000) | .000 (.000) |
| Complexity group 26 | .026 (.001) | .018 (.001) | -.008** (.001) |
| Complexity group 27 | .035 (.002) | .018 (.002) | -.017** (.002) |
| Complexity group 28 | .026 (.001) | .013 (.001) | -.013** (.001) |
| Complexity group 29 | .017 (.001) | .009 (.001) | -.008** (.001) |
| Complexity group 30 | .022 (.001) | .013 (.001) | -.009** (.001) |
| Complexity group 31 | .014 (.000) | .005 (.001) | -.008** (.001) |
| Complexity group 32 | .010 (.000) | .003 (.001) | -.007** (.001) |
| Complexity group 33 | .010 (.000) | .005 (.001) | -.005** (.001) |
| Complexity group 34 | .006 (.000) | .004 (.002) | -.002 (.002) |
| Complexity group 35 | .005 (.000) | .001 (.001) | -.005** (.001) |
| Complexity group 36 | .005 (.001) | -.002 (.003) | -.007** (.001) |
| Complexity group 37 | .000 (.001) | .004 (.011) | .004 (.003) |
| Complexity group 38 | .001 (.001) | .002 (.003) | .001 (.001) |

The numbers in the second and third columns are the sample mean changes of log occupation-related wages for men and women. The fourth column gives the female-male difference. The groups were constructed by aggregating the occupation-related wages of the workers' initial task assignments to integers. The numbers in parentheses are standard errors. ** denotes significance at 5%-level and * at 10-level.

Table 4 Change in complexity – regression results

| Variable | (3) |
|---------------------------------|-------------------|
| Female | -.008** (.000) |
| Age/10 | -.011** (.001) |
| (Age/10) ² | .001** (.000) |
| Seniority/10 | -.086** (.003) |
| (Seniority/10) ² | .066** (.002) |
| Initial task complexity dummies | Yes (15) |
| R ² | .135 |
| N | 64 198 |

Dependent variable is the difference between log of the occupation-related wage in the next period and the log of the occupation-related wage at the current period. Seniority measured as number of years that individual has been present in the metal industry. Regression also includes a full set of initial task complexity group and firm dummies. Numbers in parenthesis are robust standard errors.

Table 5 Kaplan-Meier estimates of the survivor function by gender

| Seniority | (1) The whole sample | | (2) Low complexity tasks | | (3) Medium complexity tasks | | (4) High complexity tasks | |
|---------------|---------------------------------------|-------|--|-------|--|-------|--------------------------------------|-------|
| | Men | Women | Men | Women | Men | Women | Men | Women |
| 1 | 0.709 | 0.746 | 0.596 | 0.707 | 0.679 | 0.808 | 0.859 | 0.943 |
| 2 | 0.564 | 0.628 | 0.410 | 0.580 | 0.536 | 0.709 | 0.770 | 0.862 |
| 3 | 0.473 | 0.531 | 0.327 | 0.478 | 0.441 | 0.624 | 0.696 | 0.813 |
| 4 | 0.412 | 0.468 | 0.274 | 0.413 | 0.385 | 0.567 | 0.624 | 0.766 |
| 5 | 0.371 | 0.424 | 0.237 | 0.371 | 0.345 | 0.521 | 0.583 | 0.723 |
| Log-rank test | X ² (1)=21.72 (p=0.000) | | X ² (1)=104.68 (p=0.000) | | X ² (1)=116.85 (p=0.000) | | X ² (1)=2.59 (p=0.108) | |

Table reports the Kaplan-Meier estimates of the survivor function, where hazard is the probability of promotion conditional on not being promoted up to the year of seniority. Low-complexity refers to tasks that have occupation-related wages less than or equal to 30. Medium complexity refers to tasks that have occupation-related wages larger than 30 but less than or equal to 35. High complexity refers to tasks that have occupation-related wages higher than 35. The last row reports the log-rank test statistic for the hypothesis that the male and female survivor functions are equal.

Table 6 Duration to promotion – Discrete-time complementary log-log proportional hazards estimates.

| Variable | |
|---------------------------------|-------------------|
| Female | -.357** (.026) |
| Age/10 | -.191** (.087) |
| (Age/10) ² | -.000 (.012) |
| Initial task complexity dummies | Yes (15) |
| N | 64 198 |

Estimates from a discrete-time proportional-hazards model of promotion. Complementary log-log specification was chosen for the hazard of promotion. In addition to the variables listed in the table, 11 duration dummies were included in the estimation Standard errors are reported in the parentheses.

Table 7 Median personal bonus deviations in the groups of promoted and not-promoted workers

| | Stagnant men | Stagnant women | Difference | Promoted men | Promoted women | Difference |
|------------------|----------------------------|----------------------------|------------------|----------------------------|---------------------------|------------------|
| First assignment | -.027 (.000) N=8 956 | -.027 (.001) N=2 705 | .000 (.001) | | | |
| After 1 year | -.010 (.000) N=6 345 | -.001 (.001) N=2 017 | .009** (.001) | -.014 (.001) N=2 611 | -.003 (.001) N=688 | .011** (.001) |
| After 2 years | -.005 (.001) N=5 057 | .001 (.001) N=1 675 | .007** (.001) | -.010 (.001) N=3 899 | .000 (.001) N=1 030 | .011** (.001) |
| After 3 years | -.002 (.001) N=4 229 | .005 (.001) N=1 431 | .007** (.001) | -.007 (.000) N=4 727 | .001 (.001) N=1 274 | .008** (.001) |
| After 4 years | .000 (.001) N=3 687 | .007 (.001) N=1 255 | .007** (.001) | -.005 (.001) N=5 269 | .003 (.001) N=1 450 | .008** (.001) |

Numbers in cells are medians of bonuses as deviations from firm- and task-specific means. Stagnant refers to the group of workers that are not promoted. The second row reports the average bonus deviations of men and women at the initial task assignment. In the rows 3-6 these workers are split into two groups according to whether they were promoted or not and the means of bonus deviations are reported for each group. The numbers in parentheses are standard errors. N refers to the sample size of the cell.

Table 8 Probit model of voluntary quits, marginal effects

| Variable | Marginal effect | Standard error |
|----------------------------|-----------------|----------------|
| Female dummy | .050** | (.011) |
| Age/10 | -.216** | (.002) |
| Age squared /100 | .029** | (.000) |
| (Female x age)/10 | -.008* | (.004) |
| (Female x age squared)/100 | -.001 | (.001) |
| Seniority/10 | -.044** | (.001) |
| Seniority squared /100 | .005** | (.000) |
| Firm size/1000 | .000** | (.000) |
| 14 complexity dummies | Yes | |
| N | 630 839 | |
| % correctly predicted | 91.8 | |
| Log-likelihood | -165709.14 | |
| Pseudo R ² | .072 | |

Marginal effects of the probit model of quit behaviour using the whole population of metalworkers 1990-2000. Marginal effects of the female dummy reports the effect of 0 to 1 change.

Table 9 Predicted probabilities of quitting in different age groups

| Age group | Male | Female |
|--------------|------|--------|
| 25 and below | .173 | .242 |
| 25-30 | .086 | .124 |
| 30-35 | .054 | .079 |
| 35-40 | .041 | .059 |
| 40-45 | .041 | .054 |
| 45-50 | .052 | .059 |
| 50-55 | .081 | .079 |
| 55 and above | .166 | .141 |

Predicted probabilities of quitting from the probit model in table 8.