IFN Working Paper No. 1169, 2017

Talent, Career Choice and Competition: The Gender Wage Gap at the Top

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March 6, 2023

Abstract

We propose a management career model where females face a gender-specific career hurdle. We show that female managers will, on average, be more skilled than male managers, since females from the low end of the talent distribution will abstain from investing in a career as a manager. The average female manager will then be better at mitigating more intense product market competition. When the intensity of product market competition increases, hirings and wages for female managers will therefore increase relative to those of male managers. Using Swedish matched employer-employee data, we find strong empirical evidence for all these predictions.

Keywords: Career; Gender wage-gap; Job Inflexibility; Management, Competition.
JEL classification: J7, L2, M5

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1. Introduction

In an overview article, Francine Blau and Lawrence Kahn (Blau and Kahn, 2017) show that while the gender wage gap has declined over time, the decline has been much slower at the top of the wage distribution. Goldin (2014) suggests that a likely explanation for the gender wage gap is that many high-wage career jobs are characterized by a high cost of substitution between different employees and long, inflexible hours. Such job inflexibility is more likely to harm women more than men since women—on average—take more responsibility for the family (Goldin, 2021). This implies a disadvantage for women in various inflexible high-wage occupations and presents a likely explanation for why the gender wage gap has declined much more slowly at the top. The ongoing process of making workplaces more flexible could potentially help to reduce the gender wage gap for many high-wage occupations. However, as noted by Goldin (2014): "There will always be 24/7 positions with on-call, all-the-time employees and managers, including many CEOs, trial lawyers, merger-and-acquisition bankers, surgeons, and the US Secretary of State". A high gender wage gap may therefore be a more persistent feature of such jobs.

In this paper, we begin from the premise that top-level management positions are associated with inflexible working hours and a high cost of substitution between different employees. We assume that females have a disadvantage in reaching such occupations because they demand more flexibility at work. We then construct a management career model with a gender-specific career hurdle capturing that females perceive investing in a top management career as more costly than men do and that high flexibility for managers in the workplace is costly for firms. In this setting, we examine (i) how the skill distribution differs between males and females in in top management positions, (ii) the gender wage gap in top management positions, and (iii) whether increased product market competition can mitigate the gender career and wage gaps for top managers. We then test the model's predictions on detailed matched Swedish employer-employee data.

In the online appendix (Section A.1), we provide evidence that management occupations are characterized by many of the features that Goldin (2014) refers to as characterizing inflexible occupations (e.g., time pressure and the number of workers that the employee must regularly keep in touch with).[1] This fact suggests that females aspiring to a management career will face a gender-specific manager career hurdle. When examining the gender wage gap for managers, it is, therefore, essential to take into account how the different management career hurdles that men and women face affect the selection into management occupations and how this, in turn, affects the skill distribution among female and male managers. The

[1] Results are presented in Tables A1 and A2 and in Figures A1 and A2.

ensuing skill distribution is of great importance because many managers lead firms competing in oligopolistic markets.[2] In such industries, small skill differences between managers are crucial to firms' competitive advantage and therefore their profitability.

To capture these elements in the manager job market, we propose a theoretical model in which firms hire managers with potentially different managerial skills and the hiring of a female manager is associated with an additional cost (capturing the gender-specific career hurdle). Firms compete in an oligopolistic fashion in the product market, and hiring a manager with high managerial skills improves a firm's profitability. Managerial wages are determined via Nash bargaining, and individuals need to invest in managerial skills to become a manager.

We first establish that women are harmed by job inflexibility in that female managers are offered lower wages than male managers with the same skill. The reason is that the lower wage compensates for the employer's higher cost of hiring a female manager. However, this implies that only highly talented women will invest in a managerial career and, thus, that the average skill level will be higher among female managers than among male managers. This is referred to as the *skill-biased glass ceiling effect.* Crucial for this result to hold is that talented individuals of both genders aspire for these jobs; otherwise, this selection effect would not be present.

Next, we ask how changes in the intensity of product market competition affect managerial wages. The literature on discrimination and product market competition has used different measures of product market competition, such as the number of firms in an industry, the Herfindahl index, or the level of import competition as measured by import tariffs, to explore the relationship between product market competition and discrimination. Here, we will mainly focus on a more general mechanism whereby increased product market competition affects gender differences in labor market outcomes. Following Boone (2008a,b) and Norbäck and Persson (2012), we define increased product market competition as changes in industry characteristics that increase the relative profitability of more efficient firms in an industry.[3] This formalization of the intensity of product market competition has the advantage of being consistent with different types of structural changes in an industry such as reduced entry barriers, reduced product differentiation and market integration.

In our theoretical model, we then show that if a firm hires a new manager (female or male) with sufficiently strong firm-specific managerial skills, he or she can mitigate the negative impact of increased competition on the firm's profits, such that profits increase relative to

[2] Taking into account market power effects seems highly relevant in light of the documented increase in mark-ups in many markets around the world (see for instance, De Loecker and Eeckhout (2018)).

[3] This Boone measure of product market competition is also used in the empirical analysis in Heyman, Svaleryd and Vlachos (2013).

a benchmark in which the firm retains its initial (male) manager with weaker managerial skills. We label this the *skill-biased competition effect.* A key result in our model is then that when the new manager is equipped with strong firm-specific managerial skills, the *skill-biased competition effect* increases the surplus generated by hiring the manager, which will increase the manager's wage in the wage negotiations. Consequently, the manager's wage will increase in product market competition. However, when the new manager has managerial skills that are only moderately better than the initial manager, increased product market competition may weaken the firm's profits relative to the benchmark under the initial manager. Increased product market competition then reduces the surplus from hiring and hence the managerial wage.

Under the assumption that an individual's ability cannot be perfectly observed in the data, we then derive empirical predictions from the model. We show that if the female career hurdle is sufficiently high, increasing product market competition will lead to a higher average increase in wages among female managers than among male managers. The reason is as follows: When the female career hurdle is sufficiently high, the *skill-biased glass ceiling effect* will imply that female managers will, on average, have higher managerial skills than male managers This is because only females with sufficiently high innate talent will then find it worthwhile to invest in a managerial career. Combining the result that female managers will, on average, be equipped with stronger managerial skills (the *skill-biased glass ceiling effect*), with the result that more skilled managers are will benefit more from more intense product market competition (the *skill-biased competition effect*), the model predicts that female managers' wages will, on average, increase by more than male managers' wages. Moreover, since the *skill-biased competition effect* increases the return on investing in managerial skills for females, increased product market competition can also increase the incidence of female managers in firms.

We then take these predictions to the data. Using detailed matched employer-employee data for Sweden spanning the period 1996–2009, we estimate whether male and female managers' wages are affected differently by competition for managers who remain in the same firm over time using manager-firm spell fixed effects, which control for *unobserved* individual managerial skills and firm characteristics.[4] [5] To find direct evidence of the skill-biased glass

[4]We first note that the skill-biased glass ceiling effect seems consistent with several stylized facts about the market for managers indicating a higher career hurdle for women. Women are underrepresented in top MBA programs. For instance, the female enrollment share of students in the top MBA programs in Sweden was 33 percent in the 2015. The corresponding number for the top-ranked schools worldwide was 27 percent. See www.hhs.se/en/about-us/news/2015/sse-mba-executive-format-2015/ for Sweden. For the 100 top-ranked schools globally, see http://rankings.ft.com/exportranking/global-mba-ranking-2019/pdf

[5]Keloharju et al. (2019) find that while women's career paths are similar to men's prior to childbirth, women earn substantially less than men five years after childbirth, and this gender difference persists over

ceiling effect in our matched employer-employee data, we first explore the distributions of estimated manager-firm fixed effects, which can be regarded as an imperfect measure of managers' firm-specific skills. For CEOs, we find that the distribution of proxied managers' firm-specific skills for female CEOs is heavily skewed to the right, whereas the corresponding male distribution is more symmetric, with more mass at both lower and higher values. These findings are consistent with the skill-biased glass ceiling effect, since the gender-specific hurdle implies that females with low skills will not pursue a career as a manager. We can also reject the equality of the two distributions. We also find strong evidence that positive selection among females starts early in their career, i.e., before individuals reach the position as CEO or manager (during the trainee period in our theoretical model). Moreover, we find little evidence of positive selection of women for positions other than CEOs or managers.

The strong evidence of positive selection of women into top management positions through the skill-biased glass ceiling effect suggests that we should also find evidence for the skill-biased competition effect in our data: indeed, conditional on individual characteristics, we find that female managers' wages on average increase, while male managers' wages on average are unaffected, when product-market competition intensifies. For identification, we also use changes in import tariffs as an alternative measure of product market competition and find similar results consistent with the skill-biased competition effect. It is worthwhile to yet again underscore the intuition behind these estimates: Male workers face a lower hurdle, and therefore, male workers with lower ability are able to become managers. The estimate of how male managers' wages react to increased product market competition will then be a weighted average of all types of managers, where managers of lower ability or skill see their wages decline in competition while high-ability managers see their wages increase in competition. In contrast, female managers face the female management career hurdle and therefore need higher skills to secure a managerial position. This implies that the estimate of how female managers' wages react to increased product market competition will contain higher weights on high-skilled managers whose wages increase in product market competition. This explains the positive effect of competition on female managers' wages. Consistent with the latter result, we also find that the share of female managers in firms rises when competition increases, indicating that the positive wage effect on female managers' wages also promotes women's career incentives.

We find no effect of the intensity of product market competition on the gender wage gap for lower-skilled employees. In fact, we find no effect of increased product market competition

the remaining course of the executives' careers. They also report that female executives tend to have much higher levels of education, are more likely to receive their degrees from tracks that produce a large number of top executives, and their male siblings attain higher cognitive ability test scores in military enlistment.

on the wages of groups other than managers. This result is consistent with our theoretical model since low-skilled employees will only marginally affect the profitability of the firm, and the wages for this group of employees are to a large extent determined jointly with the conditions in different product markets. It is also consistent with the absence of evidence of positive selection of women into positions other than CEOs and managers.

2. Related literature

Our paper contributes to the literature on the gender wage gap. In their overview article, Blau and Kahn (2017) use PSID microdata over the period 1980–2010 and find that the gender wage gap in the US declined considerably over this period. However, they also report that both the raw and the unexplained gender pay gap declined much more slowly at the top of the wage distribution."[6] They also review the literature on psychological attributes as explanations for the gender gap, concluding that "they account for a small to moderate portion of the gender pay gap, considerably smaller than say occupation and industry effects, though they appear to modestly contribute to these differences."[7]

Since differences in preferences for competition, risk aversion or bargaining ability appear only to have the potential to explain a part of the gender gap at the top, researchers have turned to the workplace and the interaction in the family to explain persistence of the gap. Goldin (2014) suggests and presents empirical support for the importance of specific occupational characteristics that make flexibility extremely costly in some occupations. The wage penalty for flexibility is likely to be high in jobs that require meeting deadlines, being in contact with others to perform the job, maintaining and establishing interpersonal relationships, adhering to preset schedules, and doing work for which other workers are not close substitutes. As women demand greater flexibility than men, this implies a wage disadvantage for women. Bertrand et al. (2010) examine careers of MBAs from a top US business school and find a gender gap in that women experience more career interruptions and fewer weekly hours worked. Flabbi and Moro (2012) estimate a search model and show estimation results that more than one-third of women assign a positive value to flexibility. Bøler et al. (2018) note that exporting firms may require greater flexibility from their employees regarding working time. They use Norwegian matched employer-employee data and find that a firm's entry into exporting increases the gender wage gap. Azmat and Ferrer (2017) find

[6] See Olivetti and Petrongolo (2016) for another overview of the gender gap literature.

[7] Card et al. (2016) show that women are less likely to work in high-paying jobs and that women receive a lower share of the surplus generated at the firm level, suggesting that women have weaker bargaining power. Reuben, Sapienza and Zingales (2022) study the effect of preferences for competition on the compensation of male and female MBAs at graduation and later in their careers, finding a correlation between preferences for competition and compensation but a limited role in explaining the gender gap.

evidence of a gender gap in the lower number of hours billed among female associate lawyers in the United States.

We make a theoretical contribution to the gender wage gap literature by proposing a female career model that enables us to show that if the career hurdle facing female workers—in terms of being able supply fewer hours at work or demanding more flexible work—is sufficiently high, female managers will earn less than male managers. To compensate for the lower wage, however, only more able women will find it worthwhile to pursue managerial careers. Therefore, female managers will on average, be more skilled than male managers, i.e., there will be a positive selection effect for female managers (we label this the *skill-biased glass ceiling effect*). Although being paid less (due to the hurdle), female managers will be more skilled (due to selection), and therefore, on average, manage firms better in response to increased product market competition (the *skill-biased competition effect*).

We also contribute empirically to the gender wage gap literature. Mulligan and Rubinstein (2008) find that selection into the female full-time full-year workforce shifted from negative in the 1970s to positive in the 1990s and that the majority of the narrowing of the gender wage gap reflects changes in female workforce composition. Olivetti and Petrolongo (2008) report that the gender wage gap is higher in countries with lower gender employment gaps and conclude that selection can explain a large share of the negative cross-country relationship between gender wage and employment gaps. Here, we use a novel strategy to identify positive selection of female managers. In direct comparisons between female and male managers, one cannot rule out the possibility that unobservables explain why women are paid less and less frequently hold top positions, even when researchers have access to very detailed data on individual and employer characteristics. Our empirical strategy instead builds on our theoretical prediction that if the female management career hurdle is sufficiently high, increased product market competition affects female managers' wages more positively than it affects male managers' wages. This prediction from the skill-biased competition effect is supported in our data. Our theory implies that the skill-biased glass-ceiling effect (the positive selection of female managers) serves as a necessary condition for the skill-biased competition effect (through which increased competition reduces the gender wage gap for managers). How do we know that there is positive selection of female managers in the data? In our empirical specification, we run separate log wage regressions for male and female workers augmented with individual-firm spell fixed effects. In our regressions for managers, we can use the estimated spell fixed effects as a proxy for manager-firm-specific skills. Exploring the distributions of the estimated spell fixed effects for male and female managers, we indeed find that the female distribution is heavily skewed to the right and statistically different from the male distribution at low and medium values. This is exactly what is predicted by the skill-biased glass ceiling effect, which tells us that low-skilled female managers will not pursue a managerial career if women face with a higher career hurdle than men.[8]

Our paper also contributes to the literature on discrimination, competition and welfare. In his pioneering theoretical contribution, Becker (1971) assumes that discriminatory employers may suffer disutility from employing women and shows that these employers pay lower wages to women than to men. Moreover, in a non-segregating equilibrium, all female workers receive a lower wage than men, regardless of whether they work for an employer with or without discriminatory preferences. Arrow (1973) shows that in equilibrium, non-discriminatory employers employ more women at below-productivity wages than their discriminatory counterparts and therefore gain a competitive advantage and that increased competition will force out discriminatory corporate owners. Black (1995) constructs a search model in which some employers have a distaste for hiring minority workers and shows that although only unprejudiced firms hire minority workers, minority workers receive lower wages than workers not facing discrimination. Profits are decreasing in discrimination levels, and thus, increased product market competition would force discriminators out of the market. Rosen (2003) develops a model with search frictions, wage bargaining and separation of ownership and management and shows that profits can be highest for firms with positive taste discrimination. Thus, wage differentials caused by employers having a taste for discrimination may not be eliminated through market forces.[9]

We contribute theoretically to the this literature by showing that increased product market competition can also reduce discriminatory outcomes in an environment where there is no outright discrimination—where it is instead the working environment with inflexible jobs that creates obstacles for women to pursue a career and reach the top-paying jobs. In fact, exits by discriminating firms or owners play no role whatsoever in our model: inflexibility in high-paying management jobs is not a bug in some firms—it is a feature in all firms. Nevertheless, we show that increased product market competition can still reduce the gender wage gap in top-wage career jobs and make female presence in top management jobs more common. The reason is yet again that increasing the intensity of product market competition in a setting with oligopolistic externalities makes it more costly to not give opportunities to high-skilled females to reach top positions. Moreover, our analysis indicates a market failure suggesting that too few talented women choose to become managers since talented women

[8]The findings in Gayle et al. (2012) are also consistent with our proposed skill-biased glass ceiling effect.They find that, controlling for executive rank and background, women earn higher compensation than men and are promoted more quickly.

[9]Holden and Rosen (2014) develop a search model with employment protection legislation and show that a discriminatory equilibrium may exist.

who choose not to invest in a managerial career do not internalize the positive externalities that their investment has on improved firm performance, which would have benefited both owners and consumers.

We also contribute empirically to this literature. Hsieh, Hurst, Jones, and Klenow (2019) use a Roy model to examine selection into occupations capturing discrimination as an occupation-specific wedge between wages and marginal products. Using the convergence in the occupational distribution between 1960 and 2010 in the US labour market, they estimate that between 20% and 40% of growth in aggregate market output per person can be explained by the improved allocation of talent. Black and Strahan (2001) examine the deregulation of the banking sector in the US and estimate that wage differentials between females and males decrease when competition increases. Black and Brainerd (2004) find that increased import competition increases the relative wages of females but only in industries with low competitive intensity. Heyman, Svaleryd and Vlachos (2013) find that the share of female workers increases after takeovers in industries in which the intensity of product market competition is low. We contribute to this literature by showing that more intense product market competition leads to relatively higher wages for female managers, but we find no effect of increased product market competition on wages for groups other than managers. We also find evidence that the positive selection of female managers with higher skills affects firms in the lower end of the productivity distribution, where firms with a higher share of female managers handle increased product market competition better in the lowest quantile of the productivity distribution. For firms in the highest quantile of the productivity distribution, we find no statistically significant relationship between the share of change in profit, share of female managers and increased product market competition.

3. Theory

In this section, we develop a theoretical model, in which (i) oligopolistic firms hire managers that can be female or male, (ii) females and males' management skills are drawn from the same skill distribution, and (iii) the inflexibility or hurdle associated with management jobs is more costly for females than for males. Consider a market served by a set of firms, $\mathcal{J} = \{1, ..., j, ..., n\}$. Firms hire unskilled workers for production. Production also requires the services of a manager. Initially, each firm has a *male* manager with low innate talent, $\theta = 0$. As illustrated in Figure 3.1, the following sequence of events then unfolds:

In stage 0, nature allocates to each firm a trainee who may later be offered the manager position, who then replaces the initial (male) manager. Trainees may be male or female. Denote by $\mathcal{M}$ and $\mathcal{F}$ the set of male and female trainees, respectively. A trainee has innate

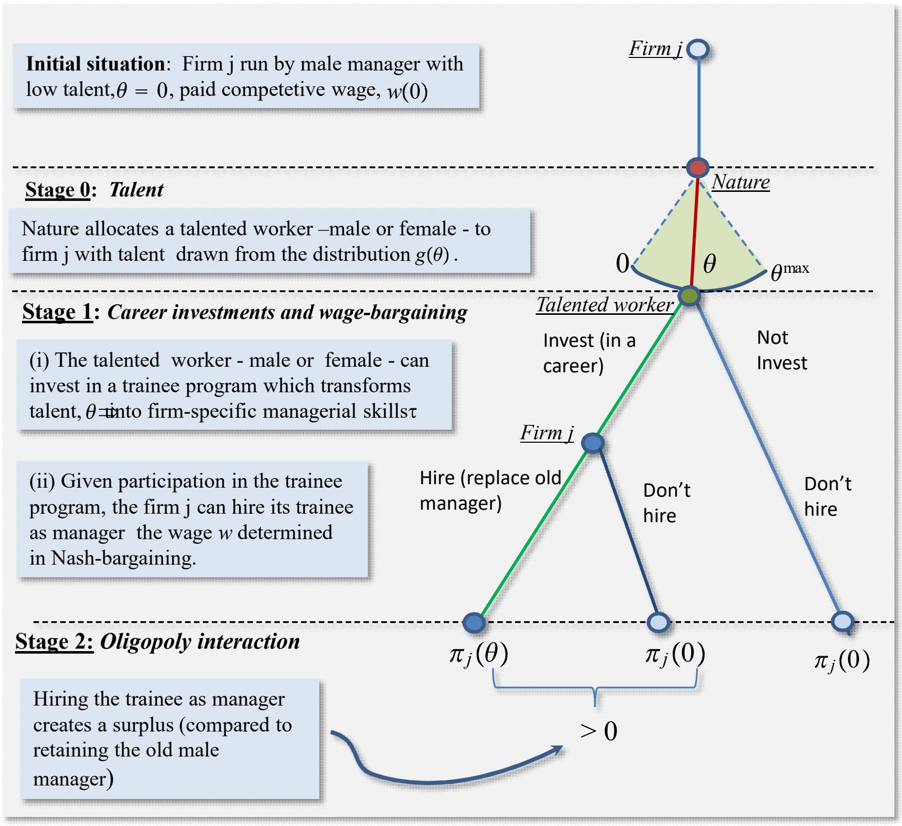

Figure 3.1: The sequence of events.

talent θ drawn from a distribution $g(\theta)$ over the interval $\theta \in [0, \theta^{\max}]$. The density function, $g(\theta)$, is identical for men and women.

In stage 1, the talent, θ, of each trainee is revealed. We will distinguish between talent (which we take to be innate) and firm-specific skills (which can be acquired). Each trainee can choose to invest in a trainee program to generate firm-specific managerial skills. For simplicity, the trainee program is associated with a fixed effort cost, I (arising from, for example, training, education, or overtime).

In stage 2, provided that the trainee has invested in firm-specific skills, each firm chooses whether to replace the old male manager with its now experienced and educated trainee. If a firm chooses to hire its trainee as the manager, wage negotiations take place according to a Nash bargaining protocol in a setting in which female managers face a hurdle associated with an exogenous fixed cost, D.

In stage 3, firms compete in an oligopolistic product market with an exogenous intensity of product market competition denoted C. We now solve the model by backward induction.

3.1. Stage 3: Product market

In the product market interaction, firm j chooses an action (a quantity or a price), $x_j \in R^+$, to maximize its direct product-market profit, $\pi_j(x_j, x_{-j} : \varphi_j)$, which depends on its own and its rivals' actions, x_j and x_{-j}, and the firm-specific skill of its manager, $\varphi_j = \varphi_j(\theta|Z)$. Thus, we let $\varphi_j(\theta|Z)$ be the firm-specific management skill of firm j's manager, where θ is the manager's innate talent, and $Z = \{0, I\}$ is an indicator for whether he – or she – has invested in the trainee program. The firm-specific management skill level of the manager in firm j, φ_j, equals zero if $Z = 0$ (i.e., if the potential trainee did not invest in managerial skills) or if $\theta = 0$ (i.e., the initial manager remains in charge). However, if the trainee has invested in the trainee program, the management skill level in firm j equals $\varphi_j(\theta|Z = I) = \theta$.

Each firm's specific management skill level is common knowledge. The vector $(\varphi_j, \varphi_{-j})$ captures the management skill levels at firm j and at firm j's rivals. We assume that there exists a unique Nash equilibrium in actions, $\mathbf{x}^*\left(\varphi_j, \varphi_{-j}\right)$, defined from

$$\pi_j(x_j^*, x_{-j}^* : \varphi_j) \geq \pi_j(x_j, x_{-j}^* : \varphi_j), \quad \forall x_j \in R^+. \tag{3.1}$$

We will assume that product market profits are always positive. Using expression (3.1), firm j's reduced-form profit is $\pi_j\left(\varphi_j, \varphi_{-j}\right) \equiv \pi_j(x_j^*\left(\varphi_j, \varphi_{-j}\right), x_{-j}^*(\varphi_j, \varphi_{-j}) : \varphi_j)$. We make the following assumption regarding reduced-form profits:

Assumption A1 *Firm j's reduced-form profit is increasing in its own manager's firm-specific skill* , $(\frac{\partial \pi_j\left(\varphi_j, \varphi_{-j}\right)}{\partial \varphi_j} > 0)$, *and decreasing in rival firms' management skill levels,*

$(\frac{\partial \pi_j(\varphi_j, \varphi_{-j})}{\partial \varphi_{-j}} < 0)$.

Recall that the firm-specific skills of firm j's manager, $\varphi_j = \varphi_j(\theta|Z)$, depend on his or her innate talent (θ) and his or her investment in managerial skills (Z). To simplify notation, we will write profits directly as functions of the manager's talent. The firm's profit then equals $\pi_j(\theta)$ if the manager has both high innate talent and has invested in the trainee program and $\pi_j(0)$ if the manager is either of low talent (the old manager) or did not invest in the trainee program. Intuitively, Assumption A1 then implies that firm j earns a *higher profit* if it employs a manager with *higher firm-specific managerial skills*: $\pi_j(\theta) > \pi_j(0)$. We may think of a more skillful manager reducing variable costs or increasing the quality of the firm's product by using better management practices, better motivating the workforce or establishing more efficient production. In standard oligopoly models, this will increase the profits of the own firm and decrease the profits of rival firms.

3.2. Stage 2: Wage setting and hiring decisions

In stage 2, conditional on having invested in firm-specific managerial skills, the trainee bargains with the firm over the wage for employment as the manager. If they agree on a wage that leaves both parties with a positive surplus, the trainee is hired. If no agreement can be reached, or if the trainee has not invested in managerial skills, the firm retains its current manager at wage $w(0)$.[10] The latter wage is a competitive wage determined in the economy-wide labor market. It is therefore also the outside option for the trainee.

3.2.1. Hiring a female skilled manager

If the trainee is a woman, the Nash bargaining product is

$$\max_{w_j}[\pi_j(\theta) - \alpha D - w_j - (\pi_j(0) - w(0))]^{1/2} \times [w_j - (1-\alpha)D - w(0)]^{1/2}, \ \theta \in \mathcal{F} \qquad (3.2)$$

where we assume equal bargaining power.

The wage negotiation in (3.2) takes into account that female managers face a hurdle. This is captured by a fixed hurdle cost, D. This capture the idea that there is an extra cost for females working as managers due to the requirement of inflexible working hours. Disutility may be due to a family situation in which women take greater responsibility for their family and children, resulting in a stressful situation when coping with overtime and

[10] If the trainee has not invested in managerial skills, the firm may also hire this worker at the same wage, $w(0)$.

greater responsibilities. It may also stem from the firm needing to pay the additional cost of finding substitute when the female manager is absent or from the firm forgoing sales that it might have been able to generate had the manager worked longer unconventional hours. We assume that the firm bears a fraction $\alpha \in (0, 1)$ of the hurdle cost, D. We assume that the female manager faces a cost from the hurdle that is the remaining fraction, $1 - \alpha \in (0, 1)$, of the fixed hurdle cost, D.

If an agreement is struck, firm j pays the female manager wage w_j and earns profit $\pi_j(\theta)$. Note that since firm j bears a cost from the hurdle, $\alpha D > 0$, it will never employ a female trainee who did not invest in obtaining firm-specific management skills. Thus, if no agreement is reached, the initial *male* manager with low talent remains at wage $w(0)$, in which case the firm earns profit $\pi_j(0)$. We further discuss the wage of the initial male manager below. The female trainee may work in the firm, or elsewhere, at the outside wage, $w(0)$.

To proceed, it is convenient to define $S_j(\theta)$ as the surplus created by a manager with firm-specific skills θ in a *benchmark without a hurdle*, $D = 0$:

$$S_j(\theta) = \tfrac{1}{2}\left[\pi_j(\theta)) - \pi_j(0)\right]. \tag{3.3}$$

Note that the surplus must be increasing in the firm-specific skills of the manager from Assumption 1, $S_j'(\theta) > 0$.

Solving the bargaining problem in (3.2), the negotiated wage for a hired *skilled female manager* is then

$$w_j^*(\theta \in \mathcal{F}) = w(0) + S_j(\theta) - \left(\tfrac{2\alpha-1}{2}\right) D \tag{3.4}$$

where the first term is the outside wage, the second term is her share of the increase in profits generated by improved management quality, and the third term reflects how the cost of the hurdle is shared between the firm and the female manager. Note that if the firm takes on a higher share of the costs of the hurdle, $\alpha > 1/2$, she will have to take a pay cut. If, by contrast, she is more adversely affected than the firm, $\alpha < 1/2$, the firm will need to compensate her for this disutility.

3.2.2. Hiring a male skilled manager

If the trainee is a male and has invested in firm-specific managerial skills, his negotiated wage if hired as the manager is simply

$$w_j^*(\theta \in \mathcal{M}) = w(0) + S_j(\theta), \tag{3.5}$$

since there is no hurdle for male managers, $D = 0$.

If no agreement is made, the initial male manager again remains in charge. Assuming that there are many male individuals of innate low ability, it is easy to verify that the wage negotiation between the firm and the old manager will then yield the outside wage, $w(0)$. The simple reason is that the old manager cannot create a surplus, i.e., $S_j(0) = 0$ from (3.3).

Using the negotiated wages in (3.4) and (3.5), we arrive at the following result.

Lemma 1. *Suppose that a trainee replaces the old male manager. If female managers face a hurdle, $D > 0$, and the larger share of the hurdle cost falls on the firm, $\alpha > 1/2$, a hired male manager earns more than a hired female manager with identical firm-specific skills, $w_j^*(\theta \in \mathcal{M}) > w_j^*(\theta \in \mathcal{F}) > w(0)$.*

3.3. Stage 1: Career decision

In stage 1, the trainee in each firm makes his or her career choice, i.e., he or she makes the decision of whether to invest in firm-specific managerial skills at cost I, internalizing that skilled managerial work will lead to a wage increase from $w(0)$ to $w_j^*(\theta|\theta \in h)$ for $h \in \{\mathcal{M}, \mathcal{F}\}$.

It follows that the trainee will choose the career path if the surplus generated from the Nash bargaining exceeds the investment cost, that is, if

$$\begin{cases} w_j^*(\theta \in \mathcal{F}) - (1-\alpha)D - w(0) > I, \\ w_j^*(\theta \in \mathcal{M}) - w(0) > I. \end{cases} \tag{3.6}$$

Using the negotiated wages (3.4) and (3.5) in (3.6) and replacing each inequality with an equality, we can obtain the critical level of innate talent necessary to make the costly investment in firm-specific skills for a career as a manager worthwhile:[11]

$$\begin{cases} S_j(\theta^{\mathcal{F}}) = I + \frac{D}{2}, \\ S_j(\theta^{\mathcal{M}}) = I. \end{cases} . \tag{3.7}$$

This leads to the following proposition:[12]

Proposition 1. *(The skill-biased glass ceiling effect) Suppose that female managers face a hurdle, $D > 0$. Then, in equilibrium, a female trainee will, all else being equal, need a higher*

[11] If firm j agrees to hire a female manager, the net surplus is $S_j(\theta) - \frac{D}{2}$, and thus, if a female talented worker invests in managerial skills, there will always be an agreement.

[12] Note that this result is independent of which of the parties bears the cost of the hurdle, i.e., independent of α. The reason is that the trainee will always obtain half of the surplus in the wage bargaining, and thus, the cost of the hurdle is always shared equally.

threshold level of talent than a male trainee to pursue a career as a manager (invest in the trainee program), $\theta^{\mathcal{F}} > \theta^{\mathcal{M}}$.

Equation 3.7 reveals that since female managers face the cost of the hurdle $(D/2)$, female trainees face a glass ceiling when pursuing a career as a manager. Female trainees will, in equilibrium, need to possess a higher minimum level of talent than male trainees to be hired as a manager, $\theta > \theta^{\mathcal{F}} > \theta^{\mathcal{M}}$. It is only when a woman has very high talent that the firm can compensate her through a high wage (generated by a higher surplus, $S_j(\theta)$). The result that female trainees need greater talent to invest in firm-specific skills and pursue managerial work will be referred to as the "*skill-biased glass ceiling effect*". The glass ceiling effect is illustrated in Figure 3.2(i). In the next section, we will explore how product market competition affects the glass ceiling.

3.4. Product market competition and managerial wages

We begin this section by introducing product market competition into the model. In the next section, we will show how variation in product market competition can be used to identify the female career hurdle in the data.

3.4.1. Intensity of product market competition

How does the intensity of product market competition affect the gender gap in the wages of managers?[13] Let C denote the intensity of product market competition in the industry in stage 3.[14] We may think of the intensity of product market competition being determined by nature in stage 0 and then being common knowledge for all players. Alternatively, we can assume that the agents form expectations over the level of product market competition in stage 3. In the latter case, nature would determine the amount of product market competition before the actual product market interaction in stage 3 but after the trainee has made his or her investment decision in stage 1 and the wage negotiations have taken place in stage 2.

The impact of the intensity of product market competition on a manager's wage, $w_j^*(\theta \in h)$, will depend on how the intensity of product market competition affects the surplus

[13] Several measures of the intensity of product market competition are used in the literature. Greater product market competition may come from having more firms in the market, reduced collusion, or import competition from firms that supply goods or services at lower wage costs. Greater product market competition may also stem from reduced product differentiation. Here, we do not specify the source of the variation in product market competition but instead model the impact of competition on the reduced profit function.

[14] The intensity of product market competition can be thought to be determined in stage 0, before the career choice in stage 1, the subsequent wage negotiation in stage 2 and the product market interaction in stage 3.

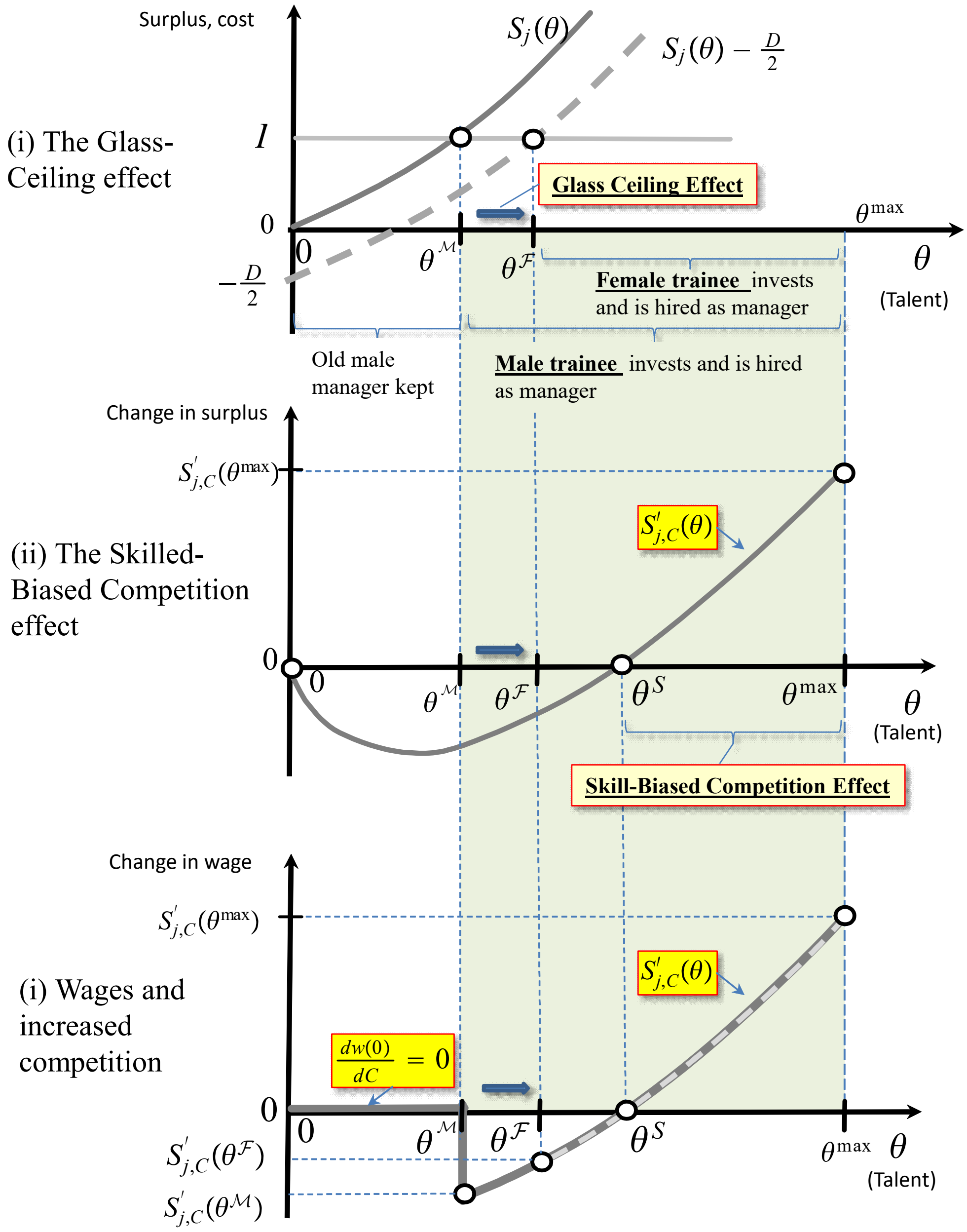

Figure 3.2: Investing in firm-specific skills: the Glass-Ceiling Effect and the Skill-Biased Competition effect.

created by the manager, $S_j(\theta)$. From (3.3), this will, in turn, depend on how the intensity of product market competition, C, affects a firm's profits, $\pi_j(\theta)$. We will make the following assumption, which builds on the work in Boone (2008a,b) and Norbäck and Persson (2012).

Assumption A2: *A firm with a manager that has a sufficiently high firm-specific skill can mitigate the negative impact of stronger product market competition on the firm's profits: (i) There exists a unique* $\delta \in (0, \theta^{\max})$ *such that* $\frac{d}{d\theta}\left(\frac{d\pi_j(\theta)}{dC}\right) < 0$ for $\theta < \delta$ *and* $\frac{d}{d\theta}\left(\frac{d\pi_j(\theta)}{dC}\right) > 0$ for $\theta > \delta$*, and (ii)* $\frac{d\pi_j(\theta^{\max})}{dC} > \frac{d\pi_j(0)}{dC} < 0$.

The first part of Assumption A2 captures the notion that if a firm has a manager with sufficiently strong firm-specific managerial skills, he or she can dampen the negative impact of increased competition on the firm's profits compared to the *benchmark* case in which the firm retains its initial manager with weak managerial skills. Conversely, with weaker firm-specific skills, stronger competition leads to a reduction in the surplus, that is, product market profits under a manager with low firm-specific skills will decline more in competition than in the benchmark case with the initial manager. We may think of a skilled manager reducing costs or creating a more innovative organization. Norbäck and Persson (2012) provide an extensive analysis of the circumstances under which Assumption A2 hold in a model in which cost-reducing innovations and product market competition affect product market profits.

Using equation (3.3) and Assumption A2, we can derive the following Lemma.

Lemma 2. *Suppose that Assumption A2 holds. Then, there exists a unique firm-specific skill level of the manager,* $\theta^S \in (0, \theta^{\max})$*, such that (i)* $S'_{j,C}(\theta^S) = S'_{j,C}(0) = 0$*, (ii)* $S'_{j,C}(\theta) < 0$ *for* $\theta \in (0, \theta^S)$ *and* $S'_{j,C}(\theta) > 0$ *for* $\theta \in (\theta^S, \theta^{\max}]$.

Lemma 2 is illustrated in Figure 3.2(ii). Note that the change in the surplus from increased competition, $S'_{j,C}(\theta)$, is a strictly convex function in the talent of the manager, θ. Importantly, the surplus first declines in competition, $S'_{j,C}(\theta) < 0$, when the manager lacks sufficient talent ($\theta < \theta^S$). The direct effect of stronger competition then dominates any strategic effects, $S'_{j,C}(\theta) = \frac{d\pi_j(\theta)}{dC} - \frac{d\pi_j(0)}{dC} < 0$. However, when the manager has a sufficiently high talent ($\theta > \theta^S$), the surplus created is increasing in competition, $S'_{j,C}(\theta) = \frac{d\pi_j(\theta)}{dC} - \frac{d\pi_j(0)}{dC} > 0$. Profits then decline less from stronger competition with a highly skilled manager (or may even increase) than without him or her, as a highly talented manager endowed with strong firm-specific skills gives the firm an advantage over its competitors.[15] We will label

[15] Typically, the impact of competition on a firm's profit can decomposed into a direct effect and a strategic effect. The direct effect is negative and stems from a reduction in the product market price. Since a firm

this result, whereby the surplus increases in competition when the manager has sufficiently strong firm-specific skills, the *skill-biased competition effect.*

We can now combine the *glass ceiling effect* associated with Proposition 1 and the *skill-biased competition effect* in Lemma 2 to determine how managers' wages react to increasing competition. For illustrative purposes, suppose that $\theta^{\mathcal{F}} < \theta^{S}$ holds. As a benchmark, start with the case in which the firm has a male manager. From (3.5), when varying the level of his innate ability, competition then has the following effect on the manager's wage:

$$\frac{dw_j(\theta \in \mathcal{M})}{dC} = \begin{cases} \frac{dw(0)}{dC} = 0, \;\; \theta \in [0, \theta^{\mathcal{M}}), \\ S'_{j,C}(\theta) < 0, \;\; \theta \in [\theta^{\mathcal{M}}, \theta^{S}), \\ S'_{j,C}(\theta) = 0, \;\; \theta = \theta^{S}, \\ S'_{j,C}(\theta) > 0, \theta \in (\theta^{\mathcal{M}}, \theta^{\max}]. \end{cases} \tag{3.8}$$

Expression (3.8) is illustrated in Figure 3.2(i): A male trainee will only find it worthwhile to invest in firm-specific managerial skills if his innate talent exceeds $\theta^{\mathcal{M}}$. In the region $\theta \in [0, \theta^{\mathcal{M}})$, he will not invest in firm-specific skills, and the firm will retain the initial male manager with low firm-specific skills, $\theta = 0$. The (initial male) manager is then simply paid the outside general equilibrium wage, $w(0)$, which – by definition – is independent of the level of competition in a particular industry. Thus, whenever firm j has a trainee with low innate ability, $\theta \in [0, \theta^{\mathcal{M}})$, the managerial wage will not be affected by competition, $\frac{dw(0)}{dC} = 0$.[16]

However, the male trainee will invest in firm-specific managerial skills when his innate talent exceeds $\theta^{\mathcal{M}}$. If his innate ability is still below the threshold θ^{S}, his acquired firm-specific skills will not be sufficient to take advantage of increasing competition, and his wage will decline in competition, $\frac{dw_j(\theta \in \mathcal{M})}{dC} = S'_{j,C}(\theta) < 0$. In contrast, when his innate talent is above θ^{S}, the trainee program provides him with strong firm-specific skills. As this gives the firm a strong advantage over its rivals, the surplus is now increasing in competition, and subsequently, his wage will be increasing in competition, $\frac{dw_j(\theta \in \mathcal{M})}{dC} = S'_{j,C}(\theta) > 0$.

The impact of competition on a female manager's wage is very similar but exhibits an important difference: The hurdle cost and the *glass ceiling effect* imply that a firm will not

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that has a more skilled manager will sell and produce more, this negative direct effect is more detrimental for a larger firm. However, the strategic effect is typically positive: When the manager has strong firm-specific skills, the firm obtains a relative advantage over its weaker competitors. These effects are analyzed in detail in Norbäck and Persson (2012).

[16] Again, since there are many such potential managers available in the economy, no surplus is created, $S_j(0) = 0$.

hire female managers of low innate talent, $\theta < \theta^{\mathcal{F}}$. Therefore,

$$\frac{dw_j(\theta \in \mathcal{F})}{dC} = \begin{cases} S^{'}_{j,C}(\theta) < 0, \;\; \theta \in [\theta^{\mathcal{F}}, \theta^{S}), \\ S^{'}_{j,C}(\theta) = 0, \;\; \theta = \theta^{S}, \\ S^{'}_{j,C}(\theta) > 0, \theta \in (\theta^{\mathcal{F}}, \theta^{\max}]. \end{cases} \tag{3.9}$$

3.5. The female career hurdle, expected wages and product market competition

Let us now make predictions on how competition affects managerial wages and, in particular, whether the impact of competition on the managerial wage differs between male and female managers. When taking these predictions to the data, we will need to take into account that in the empirical analysis, we will not have perfect information on managers' firm-specific skills or knowledge (generated, for example, by their innate talent, trainee programs and education). We will instead make use of the distribution of innate talent, $g(\theta)$, and derive our predictions in terms of expected changes in managerial wages from stronger competition.

3.5.1. The intensive margin

Suppose that we take the trainee's investment choice in stage 1 as given, treating the cutoffs $\theta^{\mathcal{F}}$ and $\theta^{\mathcal{M}}$ as fixed, and vary the actual product market competition in stage 3. How does this affect the managerial wage? As we will show below, this will correspond to the estimates in a wage regression in which we apply worker-firm *spell fixed effects*, i.e., we examine the impact over time of competition on managers who stay with the same firm. As noted above, treating the cutoffs $\theta^{\mathcal{F}}$ and $\theta^{\mathcal{M}}$ as fixed can also be thought of as the trainees making their investment decision based their expected level of future competition.

To proceed, let $\mathbb{E}[w_j^*|\theta \in \mathcal{M}]$ be the expected wage of a male manager in firm j, and let $\mathbb{E}[w_j^*|\theta \in \mathcal{F}]$ be the expected wage in firm j if it has a female manager. Using Proposition 1, and Equations 3.4 and 3.5, we have

$$\mathbb{E}[w_j^*|\theta \;\; \in \;\; \mathcal{F}] = w(0) - (2\alpha - 1)\frac{D}{2} + \int_{\theta^{\mathcal{F}}}^{\theta^{\max}} S_j(\theta)g(\theta|\theta \in \mathcal{F})d\theta, \tag{3.10}$$

$$\mathbb{E}[w_j^*|\theta \;\; \in \;\; \mathcal{M}] = w(0) + \int_{\theta^{\mathcal{M}}}^{\theta^{\max}} S_j(\theta)g(\theta)d\theta. \tag{3.11}$$

Note that while a male manager can have any innate ability $\theta \in [0, \theta^{\max}]$ and hence be represented by the density $g(\theta)$ over its full support, female managers can only be present in the interval $\theta \in [\theta^{\mathcal{F}}, \theta^{\max}]$, as they are subject to discrimination. Hence, we use a truncated density, $g(\theta|\theta \in \mathcal{F})$, for female managers in (3.10), i.e.,[17]

$$g(\theta|\theta \in \mathcal{F}) = \frac{g(\theta)}{1 - G(\theta^{\mathcal{F}})} > g(\theta), \text{ for } \theta \in [0^{\mathcal{F}}, \theta^{\max}]. \tag{3.12}$$

We can then state our main proposition in this paper:

Proposition 2. *If the hurdle cost is substantial, i.e., if D is sufficiently large, stronger product market competition, C, will*

(i) *increase the expected wage for a female manager,* $\frac{d\mathbb{E}[w_j^*|\theta \in \mathcal{F})]}{dC} > 0$,

(ii) *decrease gender wage-gap for managers,* $\frac{d\mathbb{E}[w_j^*|\theta \in \mathcal{F})]}{dC} - \frac{d\mathbb{E}[w_j^*|\theta \in \mathcal{M}]}{dC} > 0$*, and,*

(iii) *have an ambiguous effect on the expected wage of a male manager,* $\frac{d\mathbb{E}[w_j^*|\theta \in \mathcal{M}]}{dC} \lesseqgtr 0$.

This proposition shows that when female managers face a substantial hurdle, increasing competition will increase the expected wage of a female manager relative to that of a male manager. The intuition stems directly from the *glass ceiling effect*, which forces female managers to possess significantly higher firm-specific skills than male managers. However, then female managers are also more likely to reap the benefits from the *skill-biased competition effect*, which states that it is only the most skilled managers who benefit from competition in terms of a rising wage. Below, we provide a detailed proof of the proposition before turning to testing it in the data.

Male managers Start with the expected wage of a male manager. Combining (3.8) and (3.11), the expected change in the wage of a *male manager* from increasing competition is

$$\frac{d\mathbb{E}[w_j^*|\theta \in \mathcal{M}]}{dC} = \int_{\theta^{\mathcal{M}}}^{\theta^S} \underset{(-)}{S'_{j,C}(\theta)} g(\theta) d\theta + \int_{\theta^S}^{\theta^{\max}} \underset{(+)}{S'_{j,C}(\theta)} g(\theta) d\theta. \tag{3.13}$$

The intuition behind (3.13) is shown in Figure 3.3. Figure 3.3(i) depicts the investment decision for the trainee (male or female). Figure 3.3(ii) depicts the density, $g(\theta)$, by which

[17] This truncated distribution is also shown in Figure 3.3(ii) below. Consider the cutoff for female trainees, $\theta^{\mathcal{F}}$, in Figure 3.3(ii). Label the area under density $g(\theta)$ to the left of $\theta^{\mathcal{F}}$ as "A" and the area under density $g(\theta)$ to the right of $\theta^{\mathcal{F}}$ as "B". For $g(\theta)$ to be a probability distribution, areas A and B must sum to unity. Since female trainees cannot be managers unless their innate talent is at least $\theta^{\mathcal{F}}$, area A is not feasible for female managers. For the truncated distribution $g(\theta|\theta \in \mathcal{F})$ to be a probability distribution, we need to multiply $g(\theta)$ by $1/\left(1 - G(\theta^{\mathcal{F}})\right) > 1$, where $g(\theta|\theta \in \mathcal{F})$ is only feasible in the region $\theta \in [0^{\mathcal{F}}, \theta^{\max}]$. In essence, this procedure "adds" area A "on top" of area B.

the change in wage for each innate talent type, θ, is weighted in the integral (3.13). Figure 3.3(iii) depicts the change in the weighted managerial wage, $S'_{j,C}(\theta)g(\theta)$.

Again, for all realizations of innate talent below threshold $\theta^{\mathcal{M}}$, the trainee does not invest in firm-specific skills. The firm retains the old male manager who is paid the outside wage, which is not affected by competition. From Figure 3.2(iii), we know that if the trainee invests in firm-specific skills, while the skills he brings to the firm are below threshold θ^{S}, the surplus – and, hence, his wage – declines in competition, $S'_{j,C}(\theta) < 0$. Male managers of medium innate talent therefore see their wages declining in competition. However, when we are above threshold θ^{S}, the surplus is increasing in competition, $S'_{j,C}(\theta) > 0$, thereby increasing the wage of male managers with high innate talent.

Female managers Combining (3.9) and (3.10), the expected change in the wage of a *female manager* from increasing competition is

$$\frac{d\mathbb{E}[w_j^*|\theta\in\mathcal{F})]}{dC} = \int_{\theta^{\mathcal{F}}}^{\theta^{S}} \underset{(-)}{S'_{j,C}(\theta)}g(\theta|\theta\in\mathcal{F})d\theta + \int_{\theta^{S}}^{\theta^{\max}} \underset{(+)}{S'_{j,C}(\theta)}g(\theta|\theta\in\mathcal{F})d\theta. \tag{3.14}$$

The expression (3.14) is deceivingly similar to that for male managers in (3.13). However, note that the *glass ceiling effect* implies that *female trainees need higher innate talent than male trainees* to invest in firm-specific skills, $\theta^{\mathcal{F}} > \theta^{\mathcal{M}}$. This is key to understanding how increased competition will tend to reduce the wage gap between male and female managers.

Suppose that the female job inflexibility hurdle implies that female managers, on average, earn less than male managers, $\mathbb{E}[w_j^*|\theta\in\mathcal{F})] - \mathbb{E}[w_j^*|\theta\in\mathcal{M})] < 0$.[18],[19] We can then use (3.13) and (3.14) to calculate the impact of stronger competition on the wage gap between female

[18] I.e., let $D > 0$, and assume that a larger share of the discrimination cost falls on the female manager, $\alpha > 1/2$, such that female managers, conditional on firm-specific managerial skills, earn less, $w_j(\theta\in\mathcal{F}) < w_j(\theta\in\mathcal{M})$.

[19] As we show, truncation effects may imply that the average female manager earns more than the average male manager. The data in the next section show, however, that this is not the case.

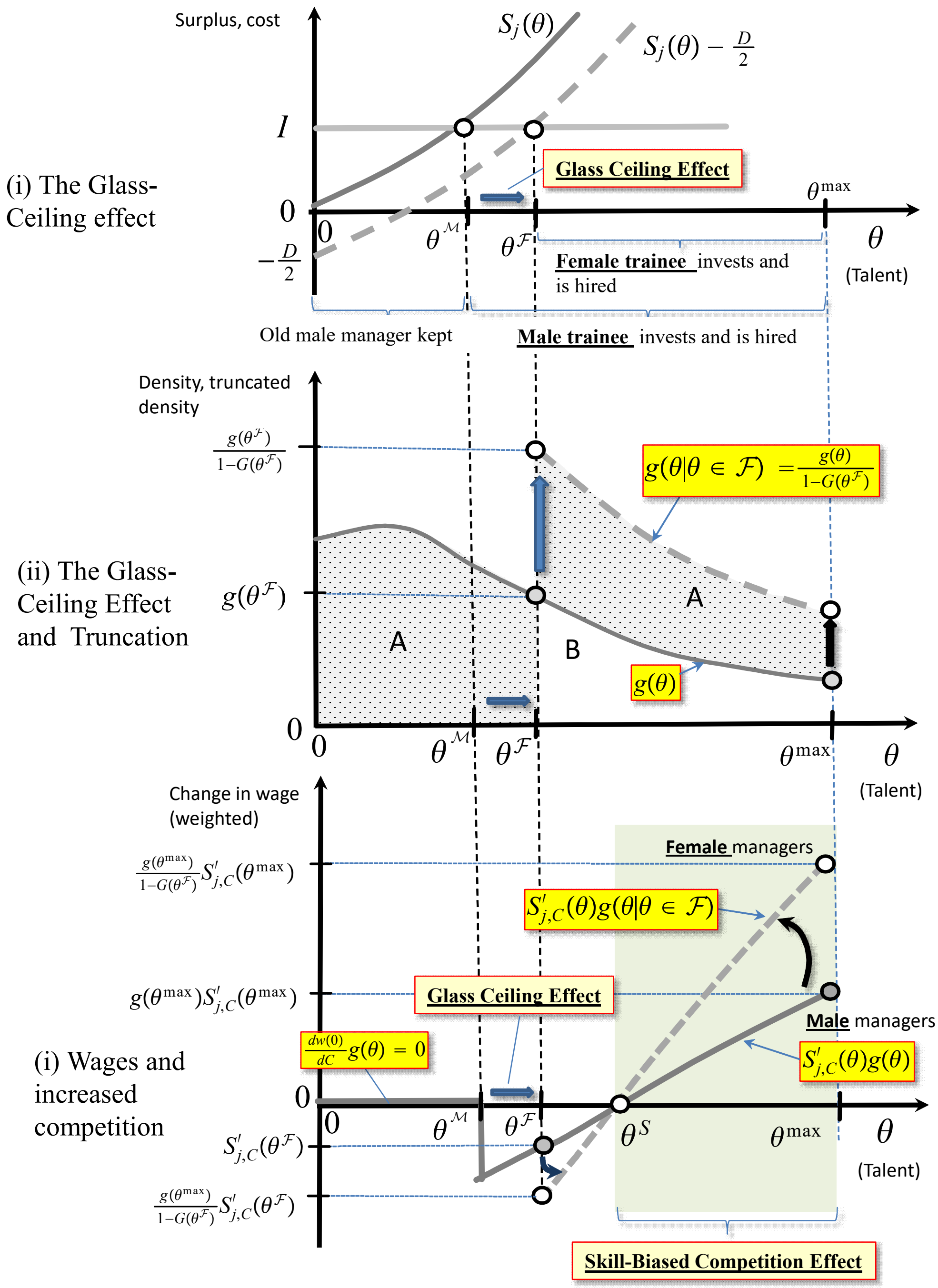

Figure 3.3: Illustrating how the Glass-Ceiling Effect and the Skill-Biased Competition Effect combine to cause increased product market competition to have different impacts on the expected wage of female and male managers.

and male managers:

$$
\begin{aligned}
\frac{d\left(\mathbb{E}[w_j^*|\theta\in\mathcal{F})]-\mathbb{E}[w_j^*|\theta\in\mathcal{M})]\right)}{dC} &= -\int_{\theta^{\mathcal{M}}}^{\theta^{\mathcal{F}}} \underset{(-)}{S'_{j,C}(\theta)} g(\theta)d\theta \\
&\quad + \int_{\theta^{\mathcal{F}}}^{\theta^{S}} \underset{(-)}{S'_{j,C}(\theta)} \underbrace{[g(\theta|\theta\in\mathcal{F})-g(\theta)]}_{(+)} d\theta \\
&\quad + \int_{\theta^{S}}^{\theta^{\max}} \underset{\text{Skill-biased comp}}{\underset{(+)}{S'_{j,C}(\theta)}} \underbrace{[g(\theta|\theta\in\mathcal{F})-g(\theta)]}_{\substack{(+)\\ \text{Glass ceiling}}} d\theta. \qquad (3.15)
\end{aligned}
$$

Since male trainees face no hurdle, they require a lower critical innate talent to invest in firm-specific managerial skills than do female trainees, $\theta^{\mathcal{M}} < \theta^{F}$. Furthermore, since increased competition leads to a lower surplus, $S'_{j,C}(\theta) < 0$, for wages in the interval $\theta \in \left[\theta^{\mathcal{M}}, \theta^{F}\right]$, the wage of male managers declines in this region. Hence, the expected wage difference between female and male managers must also decline. This is shown by the first line in (3.15) and illustrated in Figure 3.3(iii).

The last line in (3.15) also contributes to a decline in wage discrimination: When the manager has strong firm-specific skills, $\theta > \theta^{S}$, the skill-biased competition effect contributes to generating a larger surplus, $S'_{j,C}(\theta) > 0$, and the wage of a manager increases. In the last line of (3.15), we see that this skill-biased competition effect is amplified by the glass ceiling effect for female managers, as the truncated talent distribution in (3.12) assigns a larger weight to female managers in this region, $g(\theta|\theta \in \mathcal{F}) > g(\theta)$. This is also shown in Figure 3.3(iii), where the locus of the weighted change in wage for a female manager, $S'_{j,C}(\theta)g(\theta|\theta \in \mathcal{F})$, twists counter-clockwise around θ^{S}, making the density-weighted increase in wage larger for females, $S'_{j,C}(\theta)\,[g(\theta|\theta \in \mathcal{F}) - g(\theta)] > 0$.

Turning to the middle line in (3.15), truncation finally gives a higher weight to the reduction in wages for female managers when the skill-biased competition effect is negative, $S'_{j,C}(\theta) < 0$. This effect, which is shown in Figure 3.3(iii) for the interval $\theta \in [\theta^{F}, \theta^{S})$, introduces ambiguity in the sign of (3.15).

Let us now turn to the main claim of the proposition: Under sufficiently high female job inflexibility hurdles, stronger product market competition must lead to a decline in the wage gap between male and female managers. To see this, note that if we increase the hurdle cost, D, it is clear from Figure 3.3(i) that female trainees will need to possess greater innate talent to invest in firm-specific skills (i.e., shifting down the locus $S_j(\theta) - D/2$, not shown in Figure 3.3(i)). Formally, differentiating the upper line in (3.7), we obtain

$$\frac{d\theta^{\mathcal{F}}}{dD} = \frac{1}{\underset{(+)}{2S'_{j,\theta}(\theta)}} > 0 = \frac{d\theta^S}{dD}, \tag{3.16}$$

where the latter equality follows from the fact that the cutoff θ^S is independent of the cost of the hurdle.

Thus, when shifting the cutoff $\theta^{\mathcal{F}}$ toward θ^S in Figure 3.3(iii), fewer and fewer female managers are subject to a negative skill-biased competition effect, $S'_{j,\theta}(\theta) < 0$. A higher hurdle will eventually eliminate the middle line in (3.15), such that the wage gap – as measured by the difference in expected wage between male and female managers, $\mathbb{E}[w_j^*|\theta \in \mathcal{F})] - \mathbb{E}[w_j^*|\theta \in \mathcal{M})]$ – must unambiguously decrease in competition, i.e., $\frac{d\left(\mathbb{E}[w_j^*|\theta\in\mathcal{F})]-\mathbb{E}[w_j^*|\theta\in\mathcal{M})]\right)}{dC} > 0$. Note that this effect results from the fact that a female manager's expected wage will unambiguously increase in competition due to (3.14), as a higher hurdle eliminates the first term as $\theta^{\mathcal{F}}$ moves toward θ^S. Since male managers face no hurdle, the impact of stronger competition on the wage of male managers in (3.15) remains ambiguous.[20]

3.5.2. The extensive margin

Proposition 2 shows that the female job inflexibility hurdle may lead female managers' wages to increase relative to those of male managers under increasing competition. This suggests that stronger competition should also make women more likely to choose the career path and pursue managerial work.

We have the following proposition:

Proposition 3. *If the female career hurdle is sufficiently high, i.e., if D is sufficiently high, an increase in the level of product market competition ,C, will increase the probability that a firm has a female manager.*

To derive this result, we assume that a share $\phi_{\mathcal{F}}$ of all firms are endowed with a female trainee, whereas a share $1-\phi_{\mathcal{F}}$ are endowed with a male trainee. Then, the probability that a firm will have a female manager is simply the cumulative probability that female trainees invest in firm-specific skills times the share of firms endowed with female trainees:

$$\text{Prob}_j[\theta \in \mathcal{F}] = [1-G(\theta^{\mathcal{F}})] \times \phi_{\mathcal{F}}. \tag{3.17}$$

[20] If the investment cost, I, declines, while the hurdle cost, D, increases, so as to reduce the threshold $\theta^{\mathcal{M}}$ at an unchanged threshold $\theta^{\mathcal{F}}$, the region where a male manager's wage is unaffected by competition shrinks. This would increase the first term in (3.15) and strengthen our result that the wage gap declines in competition.

Differentiating (3.17) with respect to competition (or the expected competition that trainees, in stage 1, perceive to be present in stage 3), we then have

$$\frac{d\text{Prob}_j[\theta \in \mathcal{F}]}{dC} = -\phi_{\mathcal{F}} \times g(\theta^{\mathcal{F}}) \times \tfrac{d\theta^{\mathcal{F}}}{dC}. \tag{3.18}$$

We can now sign the change in the cutoff $\theta^{\mathcal{F}}$ by differentiating the upper line of (3.7) with respect to the intensity of competition, C, and talent, θ,

$$\tfrac{d\theta^{\mathcal{F}}}{dC} = -\tfrac{S'_{j,C}(\theta)}{\underset{(+)}{S'_{j,\theta}(\theta)}}. \tag{3.19}$$

From Lemma 2, we have that the surplus increases in competition if the manager has sufficiently high firm-specific skills, $S'_{j,C}(\theta) > 0$ if $\theta > \theta^S$. From (3.16), we know that the minimum talent necessary to make an investment in firm-specific skills worthwhile for female trainees increases in the hurdle cost, $\frac{d\theta^{\mathcal{F}}}{dD} > 0$. Thus, if the hurdle is sufficiently high, such that $\theta^{\mathcal{F}} > \theta^S$ holds, the probability that a firm has a female manager increases in competition, $\frac{d\text{Prob}_j[\theta \in \mathcal{F}]}{dC} > 0$.[21]

3.6. Extensions of the theoretical analysis

Proposition 2 shows that female managers' wages, on average, may increase when product market competition increases, whereas male managers' wages, on average, may be unaffected by product market competition. This asymmetry is explained by female managers facing a higher career hurdle. As shown in Proposition 1, the *glass ceiling effect* forces female managers to possess significantly higher firm-specific skills than male managers. From this positive selection, female managers are then also more likely to reap the benefits from the *skill-biased competition effect*, since only the most skilled managers benefit from competition in the form of an increased wage. In in the online Appendix (A.5.), we show that these results remain valid in a number of extensions of the benchmark model: *generalized bargaining*, *preference-based discrimination*, convex wage payments or *greedy work* (where women are restricted from making the most of their skills by working fewer hours), *competition over talent between firms*, *competition between talent within firms*, and allowing for *different ability distributions* between men and women. These exercises also give rise to new theoretical results. We now turn to the empirical analysis.

[21] Note, however, that if $\theta^{\mathcal{M}} < \theta^{\mathcal{F}} < \theta^S$, we could actually find that female participation as managers declines in competition since the marginal female trainee's relative wage compensation is declining in competition.

4. Empirical Analysis

We now turn to the empirical analysis. In Section 4.1, we discuss the gender wage gap in Swedish linked employer-employee data, leaving more detailed analysis to the online appendix. We docucment that the gender wage gap is higher in managerial positions, with the largest gender wage gap in top management. In Section 4.2, we explore whether the mechanism proposed in our theoretical model—where inflexible work, family concerns and cultural traits create a higher female career hurdle—can explain this pattern and whether stronger product market competition can reduce the gender wage gap and the gender career gap. We show that the female career hurdle can indirectly be identified from combined evidence for the skill-biased glass ceiling effect and the skill-biased competition effect. Section 4.3.1 presents the empirical evidence on the skill-biased glass ceiling effect, and Section 4.3.2 presents the empirical results on the skill-biased competition effect.

4.1. Data

We use detailed, register-based, matched employer-employee data from Statistics Sweden (SCB). The database comprises firm, plant and individual data, which are linked with unique identification numbers and cover the period from 1996 to 2009. The firm data contain detailed information on all Swedish firms, including variables such as value added, capital stock (book value), number of employees, wages, ownership status, sales, and industry. Moreover, the Regional Labor Market Statistics (RAMS) provide plant-level information on education and demographics, which we aggregate to the firm level.[22] The data on individuals originate from Sweden's official wage statistics and contain detailed information on a representative sample of the labor force, including full-time equivalent wages, education, occupation, and gender. All data sets are matched by unique identification codes. To make the sample of firms consistent across the time periods, we restrict our analysis to firms with at least 20 employees in the non-agricultural private sector, which are available throughout the period. Table 1 gives basic descriptives of the data. The online appendix (Section A.2) provides more details about the data and includes some basic regression analysis that we summarize below.

Table 1

The Swedish data share the same characteristics and trends found in many other developed countries. Approximately one-third of the workers are females, with the share of women slight increasing women over the period (see Table 1). The share of women with high

[22] RAMS include data on all Swedish plants.

education is higher than the total share of highly educated workers. The share of women with higher education also increases significantly over the period, from approximately 29 percent in 1996 to approximately 42 percent in 2009. The share of female managers shows a distinct increase: During the period 1996–2002, the average share of female managers was 16 percent. By the later period, 2003–2009, this share had increased to 21 percent. Nevertheless, the share of female managers remained considerably below the total share of women, 34 percent, in the latter period. Moreover, only 13 percent of the firms had a female CEO during this period. Turning to the gender wage gap, the online appendix shows that the average male worker had an approximately 16 per cent higher wage than his female counterpart during 1996–2002. For CEOs the gender wage gap is approximately 45%. When estimating individual wage regressions, controlling for a large number of individual, firm and industry characteristics for different occupations, we still find large and significant estimated gender wage gaps ranging from about 10 % for non-managers to about 21 % for CEOs.

4.2. Empirical specification

The underrepresentation of females combined with a higher gender wage gap in managerial positions, particularly in top management positions, are consistent with our theoretical predictions emerging from the presence a female career hurdle.[23] To find evidence for this hurdle, however, we need to seek evidence for the specific economic mechanisms emerging from our theory: *the skill-biased glass ceiling effect* and the *skill-biased competition effect.*

To this end, we will estimate individual wage regressions separately for female and male workers. We will run the following regressions on female and male workers' wages that explicitly control for characteristics that are common to the worker and the firm:

$$\log w_{ijt}(i \in \mathcal{F}) = \alpha + \beta_{\mathcal{F}} C_{rt} + \varsigma_{ij} + \varsigma_t + \varkappa Experience_{it}^2 + \mathbf{X}'_{jt}\boldsymbol{\lambda} + \varepsilon_{ijt}, \qquad (4.1)$$

$$\log w_{ijt}(i \in \mathcal{M}) = \alpha + \beta_{\mathcal{M}} C_{rt} + \varsigma_{ij} + \varsigma_t + \varkappa Experience_{it}^2 + \mathbf{X}'_{jt}\boldsymbol{\lambda} + \varepsilon_{ijt}, \qquad (4.2)$$

where $\log w_{ijt}(i \in \mathcal{F})$ is the log monthly wage of a female worker i in firm j in year t and $\log w_{ijt}(i \in \mathcal{M})$ is the corresponding log monthly wage of a male worker. Both equations include a vector, $\mathbf{X}_{jt}$, of time-varying firm characteristics as controls, such as firm size, capital intensity, and the share of skilled workers. We also control for (squared) worker experience and add a time-specific effect, ς_t.[24]

[23] In the model, we assume that the gender wage gap is zero in the competitive labor market, that is, that there is no difference in the outside wage for men and women. We can also introduce a gender pay gap in the outside wage and show that this would not qualitatively change our main results in terms of a higher female career hurdle causing the skill-biased glass-ceiling effect and the skill-biased competition effect.

[24] Note that education is essentially time invariant and is therefore subsumed in the worker-firm fixed

To explore *the skill-biased glass-ceiling effect* in the data, we will investigate the "spell" fixed effects, ς_{ij}, which control for both unobserved individual- and firm-specific factors. We are thus following a worker employed at the same firm over time in (4.1) and (4.2). Importantly, since the spell fixed effect is a time-invariant unobservable component of each unique employer-employee combination, this allows us to obtain a measure of individual firm-specific skills or talents, i.e., the firm-specific skills θ in the theory. We will then study the distributions of the estimates of these spell fixed effects to make inference about the skill-biased glass-ceiling effect.

To explore the skill-biased competition effect, we will compare estimates of how male- and female wages are affected by product market competition. We apply two different measures of the level of product market competition in industry r at time t (i.e., industry r at time t in which firm i is active), C_{rt}. Our primary measure is the sensitivity of profits to increasing costs, which Jan Boone proposed (see Boone, 2008a,b).[25] The main idea behind his measure is that intense competition will enable efficient firms to earn relatively higher profits than their less efficient competitors (consistent with Assumption 2 in our theoretical model). Therefore, in a highly competitive market, the elasticity of profits with respect to costs will be higher (for an elaborate discussion, see OECD, 2021).

Boone's profit elasticity is estimated in each industry r and year t from the following firm-level regression:

$$\log(\pi_{jt}) = \mu_j + \mu_t + C_{rt} \times \log(AVC_{jt}) + \varepsilon_{jt}, \tag{4.3}$$

where π_{jt} is the profit of firm j in industry r in year t. Profits are measured as the log of value added net of the firm's wage bill. Ideally, we would use the log of a firm's marginal cost as a regressor to obtain the profit elasticity with respect to costs, C_{rt}. However, due to the problem of isolating marginal costs in accounting data, we will need to use average variable cost (measured as a firm's total wage bill plus the cost of materials as a share of total sales). We also control for unobserved heterogeneity by adding firm-specific effects, μ_j, and time-specific effects, μ_t. A higher estimated elasticity (higher absolute value), C_{rt}, indicates that the industry is characterized by a higher degree of competition. Thus, the source of variation in the intensity of product market competition stems from yearly changes in how

effects. Experience is constructed as age minus the number of years of schooling minus seven. Because the years of schooling rarely change in the sample, when both spell and year fixed effects are included, experience varies directly with the year fixed effects, that is, the impact of experience on wages is captured by the year fixed effects. Therefore, experience is excluded from the regression equation.

[25] This measure has been used extensively in the finance literature, and the World Bank produces it as a measure of banking competition. See, http://www.worldbank.org/en/publication/gfdr/background/banking-competition. See also Heyman et al. (2013) for another study that uses the Boone measure of product market competition.

sensitive profits are to cost changes at the industry level. In the online appendix (Section A4) we also show that firms' profits indeed decline when competition, as measured by the Boone elasticity, increases and that this reduction in profits is stronger for firms with low productivity (consistent with Assumption 2 in the theoretical model).

Using the estimated Boone elasticity $\hat{C}_{rt}$ in (4.3) as a measure of the intensity of competition in the wage regressions (4.1) and (4.2), naturally raises an endogeneity concern—the source of the Boone elasticity is essentially firms' profits, and profits are essentially what determine managerial wages. To allow for a causal interpretation, we also use variation in product market competition from shifts in European Union (EU) industry-level import tariffs (where lower tariffs imply fiercer product market competition and vice versa). We can reasonably argue that the latter measure is exogenous since trade policy is a competence of the EU—not of its individual member states.[26] The drawback of using import tariffs as a measure of competition is that it has lower coverage: in particular, it does not cover large segments of service industries. However, if the results with our exogenous tariff-based measure of competition are in line with the results we find when using our Boone measure (available for all industries), this will give greater confidence in our Boone measure and suggest that endogeneity is not a major concern.

4.2.1. Identifying the skill-biased glass ceiling effect

More precisely, from the estimates of (4.1) and (4.2), we can make three specific empirical predictions from the skill-biased glass ceiling effect:

Prediction 1 (The skill-biased glass-ceiling effect) *If females face a significantly higher career hurdle than males in inflexible jobs such as managers, then we have the following:*

(i). *The distribution of estimated individual-firm (spell) fixed effects for female managers* $\hat{\varsigma}_{ij}(i \in \mathcal{F})$ in (4.1), *should be more skewed to the right than the distribution of estimated individual-firm (spell) fixed effects for male managers* $\hat{\varsigma}_{ij}(i \in \mathcal{M})$ in (4.2).

(ii). *The (raw) distribution of the log wage of female managers,* $\log w_{ijt}(i \in \mathcal{F})$, *should be more skewed to the right than the distribution of the log wage for male managers,* $\log w_{ijt}(i \in \mathcal{M})$.

(iii). *The gender wage gap should increase as we move up the log wage distribution of female and male managers,* $\log w_{ijt}(i \in \mathcal{F})$ *and* $\log w_{ijt}(i \in \mathcal{M})$.

[26] Sweden has been a member of the EU since 1995.

Recall that the estimated individual-firm spell fixed effects, $\hat{\varsigma}_{ij}$, serve as a proxy for individual firm-specific skills θ in the theoretical model. Part (i) of Prediction 1 then follows directly from Proposition 1: if women face a higher hurdle when investing in a career as a manager or CEO than men, the least skilled (least talented) women abstain from a managerial career. The skill distribution for women in occupations with high career hurdles should then be more skewed to the right than the corresponding skill distributions for males: in other words, the lower part of the skill distribution of females will be "more skilled" (or talented) than the corresponding lower part of the skill distribution of males. Part (ii) of Prediction 1 then follows directly given that wages are positively correlated with firm-specific skills and individuals have some bargaining power over their wage.

To see why part (iii) of Prediction 1 must hold, first note that Lemma 1 implies that a female manager or CEO will earn less than a male manager or CEO—even when they share the same skills—if a higher share of the extra cost from hiring a female manager falls on the firm. However, since females with lower skills (or talents) abstain from investing in a career, the negative effect on female wages from a higher cost of hiring females will be dampened by the positive selection of women with higher skills. The latter selection effect will then tend to increase female wages relative to male wages at the bottom of the wage distribution. Moving up in the wage and skills distribution, however, the impact of the positive selection of women should taper off.

4.2.2. Identifying the skill-biased competition effect

If the positive selection of women into managers is sufficiently strong, we should expect to find evidence for the *skill-biased competition effect*—i.e., when competition increases, female managers should then see their wages increase more than those of male managers. Recall again that Proposition 2(i) showed that when the female career hurdle in an occupation such as manager is sufficiently severe, the strong positive selection of female managers would imply that female managers, on average, should experience an increase in their wages when competition increases (i.e., $\beta_{\mathcal{F}} = \frac{d\mathbb{E}[w_j^*|\theta\in\mathcal{F})]}{dC} > 0$ in Equation 3.13). If male managers do not face such a career hurdle (or less of such a hurdle), Proposition 2(ii) shows that the impact of competition on males' wages is ambiguous (i.e., $\beta_{\mathcal{M}} = \frac{d\mathbb{E}[w_j^*|\theta\in\mathcal{M})]}{dC} \gtreqless 0$ in Equation 3.13). Proposition 2(iii) then posited that when females face a sufficiently high hurdle, female managers' wages should increase relative to those of male managers (i.e., $\beta_{\mathcal{F}} - \beta_{\mathcal{M}} = \frac{d\left(\mathbb{E}[w_j^*|\theta\in\mathcal{F})]-\mathbb{E}[w_j^*|\theta\in\mathcal{M})]\right)}{dC} > 0$ in Equation 3.15).

Thus, considering the log wage equations (4.1) and (4.2), obtaining evidence in favor of the skill-biased competition effect implies $\hat{\beta}_{\mathcal{F}} > 0$ as well as $\hat{\beta}_{\mathcal{F}} > \hat{\beta}_{\mathcal{M}} \lesseqgtr 0$ for inflexible occupations such as managers or CEOs. This yields our second empirical prediction:

Prediction 2 (***The skill-biased competition effect***) *If females face a significantly higher career hurdle than males in inflexible jobs such as manager or CEO, the least skilled (talented) females will abstain from investing in a career as a manager or CEO. The positive selection of females implies that the expected wage of females in inflexible jobs such as managers, or CEOs, should increase relative to that of males when product market competition increases.*

Thus, given that females face a sufficiently high hurdle associated with a career as manager or CEO, strong positive selection of high-skilled women should imply that increased product market competition should reduce the gender wage gap in inflexible jobs such as manager or CEO.

4.3. Empirical results

We now present our empirical evidence on the skilled biased glass-ceiling effect (Prediction 1) and the skill-biased competition effect (Prediction 2). We gather evidence from separately estimating (4.1) and (4.2), using five different samples: all employees, non-managerial employees, managerial employees, managers below CEO, and CEOs. Results are presented in Table 2 and are based on regressions on over 8 million individual-year observations, consisting of over 2 million individual-firm pairs ("spells"). We posit that the female career hurdle should be highest in top managerial work, such as CEO, followed by managerial position under the CEO level and lowest in non-managerial work.[27] Hence, we expect the positive female selection from the skill-biased glass-ceiling effect should be strongest among CEOs and weakest among non-managerial workers. In the next section, we show how the spell fixed effects associated with the estimates in Table 2 and the log wage distributions identify the skilled-biased glass-ceiling effect (Prediction 1). In Section 4.3.2, we will discuss the regression results in Table 2 in more detail when we analyze evidence of a skill-biased competition effect (Prediction 2).

Table 2

4.3.1. The skill-biased glass-ceiling effect (Prediction 1)

Spell fixed effects If the skilled-biased glass-ceiling effect is present in the data, we should find the most substantial evidence at the highest management level, i.e. for CEOs. The top panel in Figure 4.1 depicts kernel density plots for estimated individual-firm fixed effects for

[27] In the online appendix (Section A.1), we discuss in more detail why manager is an occupation with a particularly high career hurdle for females. We show that management occupations are characterized by many of the features that Goldin (2014) refers to as characterizing inflexible occupations (e.g., time pressure and the number of workers that the employee must regularly keep in touch with).

male CEOs and female CEOs from (4.1) and (4.2), $\hat{\varsigma}_{ij}(i \in \mathcal{M})$ and $\hat{\varsigma}_{ij}(i \in \mathcal{F})$, respectively. Recall again that these fixed effects allows us to obtain a measure of individual firm-specific skills or talents, i.e., the firm-specific skills θ in the theory. The visual pattern provides strong support for Prediction 1(i): while the male "skill" distribution is relatively symmetric around its mean (indicated as zero), the female "skill" distribution is heavily skewed to the right with little mass in its left tail: the lower part of the skill distribution of female CEOs is "more skilled" than the corresponding lower part of the skill distribution of male CEOs. The detailed statistical information in Table 3 provides further evidence for Prediction 1(i): skewness is more than four times higher in the female CEO distribution according to conventional measures. The female distribution also has a lower standard deviation, a higher mean and higher kurtosis.[28]

We can also formally test whether the distributions of estimated CEO-firm spell fixed effects for male and female CEOs are *statistically different* at different parts of the distributions using the Goldman-Kaplan equality of distribution test.[29] This is depicted in the lower panel of Figure 4.1. In the lower panel, the two CDFs of estimated CEO-firm spell fixed effects for male and female CEOs are plotted, and the range of values for which the test rejects the equality of distribution are displayed as horizontal lines. In line with the top panel, equality of the two distributions is rejected at low and middle values of proxied ability or skill but not at high proxied ability. Overall, the Goldman and Kaplan test rejects equality of the distributions at the 0.001 level.

If we use the mean log wages for male and female CEOs in Table 3 and add their estimated spell fixed effects $\hat{\varsigma}_{ij}(i \in \mathcal{M})$ and $\hat{\varsigma}_{ij}(i \in \mathcal{F})$ for the different percentiles, we can obtain a *rough quantification* of the skill-biased glass ceiling effect. The last column in Table 3 then reveals that from the CEO-firm spell fixed effects, female CEOs are compensated more than male CEOs in the lowest percentiles—with a female premium of rougly 20% in the lowest percentile.[30] This relationship is then reversed at higher percentiles. In line with the mechanism in Prediction 1(iii), the positive selection arising from the skill-biased glass-ceiling effect in Section 3 predicts a female skill premium in the lowest percentiles, which should then decline as we move up the skill distribution, and females and males should be

[28]Shapiro-Wilk tests in Table 3 also reject normality for both distributions of CEO-firm spell fixed effects.

[29]The Goldman-Kaplan approach is a generalization of the Kolgomorov-Smirnov test, which tests a single hypothesis of equality of distributions as their maximum difference. The Goldman-Kaplan test examines the equality of the distribution functions at each possible value. See Goldman and Kaplan (2018).

[30]We can also use the time dummies, the intercept and the estimated spell fixed effects to display the evolution over time. This shows an upward trend in the male premium over the time period. Since the spell fixed effects are time-invariant, this translates into a negative male premium at the lowest percentiles in the early years of the period and a slightly positive gender gap during the end of the period.

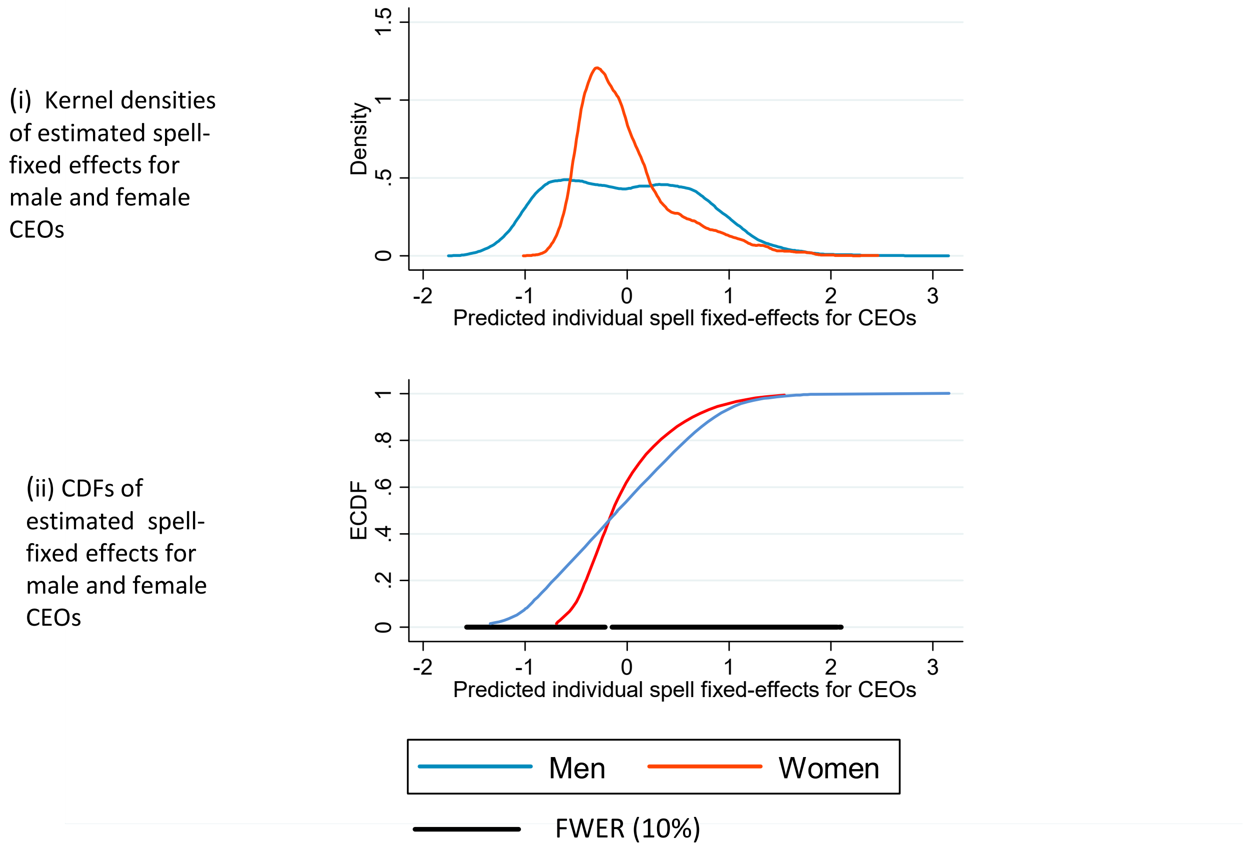

Figure 4.1: Illustrating positive female selection from the skill-biased glass-ceiling effect. Panel (i) shows the distributions of estimated spell fixed effects for male- and female CEOs, $\hat{\varsigma}_{ij}(i \in \mathcal{M})$ and $\hat{\varsigma}_{ij}(i \in \mathcal{F})$. Panel (ii) depicts the CDFs for estimated spell-fixed effects for male CEOs, $\hat{\varsigma}_{ij}(i \in \mathcal{M})$, and female CEOs, $\hat{\varsigma}_{ij}(i \in \mathcal{F})$. Also depicted are the regions over which equality of the CDFs is rejected, based on the null hypothesis $H_{0_{\hat{\varsigma}}} : \Xi(\hat{\varsigma}_{ij}(i \in \mathcal{F})) = \Gamma(\hat{\varsigma}_{ij}(i \in \mathcal{M}))$ for all $\hat{\varsigma}$, where $\Xi(\hat{\varsigma}_{ij}(i \in \mathcal{F}))$ is the female CDF and $\Gamma(\hat{\varsigma}_{ij}(i \in \mathcal{M}))$ is the male CDF and $\hat{\varsigma}$ are the estimated spell fixed effects. The indicated FWER is the probabality of rejecting any true $H_{0_{\hat{\varsigma}}}$ which controls for type I error for multiple testing. Goldman and Kaplan apply a strong control for FWER. The stated 10 % level can be interpreted as false positives will be absent 90 % of the time (see Kaplan, 2019).

equally skilled at the top of their respective distributions. The latter is in line with the Goldman and Kaplan test in Figure 4.1—but at odds with the information in Table 3, which indicates a male skill premium at the top.[31] In the online appendix (Section A4.), we show how one can reconcile the female skill premium at the bottom of the skill distribution with a male skill premium at the top by extending the benchmark model in Section 3 into a setting where female CEOs are constrained in their labor supply.[32]

Table 3

Do we find a less positive selection of female workers below top management? Panel (i) on the top the left column in Figure 4.2 reproduces the distribution of spell fixed effects for male and female CEOs, for reference. The distributions of the estimated spell fixed effects for managers below CEOs and non-managers are shown in panel (iii) and panel (v) in the left column of Figure 4.2. Consistent with a lower career hurdle for women in lower level management, we note that the difference in skewness between the female and male distributions of spell fixed effects for managers at a lower level than CEO is similar to that of CEOs—but less accentuated. In the online appendix (see Table A4), we also show that measured skewness in the female distribution for managers below CEO is approximately twice as high as for male managers below CEO—for CEOs, female skewness was found to be approximately four times higher.[33] Turning to non-managers in panel (v) in Figure 4.2, we can see that the female and male distributions of spell fixed effects are almost identical, albeit with the male distribution again having a longer thin lower tail. In the online Appendix (see Table A5), we show that skewness is approximately the same between the male and female distributions in this group.

[31] A likely reason is that the male distribution in Figure 4.1 has a longer support at higher values than the female distribution.

[32] This model shows that while selection will still tend to make female CEOs more skilled than their male peers, they will still be less productive. The lower productivity essentially stems from not being able to put in the extra hours, and this turns out to be more costly for female CEOs with higher skills than for female CEOs with lower skills. The extended model can be thought of capturing what Goldin (2021) calls "greedy work". Greedy work essentially refers to inflexible jobs with limited possibilities for substitution between workers, where marginal hours on weekends or being able to be on stand-by for late night calls, pay substantially more than regulated work. If women—from cultural traits or stronger family considerations—refrain from taking up such jobs, they will lag behind in their wage trajectories and be less likely to be promoted than male peers who are more inclined to take up such jobs.

[33] Table A4 reveals that for managers below CEO, female skills, as measured by the spell fixed effects, are again higher than male skills in the lowest ten percentiles. However, the female "skill-premium" is about half the size of the corresponding skill premium for female CEOs in the lowest percentile. Another noteworthy feature in Table A4 is that females managers' predicted log wages from observables are higher than male managers' predicted wages in the bottom percentiles.

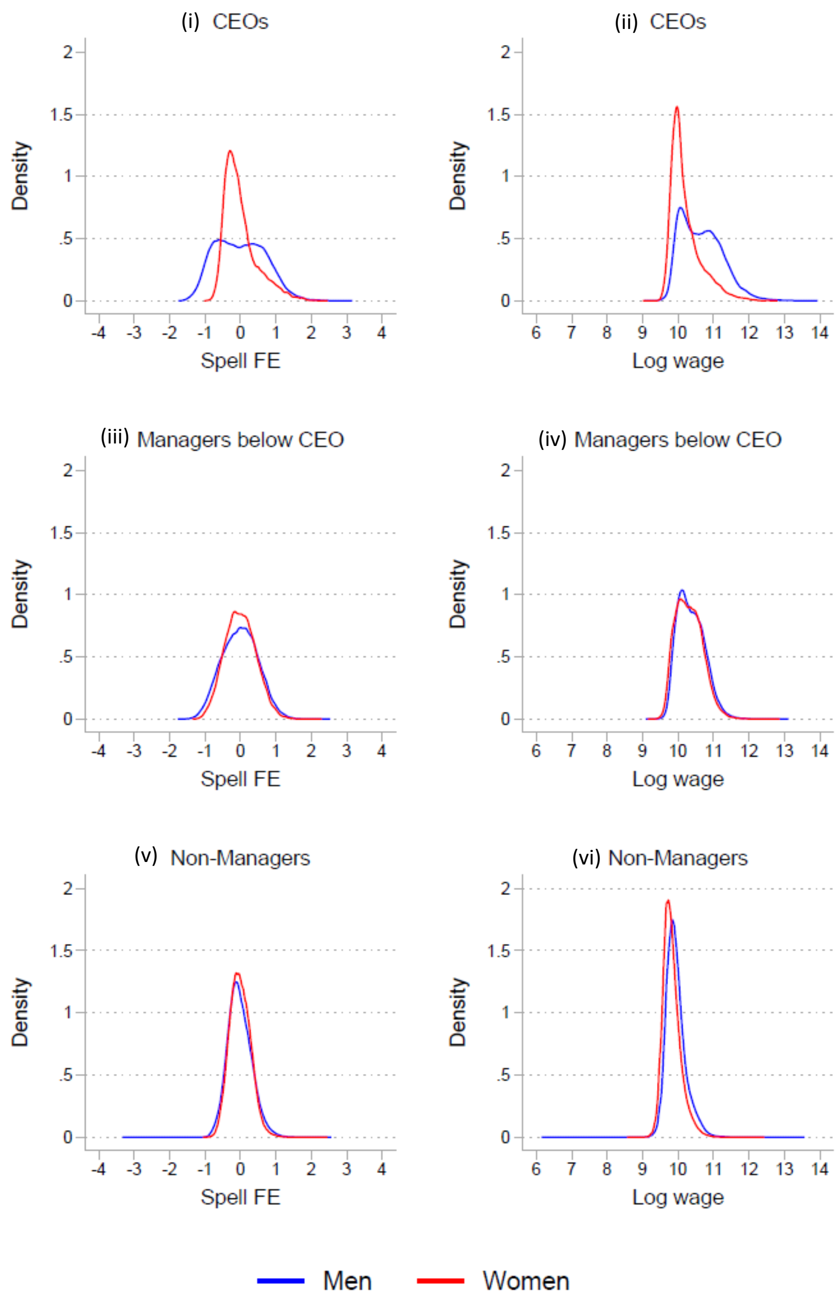

Figure 4.2: Illustrating how the positive female selection from the skill-biased glass-ceiling effect is strongest among CEOs and weakest among non-managerial workers. This figure compares the distributions of estimated individual spell-fixed effects (left column) and log wages (right column) of men and women. The top row with panels (i) and (ii) compare male and female CEOs. The middle row with panels (iii) and (iv) compare male and female managers below the level of CEO. The bottom row with panels (v) and (vi) finally compare male and female non-managers.

Raw log wages Prediction 1(ii) suggests that positive female selection should also be reflected in the log wage distributions. The right column in Figure 4.2 depicts kernel density plots for the raw log wage distributions for males, $\log w_{ijt}(i \in \mathcal{M})$, and females, $\log w_{ijt}(i \in \mathcal{F})$, for our three types of employees. The distributions of log wages and spell fixed effects tell a similar story, consistent with individual skills being correlated with remuneration. For CEOs in panel (ii), we again find higher skewness in the female wage distribution than in the male wage distribution (Table 3), consistent with Prediction 1(ii). This difference is much smaller for managers below CEO in panel (iv) and for non-managers in panel (vi), again indicating a lower career hurdle in the latter two groups.[34] [35]

Turning to Prediction 1(iii), Table 3 confirms that the gender wage gap for CEOs is much lower at the bottom end of the distributions than at the top end—it is almost 20% when we compare the bottom ten percentiles of male and female CEOs, reaching approximately 67% at the median, and then further increasing at higher percentiles. Consistent with weaker positive selection, Figure 4.2 also reveal that the pattern of an increasing gender wage gap as we move up the wage distribution is less present for managers below CEOs and for non-managers.

Career paths of CEOs The evidence so far—regardless if inferred from estimated firm-specific individual skills or directly through individual wages—point towards strong positive selection of women into top management. We can obtain further evidence by exploring how individual careers proceed over time. More specifically, if the skill-biased glass ceiling effect is present in the data, positive selection among females should be visible already early in their career, i.e., before individuals reach the position as CEO, say.[36] Exploiting that individuals will have different estimated individual-firm spell effects, $\hat{\varsigma}_{ij}$, when employed in different firms, we then reestimate the wage regressions for females (4.1) and males (4.2) for all males and females who ever reach the position of CEO over the period 1996–2009. We run these regressions when they are younger than 30, when younger than 35, and when younger than 40. The results from these regressions are given in the online appendix (Section A.3.) and provide strong evidence of a positive selection of females starting already before the position of CEO is reached.

[34] See also Tables A4 and A5 in the online appendix.

[35] Goldman-Kaplan equality of distribution tests still reject equality of the male and female log wage distribution for all three types of workers.

[36] This would correspond to the trainee period in our theoretical model in Section 3.

4.3.2. The skill-biased competition effect (Prediction 2)

The results presented in Section 4.2.1 give strong support for Prediction 1: the threshold in terms of talents or skills to find it worthwhile to invest in a managerial career is higher for females than for males, leading to positive selection of women into managerial positions. The strong empirical support for the skill-biased glass-ceiling effect suggests that we should find evidence for the skill-biased competition effect in Prediction 2: hence, the expected wage of females in inflexible jobs such as managers, or CEO, should increase relative to that of males when product market competition increases.

Competition measured from the Boone elasticity To find evidence for the skill-biased competition effect, we return to the estimates in Table 2. As a reference point, start with the two first columns in Table 2 which report the estimates using all individuals in the data, irrespective of occupation. From these specifications, we find that the Boone elasticity, measuring the level of competition, is statistically insignificant. This is the case for both men and women. This is also expected. For the vast majority of individuals, the level of competition in the industry in which they are employed should have no effect on their wage since their wages are determined in a nationwide competitive labor market. This is also in line with the absence of evidence for a skill-biased glass ceiling effect for workers other than managers in Section 4.2.1. This is further validated in columns three and four.

Columns (5)–(10) then present the results for employees holding different management positions. Here, we find interesting gender differences. Columns five and six are estimated on all types of managerial positions, comparing men and women. The results reveal a clear difference in the impact of stronger competition on wages for male and female managers. When product market competition increases through an increase in the Boone elasticity, this leads to a statistically significant increase in the wage of female managers, $\hat{\beta}_{\mathcal{F}} > 0$, whereas we cannot reject the null hypothesis of no effect of competition on male managers' wages, $\hat{\beta}_{\mathcal{M}} = 0$. These estimates thus give strong support to the predictions of Prediction 2 and the skilled-biased competition effect. Recall that through the glass ceiling effect, female workers need greater innate talent than male workers to invest in firm-specific skills and take a job as a manager. Since only top managers will be able to reap the benefits from stronger competition through the skill-biased competition effect, female managers are then more likely to see their wages increase when competition increases, which is confirmed in the estimates.

Further support for the asymmetry between male and female managers is given in columns seven and eight, which repeat the estimation for managers below the CEO level, while columns nine and ten depict the results for CEOs. In line with our finding that the skill-biased glass-ceiling effect is strongest at the very top management level, the impact of competition on female managers' wages is also strongest for the highest positions in the firm. The size of the estimated effect is twice as large for CEOs as for lower managerial positions.

In the online appendix (see Table A6), we also re-estimate Equations (4.1) and (4.2) for different size classes of firms. This does not qualitatively change the results. We do however find that it is primarily at the CEO level that the differences persist. Again, this is consistent with our proposed model, which stresses that the selection or glass ceiling effect may be stronger for women in top positions.

Competition measured from EU-level import tariffs As we have already noted, one potential critique of the Boone measure of competition is endogeneity. In Table 4, we therefore use an alternative measure of competition, namely EU import tariffs. Lower import tariffs should lead to increased competition, and hence, the variation in import tariffs could serve the same role as the Boone elasticity. The main advantage of using tariffs is that they can be considered exogenous after 1995, when Sweden joined the EU. As one of its (then) 28 members and, in particular, as on of its smaller members, it is highly unlikely that Sweden would have an impact on the trade policy of the EU. This is even less likely since trade policy is a unique competence of the EU and with trade agreements and trade policy falling under the jurisdiction of the EU commission. We aggregate the six-digit HS tariff data from the UNCTAD TRAINS database up to the three-digit level of SNI (the Swedish Industrial Classification) using trade shares as weights.[37] Specifically, to construct the industry-level import tariffs, the shares of Swedish imports in 1996 (the first year in the sample) are used as weights. We note that import tariffs were reduced over the sample period and that tariff reductions vary across industries. The tariff data are only available for the manufacturing sector.

Table 4

Starting with regressions on all employees, independent of occupation, (columns 1–2) and on all non-managers (columns 3–4), we find no effect of competition and no gender differences. These results are in accordance with the results in Table 2. Similar results are found for employees with lower-level management positions and in estimations in which we pool all managers (columns 5–8). These results differ from those of the corresponding specifications in Table 2. Continuing with the impact on CEOs, columns 9–10 reveal that the asymmetry between males and females remains for CEOs, where higher import tariffs (weakening competition) lead to a reduction in the wages of female CEOs. Again, for male

[37] SNI roughly corresponds to Standard Industrial Classification (SIC).

CEOs, there is no statistically significant effect of import tariffs on their wages.

4.4. Additional evidence

4.4.1. The extensive margin and competition

Our results on the skill-biased competition effect showed that increased product market competition led to a statistically significant increase in the wage of female managers, $\hat{\beta}_{\mathcal{F}} > 0$. This should encourage more women to invest in firm-specific skills to pursue a career as a manager, which was also a prediction from Proposition 3. In contrast, we could not reject the null hypothesis of no effect of competition on male managers' wages, $\hat{\beta}_{\mathcal{M}} = 0$. These results indicate that the skill-biased competition effect should also work toward increasing the share of women in management positions in firms. We can test the latter prediction by estimating the following firm-level regression:

$$share_{jt} = \nu_{\mathcal{M}} + \nu_{\mathcal{M}}\hat{C}_{rt} + \varsigma_j + \varsigma_t + \mathbf{X}'_{jt}\boldsymbol{\gamma} + \varepsilon_{jt}, \tag{4.4}$$

where $share_{jt}$ is the share of female managers in firm j in year t. The main explanatory variable of interest is product market competition (C_{rt}), where we expect $\nu_{\mathcal{M}} > 0$ when the female career hurdle is sufficiently large. We also include a vector, $\mathbf{X}_{jt}$, of time-varying firm characteristics (identical to that used above). All of the estimations also include firm fixed effects, ς_j, to control for unobserved firm heterogeneity and year fixed effects, ς_t, that control for common macro-level shocks. Finally, ε_{jt}, is the error term. The results are presented in Table 5.

Table 5

The results in column 1 show that there is no effect on the overall share of women in a firm, although there seems to be a positive and significant effect on the share of women, excluding managers, as seen in column two. However, as shown in column 7, where we control for the share of women at the industry level, this result seems to be partly driven by industries having inherent differences in the share of women. Regarding the results on the share of female managers, the share of non-CEO managers or whether the firm has a female CEO, we obtain consistent evidence that an increase in product market competition is associated with a greater presence of female executives. Similar to our results above on individual wages, the results are strongest for CEOs (columns 5 and 10).

4.4.2. Profits, female managers and competition

We can also shed some light on how the positive selection of female managers mutes the negative effect of competition on firms profits. The skill-biased glass ceiling effect thus implies a positive selection of female managers where individuals in the lower part of the skill distribution are removed. If management skills are correlated with firm productivity, this would suggest that firms with a larger presence of female managers may cope better with stronger competition than firms with a stronger male dominance in management, in particular in the lower part of the firm productivity distribution. In the online appendix (Section A.4.) we examine this issue and we find that a higher share of females in management dampens the reduction in profits when competition increases for firms in the lower end of the productivity distribution. For firms in the highest quantile of the productivity distribution, we find no such relationship.

5. Conclusions

In this paper, we have investigated how product market competition and gender-specific management career hurdles affect the gender wage gap for managers. We develop a model in which (i) oligopolistic firms hire managers that can be female or male, (ii) females' and males' management skills are drawn from the same skill distribution, and (iii) the inflexibility associated with management jobs is more costly for females.

If the inflexibility associated with management jobs also makes it more costly for firms to hire female managers, a female manager with the same skill level as a male manager will receive a lower wage. This implies that only more talented females will find it worthwhile to invest in a career as a manager. Estimating wage regressions with individual-firm spell fixed effects (serving as a proxy for individual firm-specific managerial skills) on Swedish matched-employer employee data, we find strong evidence of a positive selection of female managers (the skill-biased glass ceiling effect). For top management such as CEOs, we find that while the male distribution of individual-firm spell fixed effects is fairly symmetric, the female distribution is heavily skewed to the right, consistent with the presence of a female career hurdle that induces females with lower talent to abstain from a managerial career. For non-managers, we find hardly any differences in the male and female distributions, suggesting a lower female career hurdle outside management.

Given the positive selection of female managers and plausible assumptions regarding how profits depend on a manager's skills and product market competition, our model then predicts that increased product market competition can reduce the gender wage gap for managers. The positive selection implies that female managers must, on average, be more skilled than male managers and, therefore, female managers will, on average, be able to respond better to more intense product market competition. Hiring and wages should then increase more for female managers when the intensity of product market competition increases (the skill-biased competition effect). Using our Swedish matched employer-employee data, we then find strong empirical evidence for these predictions for managers and, in particular, for CEOs.

At the end of our period of study, 1996-2009, approximately half of the workers in our Swedish matched employer-employee data with higher education were females—but females only represented approximately ten percent of the CEOs. We have shown how the empirical evidence for two interlinked theoretical mechanisms—the skill-biased glass ceiling effect and the skill-biased competition effect—identifies a female-specific career hurdle in management positions in the Swedish labor market as the cause of this inequality. What are the policy implications of these findings?

A full-fledged welfare analysis is beyond the scope of this paper. However, our analysis points to several market failures that can serve as a starting point for a policy discussion. If the female career hurdle is mainly due to an inefficiency emerging from entrenched cultural norms and beliefs related to family and children, while providing flexibility at the workplace is inexpensive for firms, it follows directly that policies that reduce the female career hurdle would benefit talented women who are kept from reaching managerial positions at low cost. However, what if the female career hurdle emerges from differences in preferences over market and non-market work between men and women, while providing flexibility is very costly for firms. Even in such a case, there would be market failure indicating that too few talented women choose to become managers. Why? When talented women choose not to invest in a managerial career, they do not internalize the positive externalities that their investment has on improved firm performance. That is, they do not internalize how their investment in a career will increase firm owners' wealth and consumer surplus—when more able females replace less able males as managers, firms will be able to invest in better projects and organize their production and markets in a more efficient way, benefiting both owners and other stakeholders such as consumers.

Which factors and policies may then affect the magnitude and consequences of the female career hurdle? We have shown how increasing product market competition has the potential to mitigate the negative effect of this hurdle. Increasing product market competition to promote more female participation in management may also be preferred over outright female quotas: increasing competition benefits more talented women; gender quotas may benefit both more talented women and less talented women and might thus entail inefficiencies. It is also interesting to consider how recent advancements in new technologies and different policy changes affect the female career hurdle. An exciting avenue for future research would be to study the effect on gender wage gaps and gender skill distribution gaps for managers when firms implement new technologies and policies that make jobs more flexible. Another interesting issue to explore is how different family policies influence the specific gender wage gaps for managers. Yet another avenue for research would be to examine how gender composition on corporate boards affects gender wage gaps and gender skill distribution gaps for managers. Extending our theoretical exercise to a welfare analysis of different policies to encourage women to pursue a managerial career also appears to be a fruitful avenue for future research. Such an analysis could endogenize the time allocation within the family and explore the interaction between couples under different norms in society.

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Tables

Table 1. Descriptive statistics

Source	Variable	All years (1996–2013)		1996–2002		2003–2009	
		Mean	SD	Mean	SD	Mean	SD
A. Firms Position	Share of women	0.33	0.23	0.32	0.23	0.34	0.24
	Share high-edu.: women	0.36	0.29	0.32	-0.29	0.38	0.29
	Share medium-edu.: women	0.33	0.25	0.33	0.24	0.34	0.25
	Share low-edu.: women	0.33	0.3	0.34	0.3	0.33	0.31
	Share female managers	0.19	0.25	0.16	0.23	0.21	0.26
	Share female CEOs	0.12	0.28	0.09	0.25	0.13	0.29
	Competition	4.24	1.41	4.28	1.45	4.19	1.38
	Number of employees	326	1161	342	1260	312	1071
	Capital intensity	0.98	0.43	1	4.31	0.97	4.37
	Share high-skilled	0.25	0.23	0.22	0.21	0.28	0.24
	Age	40.78	5.19	40.26	5.1	41.22	5.23
	Number of observations	41,183		18,852		22,331	
B. Individual level	Wage (in logs)	9.94	0.33	9.87	0.31	10.02	0.33
	Wage (in logs): women	9.85	0.29	9.77	0.26	9.93	0.29
	Wage (in logs): men	10	0.34	9.92	0.32	10.07	0.34
	Work experience	22.56	12.58	22.47	12.44	22.64	12.71
	Number of observations	1,298,218		6,216,633		6,765,556	

Notes: Share high-edu.: women is share of women with least three years of university studies, Share medium-edu.: women is share of women with at least upper secondary school and Share low-edu.: women is share of women with at least compulsory school. Competition is based on Boone measure (see Section 3 for details), Capital intensity is Capital stock/Number of employees, Firm size is number of employees and Share skill high is share of the labor force with at least 3 years of post-secondary education. Firm level statistics on workers education stem from aggregated plant level data on education. Data on individual workers' education stem from individual register data on education. Wages at the worker level are gross real monthly full-time-equivalent wages (in 1995 SEK).

Table 2. Wage regressions with individual-firm spell fixed effects by gender 1996-2009

	Type of position									
	All		Non-managerial		All managerial		Managerial below CEO		CEOs only	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Competition	0.148	0.159	0.159	0.157	0.147	0.499**	0.099	0.342*	0.302	0.707***
	(0.155)	(0.179)	(0.151)	(0.191)	(0.110)	(0.222)	(0.111)	(0.198)	(0.274)	(0.241)
Experience/100^2	-0.035***	-0.031***	-0.033***	-0.029***	-0.064***	-0.046***	-0.064***	-0.049***	-0.047***	-0.026***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Capital intensity	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Log firm size	0.005	-0.000	0.005	-0.001	0.002	0.004***	0.001	0.005***	0.017	0.012**
	(0.006)	(0.003)	(0.006)	(0.003)	(0.004)	(0.001)	(0.004)	(0.001)	(0.010)	(0.005)
Share skill high	0.117**	0.111***	0.091*	0.091***	0.060**	0.066**	0.048**	0.085***	0.223***	0.046
	(0.055)	(0.036)	(0.049)	(0.033)	(0.023)	(0.031)	(0.022)	(0.031)	(0.042)	(0.064)
R^2	0.40	0.43	0.37	0.42	0.49	0.47	0.51	0.49	0.29	0.28
No. spells	2,275,488	1,451,939	2,111,681	1,388,023	201,468	59,595	180,077	51,881	31,469	11,256
No. obs.	8,258,078	4,596,236	7,434,113	4,329,862	632,687	161,574	556,838	135,835	75,849	25,739

Notes: Dependent variable is log full-time equivalent wages. Competition is based on Boone measure (see Section 3 for details). Capital intensity is Capital stock/Number of employees, Firm size is number of employees, Share skill high is share of the labor force with at least 3 years of post-secondary education. Standard errors are clustered by industry. ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

Table 3. Decomposition of CEO' wages, 1996-2009

	Log wage			Predicted wage from observables			Individual-firm fixed effects ("spell FE")		
	Female	Male	Gender gap (%)	Female	Male	Gender gap (%)	Female	Male	Gender gap* (%)
1%	11.63	12.15	68.7	10.58	11.34	114.8	1.42	1.59	80.4
5%	11.08	11.62	70.4	10.53	11.23	102.9	0.95	1.1	76.8
10%	10.83	11.38	73.2	10.48	11.15	93.9	0.67	0.87	85.9
25%	10.41	11.02	83.0	10.39	10.96	76.5	0.21	0.46	95.4
50%	10.07	10.58	66.5	10.25	10.71	58.7	-0.13	-0.08	60
75%	9.9	10.16	29.8	10.09	10.44	40.8	-0.36	-0.61	18.5
90%	9.79	9.96	18.9	9.93	10.2	31.1	-0.51	-0.94	-1
95%	9.73	9.88	16.5	9.84	10.07	25.6	-0.59	-1.09	-7.7
99%	9.61	9.73	12.9	9.66	9.83	18.9	-0.71	-1.36	-20.5
Mean	10.21	10.63	53.48	10.23	10.69	58.57	-0.02	-0.05	43.09
Std Dev.	0.43	0.56		0.21	0.36		0.48	0.7	
Variance	0.19	0.32		0.04	0.13		0.23	0.49	
Skewness	1.38	0.63		-0.6	-0.31		1.15	0.27	
Kurtosis	5.13	3.27		3.03	2.58		4.33	2.59	
	Shapiro Wilk test for normality								
W	0.89	0.97		0.97	0.99		0.92	0.99	
V	610.88	425.18		157.10	161,07		449.11	170.38	
z	17.23	16.64		13.58	13.97		16.40	14.13	
Prob > z	0.000	0.000		0.000	0.000		0.000	0.000	
No. of spells (CEO-firm)	11,256	31,469		11,256	31,469		11,256	31,469	

*Note: Numbers in this table are based on the specifications for CEOs in Table 5, calculated from gender-specific means. For example, the implied gender-wage gap from estimated CEO-firm fixed effects at the 99 % percentile is given as

$$100 \times \frac{e^{10.63-1.36} - e^{10.21-0.71}}{e^{10.21-0.71}} = -20.5\%.$$

Table 4. Wage regressions with individual-firm spell fixed effects by gender 1996-2009 by gender 1996-2009. Competition measured from import tariffs

	Type of position									
	All		Non-managerial		All managerial		Managerial below CEO		CEOs only	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Competition	-0.001	0.002	0.005	0.006	-0.002	-0.005	0.001	0.001	-0.005	-0.111**
	(0.018)	(0.011)	(0.015)	(0.009)	(0.009)	(0.012)	(0.008)	(0.011)	(0.019)	(0.051)
Experience/	-0.029***	-0.029***	-0.027***	-0.026***	-0.061***	-0.052***	-0.059***	-0.051***	-0.067***	-0.070***
100^2	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Capital	0.004***	0.004***	0.004***	0.004***	0.005***	0.003***	0.005***	0.003***	0.003*	0.003
intensity	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Log firm size	0.032***	0.022***	0.032***	0.021***	0.013*	0.008	0.015**	0.009*	0.013	0.025
	(0.007)	(0.004)	(0.008)	(0.004)	(0.008)	(0.005)	(0.007)	(0.005)	(0.018)	(0.025)
Share skill	0.164*	0.160***	0.119*	0.122***	0.034	0.040	0.033	0.040	0.125*	0.141
high	(0.084)	(0.056)	(0.069)	(0.035)	(0.024)	(0.037)	(0.023)	(0.032)	(0.061)	(0.169)
R^2	0.41	0.47	0.39	0.46	0.50	0.52	0.52	0.53	0.34	0.37
No. spells	990,316	393,662	911,852	372,479	90,739	16,271	82,028	14,837	13,018	2,154
No. obs.	4,232,266	1,502,356	3,799,480	1,404,535	307,125	46,820	274,652	42,211	32,473	4,609

Notes: Dependent variable is log full-time equivalent wages. Competition is based on import tariffs (see Section 3 for details). Capital intensity is Capital stock/Number of employees, Firm size is number of employees, Share skill high is share of the labor force with at least 3 years of post-secondary education. Standard errors are clustered by industry. ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

Table 5. Product market competition (Boone) and share of female employees. All employees: firm level estimates 1996-2009

	Type of position									
	All	Non-managerial	All managerial	Managerial below CEO	CEOs only	All	Non-managerial	All managerial	Managerial below CEO	CEOs only
Competition	0.034	0.157**	0.359**	0.281*	0.748***	-0.007	0.124*	0.323*	0.257*	0.719***
	(0.043)	(0.072)	(0.168)	(0.155)	(0.195)	(0.040)	(0.070)	(0.169)	(0.152)	(0.194)
Log firm size	0.002	-0.001	0.005	0.003	0.017**	0.002	-0.001	0.005	0.002	0.016**
	(0.002)	(0.002)	(0.003)	(0.004)	(0.007)	(0.002)	(0.002)	(0.003)	(0.004)	(0.007)
Capital	-0.000	0.000	0.000	-0.001	0.000	-0.000	0.000	0.000	-0.001	0.000
intensity	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Share skill	0.010	0.019	0.043	0.079*	-0.024	0.009	0.015	0.039	0.076	-0.030
high	(0.019)	(0.023)	(0.039)	(0.046)	(0.047)	(0.019)	(0.023)	(0.040)	(0.046)	(0.049)
Share skill high (industry						0.078***	0.111***	0.117**	0.081*	0.164**
level)						(0.009)	(0.020)	(0.048)	(0.046)	(0.065)
No. of obs.	191,502	40,983	35,806	33,022	23,578	191,502	40,983	35,806	33,022	23,578
R^2	0.005	0.007	0.034	0.030	0.012	0.007	0.013	0.035	0.031	0.012

Notes: Dependent variable is share of females. Competition is based on Boone measure (see Section 3 for details). Capital intensity is Capital stock/Number of employees, Firm size is number of employees, Share skill high is share of the labor force with at least 3 years of post-secondary education. Standard errors are clustered by industry. ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

A. Online Appendix (not for publication)

A.1. Manager—an inflexible job with a high career hurdle?

This section provides evidence that top-level management occupations are associated with greater inflexibility. Goldin (2014) shows that occupations vary substantially in terms of how inflexible the job is and notes that inflexibility on the job likely harms women more than men since women take more responsibility for the family. Below, we show that management occupations are characterized by many of the features that Goldin (2014) identifies as making occupations inflexible. We follow Goldin (2014) and adopt the occupational characteristics used in her analysis as our starting point. She bases her analysis on occupations in the O*Net online database and focuses on "work context" (57 characteristics) and "work activities" (41 characteristics). We then use the same five characteristics that she adopts to identify inflexible occupations (listed in the notes to Table 2 in Goldin (2014)). These characteristics reflect time pressure, the need for workers to be present at particular times, the flexibility of the occupation in terms of scheduling, the groups and workers that the employee must regularly keep in touch with, and the degree to which the worker has close substitutes. Each of the O*Net characteristics has been normalized to have a mean of zero and a standard deviation of one.

Table A1 presents basic descriptive statistics. The first four columns report the means of the five measures of job inflexibility for occupations in Technology and Science, Business, Health and Law. These are the same as those listed in Table 2 in Goldin (2014), except that we have here removed all management occupations within these broad occupational groups. These are instead presented separately in columns 5 and 6. As Table A1 shows, the management occupations score high on all five measures of job inflexibility. Relative to jobs in technology and science in particular but also to health and business occupations, those in management have less time flexibility, more client and worker contacts, more working relationships with others, and more specific projects with more discretion over them. We also separate out the top managers, chief executives and legislators and find that this occupation scores high in most characteristics.

Table A1

Next, in Table A2, we report the results of basic regressions on differences in O*Net characteristics between managerial and non-managerial occupations. Each specification has O*Net characteristics (normalized) as the dependent variable and our main explanatory variable of interest is *Manager*, which is an indicator variable equal to one if an occupation is a managerial occupation. Hence, we compare managerial occupations with non-managerial occupations for the 94 occupations included in Goldin (2014). As Table A2 shows, the estimated coefficient for *Manager* is positive and statistically significant for all O*Net characteristics. This indicates that management occupations have characteristics skewed more toward inflexible job tasks.

Table A2

To show that these results are not driven by a few management jobs in specific broad occupational groups, we provide scatter plots of the simple means of the O*Net characteristics for each of the 94 occupations for the five different characteristics. These figures are presented in Figures A1 and A2. We have marked management occupations in each of the plots. The figures clearly illustrate that most management occupations are located in the upper-right corner of the plots, which is consistent with management jobs being characterized by high inflexibility.

Figure A1 and Figure A2

We have thus provided basic evidence that management occupations are indeed characterized by many of the features that Goldin (2014) identifies as making some occupations inflexible. For these occupations—characterized by high costs of substitution of tasks between different employees and the requirement of long, inflexible hours at the workplace—firms will face additional costs when hiring people that need flexibility in work hours. Moreover, choosing such occupations will also come at a higher cost for people who value flexibility or have inflexible demands outside the workplace such as caring for children.

A.2. The Swedish linked employer-employee data

In this section, we present the Swedish linked employer-employee data in more detail. As described in the main paper, our data consist of detailed, register-based, matched employer-employee data from Statistics Sweden (SCB). The database comprises firm, plant and individual data, which are linked with unique identification numbers and cover the period from 1996 to 2009. The firm data contain detailed information on all Swedish firms, including variables such as value added, capital stock (book value), number of employees, wages, ownership status, sales, and industry. Moreover, the Regional Labor Market Statistics (RAMS) provide plant-level information on education and demographics, which we aggregate to the firm level. RAMS include data on all Swedish plants. The data on individuals originate from Sweden's official wage statistics and contain detailed information on a representative sample of the labor force, including full-time equivalent wages, education, occupation, and gender.[38] All data sets are matched by unique identification codes. To make the sample of firms consistent across the time periods, we restrict our analysis to firms with at least 20 employees in the non-agricultural private sector, which are available throughout the period.

Panel A of Table 1 in the main paper reports descriptive statistics at the firm level for the firms in our matched employer-employee data set over the period 1996–2009 (firms with at least 20 employees). For these firms, we have detailed information at the worker level on, e.g., education and occupation status, implying that we can calculate the share of women at the firm level with different occupations and education levels. Panel A reveals a slight increase in the share of women over the period (comparing the two sub-periods 1996–2002 and 2003–2009). Approximately one-third of the workers are females. A number of additional interesting observations can be made from Panel A: The share of women with high education is higher than the total share of highly educated workers. Hence, women are, on average, more educated than males. The share of women with higher education also increases significantly over the period, from approximately 29 percent in 1996 to approximately 42 percent in 2009 (32 percent in the 1996–2002 period and 38 percent in the 2003–2009 period). Even more interesting is that the share of female managers shows a distinct increase: During the period 1996–2002, the average share of female managers was 16 percent. By the later period, 2003–2009, this share had increased to 21 percent. Nevertheless, the share of female managers remained considerably below the total share of women, 34 percent, in the latter period. Furthermore, only 13 percent of the firms had a female CEO during this period.

Panel B in Table 1 in the main paper adds descriptive statistics at the worker level. The panel illustrates that there are significant differences in the wages of male and female workers. During the period 1996–2002, the average male worker had an approximately 16 percent higher wage than his female counterpart (the average monthly wage for a man was approximately SEK 20,300 per month, whereas the corresponding wage for a woman was SEK 17,500).[39] This wage difference declines somewhat during the later period, 2003–2009, where the wage advantage for men is approximately 15 percent.

To illustrate the gender pay gap, if we control for factors such as education, work expe-

[38] The worker data originate from the Swedish annual salary survey (*Lönestrukturstatistiken*). The survey's sampling units consist of firms included in Statistics Sweden's firm data base (FS). A representative sample of firms is drawn from FS and stratified according to industry affiliation and firm size (number of employees). The sample size consists of between 8,000 and 11,000 firms. The Central Confederation of Private Employers then provides employee information to Statistics Sweden on all its member firms that have (i) at least ten employees and (ii) are included in the sample. Firms with at least 500 employees are examined with probability one. The final sample includes information on approximately 50 percent of all employees in the private sector and is representative of the Swedish labor force. See www.scb.se for further details on the data.

[39] Wages are expressed as full-time equivalent monthly wages (in 1995 prices).

rience, occupation and firm or industry characteristics, we run the following regression:

$$\log(w_{ijt}) = \gamma_0 + \gamma_1 \cdot wom + \mathbf{X}'_{it}\boldsymbol{\xi} + \mathbf{Z}'_{jt}\boldsymbol{\lambda} + \theta_t + \vartheta_h + \varepsilon_{ijt} \tag{A.1}$$

where $\log(w_{ijt})$ is the log wage of worker i in firm j at time t measured as full-time equivalent wages, X_{it} is a vector of observable time-varying worker characteristics, Z_{jt} is a vector of observable time-varying firm characteristics, θ_t is a year fixed effect, ϑ_h is an industry fixed effect, and ε_{ijt} is the error term. Our main interest is in the estimated coefficient on γ_1, which gives us the percentage difference in wages for female and male workers. Time-varying worker characteristics include experience, experience squared, and dummy variables for educational attainment and occupation. Turning our attention to the firm, time-varying characteristics include capital intensity, firm size (number of employees), and the share of high-skill workers (i.e., the share of the labor force with at least 3 years of post-secondary education).

The results from the individual wage regressions for the period 1996–2009 are presented in Table A3a. Column 1 reports results for the estimated gender wage gap when only year fixed effects are included. We then add different controls. Inspecting the various specifications reported in Table A3a reveals that adding detailed controls only reduces the wage differential from approximately 15 percent to slightly below 10 percent ($\hat{\gamma}_1 \approx -0.147$ in column one but $\hat{\gamma}_1 \approx -0.094$ in column six in Table A3a).

Table A3a

In Table A3b, we then explore whether the pay gap is higher in managerial positions. For all types of managerial positions, we find much larger and significant estimated gender wage gaps that persist after controlling for a variety of firm and individual characteristics. The greatest wage gap is found for CEOs ($\hat{\gamma}_1 \approx -0.454$ in column five and $\hat{\gamma}_1 \approx -0.219$ in column six in Table A3b). We note that the higher gender pay gap in managerial positions, particularly in top management positions, is consistent with our theory of a gender pay gap in management positions generated by a female career hurdle.[40] To identify this hurdle, however, we need to go further and find direct evidence for the specific economic mechanisms emerging from our theory: the skill-biased glass ceiling effect and the skill-biased competition effect.

Table A3b

[40] In the model, we assume that the gender wage gap is zero in the competitive labor market, that is, that there is no difference in the outside wage for men and women. We can also introduce a gender pay gap in the outside wage and show that this would not qualitatively change our main results in terms of a higher female career hurdle causing the skill-biased glass-ceiling effect and the skill-biased competition effect.

A.3. Evidence of the skilled-biased glass ceiling effect in the career paths of CEOs

This section shows how one can obtain further evidence of the skill-biased glass ceiling effect by exploring how individual careers proceed over time. As argued in the main text, if the skill-biased glass ceiling effect is present in the data, positive selection among females should be visible early in their career, i.e., before individuals reach the position of CEO, say.

Exploiting that individuals will have different estimated individual-firm spell effects, $\hat{\varsigma}_{ij}$, when employed in different firms, we reestimate the wage regressions for females (4.1) and males (4.2) for all males and females who ever reach the position of CEO over the period 1996–2009. We run these regressions when they are younger than 30, when younger than 35, and when younger than 40. Intuitively, few individuals would have reached the position of CEO when below 30, while this share will increase at higher ages.

The three top panels in the left column in Figure A.1 show kernel density plots from estimated individual-firm spell fixed effects for females and males that will *become CEOs* at these age cutoffs. As a reference, the three diagrams in the right column depict the corresponding kernel density plots for individuals who *never become CEO*. The three left kernel density plots gives strong support for the presence of early positive selection among females who later go into top management (as predicted by the skill-biased glass ceiling effect). The distribution of spell fixed effects of females who will eventually become CEOs, when under 30, is even centered to the right of the corresponding distribution of males, as shown in panel (i). For individuals under 30 who never become CEOs in panel (ii), there is a slight tendency toward a positive selection of women—but this effect is nowhere near as accentuated as in the CEO sample in panel (i). For individuals under 35 (panels (iii) and (iv) in the second row) and under 40 (panels (v) and (vi) in the third row), the pattern is very similar, although the distributions become more skewed to the right, as mass is shifted to higher values when individuals start to pursue more successful careers. Finally, the left bottom panel (vii) depicts a kernel density plot of estimated spell fixed effects for females and males that will become CEOs without the age restriction (including spells when these individuals are not CEOs). The right bottom panel (viii) shows the corresponding estimated spell fixed effects for individuals who never become CEOs. The pattern is similar to the rows above, although the distributions become more skewed to the right, as mass is shifted even more to higher values due to longer successful careers.

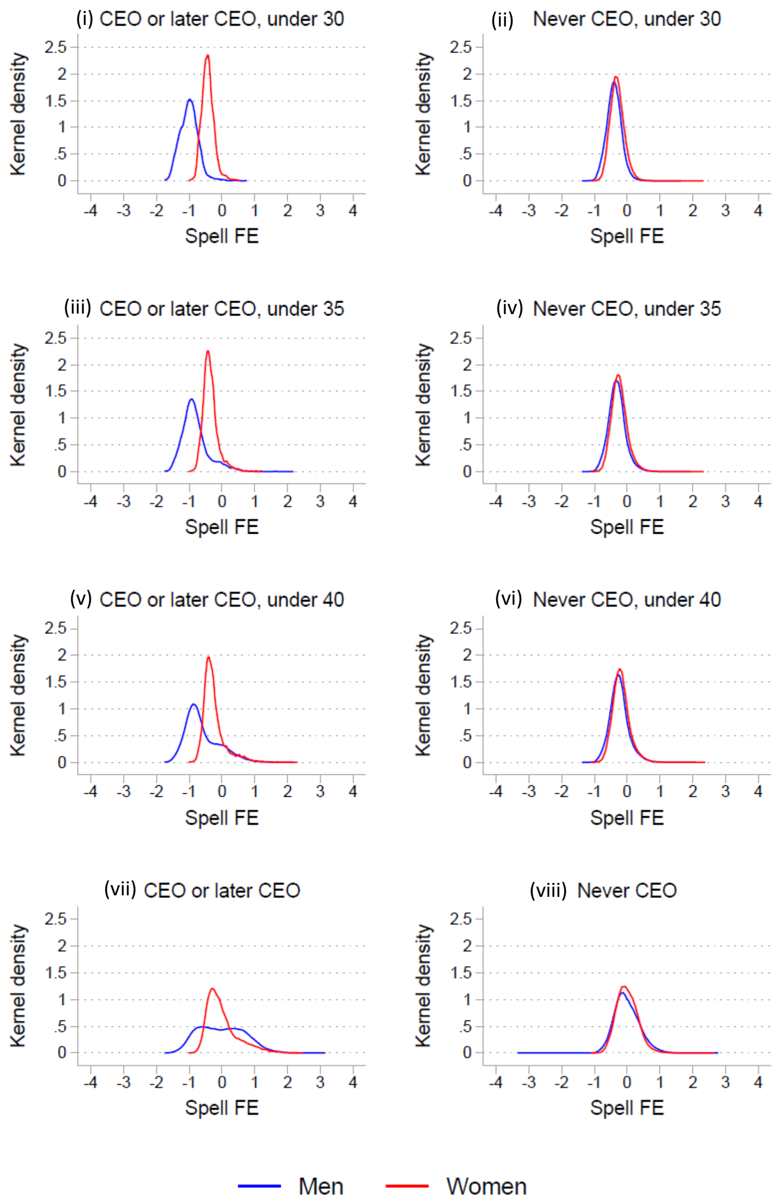

Figure A.1: Illustrating positive selection among females occuring early in their career. The left column shows kernel density plots from estimated individual-firm spell fixed effects for females and males that will *become CEOs* at different age cutoffs. The right column shows the correponding kernel density plots from estimated individual-firm spell fixed effects for females and males that *never become CEOs.*

A.4. Profits, female managers and competition

The basic premise of analysis is that women face a higher hurdle than men when pursuing a career in inflexible jobs such as manager. This, in turn, makes it harder for women with lower skills and talents to pursue a career. Positive selection of female managers will then—on average—make female managers better equipped to cope with increased product market competition, limiting the adverse effects on firms' profits when competition increases. The latter mechanism explains why firms are willing to pay female managers more when competition increases—even if their profits decline. In this appendix, we explore in more detail how the positive selection of female managers can affect the negative effect of competition on firms' profits.

We proceed in several steps. The two first columns in Table A7 show that the partial correlation between firms' logged profits and our measure of industry-level competition, $\hat{C}_{rt}$ is negative and highly statistically significant, as expected. From the skill-biased competition effect, we know that increased competition should have a less negative impact on the profits of more-productive firms relative to less-productive firms (Assumption 2). To assess whether this also holds in the data, we then estimate the impact of stronger product market competition on firms' profits in different parts of the within-industry productivity distribution. The results are shown in specifications (3)-(8) in Table A7. Regardless of specification, we find a stronger negative impact on profits for firms in the lower part of the productivity distribution for their respective industries. The asymmetry in impact also appears to be strongest in the tails of the productivity distribution, giving some support for the mechanism in Assumption 2.

Table A7

The skill-biased glass ceiling effect thus implies a positive selection of female managers where individuals in the lower part of the skill distribution are removed. If management skills are correlated with firm productivity, this would suggest that firms with a larger presence of female managers may cope better with stronger competition than firms with a stronger male dominance in management, in particular in the lower part of the firm productivity distribution. The final two columns in Table A7 explore this hypothesis by including the share of female managers and its interaction with the intensity of product market competition. For firms in the highest quantile of the productivity distribution, we find no statistically significant relation between the share of female managers and profits—neither directly nor through its interaction with product market interaction. Turning to low-productivity firms, however, we find a negative and significant effect on profits of a higher share of women in management consistent with a higher cost associated with female management (reflected by the cost lower flexibility $(1-\alpha)D$ in the theory). However, we also find a positive and significant coefficient of the interaction between the share of female managers and competition. This suggests that a higher share of females in management in less-productive firms indeed dampens the negative effect on profits from stronger competition, consistent with the evidence of a positive selection of female managers.

A.5. Extensions of the theory

In this section, we show that our theoretical results on the skilled-biased glass ceiling effect and the skilled-biased competition effect remain valid in a number of extensions of the simple benchmark model.

In Section A.5.1, we allow for *generalized bargaining*. Section A.5.2 explores *preference-based discrimination*. Section A.5.3 discusses *competition over talent between firms*, while Section A.5.4 deals with *competition between talent within firms*. Section A.5.5 allows for *different ability distributions between men and women*. In Section A.5.6, finally, we extend the analysis to *convex wage payments or "greedy work"* (where women are restricted from making the most of their skills by working fewer hours). These exercises also give rise to additional theoretical results.

A.5.1. Generalized bargaining

The benchmark model assumes that women and men are *equally able* in wage negotiations. Card et al. (2016), however, show that women are less likely to work in high-paying jobs and that women receive a lower share of the surplus generated at the firm level. This suggests that women may—for some reason— have weaker bargaining power.

To examine how weaker bargaining power for women would affect our results, let the firm have bargaining power, $\eta > 0$. If there is a female talent in firm j in (3.2) then she has $\psi > 0$ in bargaining power. Correspondingly, if firm j has a male talent, he has $\delta > 0$. In solving the model for the generalized Nash-bargaining solution, it is straightforward to show that the critical abilities needed to fulfill the investment conditions in (3.7) now become:

$$\begin{cases} S_j(\theta^{\mathcal{F}}) = \frac{\psi+\eta}{\psi} \times I + \psi D, \\ S_j(\theta^{\mathcal{M}}) = \frac{\delta+\eta}{\delta} \times I. \end{cases} \tag{A.2}$$

where under generalized bargaining it is convenient to redefine the surplus in (3.3) as $S_j(\theta) = \pi_j(\theta) - \pi_j(0)$.

Equation A.2 yet again reveals how the hurdle cost D forces women to have a higher ability than men to become managers. Interestingly, if females are worse at wage bargaining than males, $\psi < \delta$, this will *strengthen* the glass ceiling effect—if women receive a lower share of the generated surplus than men, then an even higher surplus, $S_j(\theta)$, and, hence, an even higher ability, θ, is needed to make career investment worthwhile.

Turning to the skill-biased competition effect, Lemma 2 still holds—the change in the surplus in competition, $S'_{j,C}(\theta)$ is U-shaped in ability θ. It then follows that the prediction in Proposition 2 on how competition can affect male and female managers' average wages differently also applies when $D = 0$, that is, when there is neither an additional disutility for women from taking up a position as manager nor an extra cost for firms to hire women as managers. Why? If women have a sufficiently strong disadvantage in bargaining, $\psi < \delta$, Equation (A.2) reveals that the glass ceiling effect arises from women needing a higher ability, θ, to cover the investment cost I. Adding the skill-biased competition effect and again assuming a sufficiently strong disadvantage, it follows that the average wage for female managers will be increasing in competition, while the impact of competition on the average wage for male managers will be ambiguous.

Thus, the asymmetric impact of stronger competition on female and male CEOs' wages is also compatible with women having lower bargaining power than men. Interestingly, and in contrast to the benchmark model that predicts a fixed gender pay gap (derived from the fixed cost, D), if women also have weaker bargaining power than men, then it can be shown that the *gender wage gap will be an increasing function of ability or firm-specific skill,* θ. Hence, that the gender pay gap will be highest "at the top".

A.5.2. Preference-based discrimination

We have assumed that the hurdle females face when working as managers stems from the job being inflexible and that this comes at a higher cost for females. An alternative explanation for the hurdle, based on preferences, can be found in the literature on the "glass ceiling"—a barrier of prejudice and discrimination that excludes women from higher level leadership positions.[41] The general presence of the glass ceiling has been explained based on attitudes within the workplace suggesting that workers prefer male to female supervisors and managers (Simon and Landis, 1989).[42] An easy way to capture pure discrimination in the benchmark model in Section 3 is to assume that the full cost D falls on the firm (i.e., assume that $\alpha = 1$).

[41] See, for instance, Federal Glass Ceiling Commission, 1995; Morrison et. al. (1987).

[42] Discrimination is often identity specific and, therefore, occupation specific. For instance, a male security guard might not want to work with a female security guard but might not have a problem working around a better paid female teacher (Akerlof and Kranton, 2000).

A.5.3. Competition for managers

A strong assumption in our benchmark model is that investments in a career as a manager only produce firm-specific skills. This implies that the only outside option for a potential manager, if the wage negotiation with the firm breaks down, is regular work at the outside wage, $w(0)$. How would the results change if we allowed for transfers of managerial skills across firms?

Applying a framework similar to that of Anton and Yao (1994), suppose that in the bargaining game in Stage 2, the talent first negotiates with firm j, and then—if no agreement is made—he or she can proceed to negotiate with a rival firm $k \neq j$. Furthermore, assume that a breakdown of negotiations with firm k gives no further opportunity for managerial work. The latter wage negotiations will then give rise to the wages given in (3.4), or (3.5), merely replacing firm-subscripts, i.e., $w_k^*(\theta \in \mathcal{M})$ or $w_k^*(\theta \in \mathcal{F})$. Using (the out-of-equilibrium) wage paid by firm k as the outside option in the negotiation with firm j, it can be shown that critical abilities needed to fulfill the investment conditions in (3.7) now become:

$$\begin{cases} S_j(\theta^{\mathcal{F}}) + \frac{\eta}{\psi+\eta} \times S_k(\theta^{\mathcal{F}}) = \frac{\psi+\eta}{\psi} \times I + \frac{\psi+2\eta}{\psi+\eta} \times D, \\ S_j(\theta^{\mathcal{M}}) + \frac{\eta}{\delta+\eta} \times S_k(\theta^{\mathcal{F}}) = \frac{\delta+\eta}{\delta} \times I. \end{cases} \tag{A.3}$$

where the surplus created when the potential manager works for firm k is $S_k(\theta) = \pi_k(\theta) - \pi_k(0)$. Note also that the surplus generated when the potential manager works for firm j is now $S_j(\theta) = \pi_j(\theta, 0) - \pi_j(0, \theta)$, with $\frac{d\pi_j(\theta,0)}{d\theta} > 0 > \frac{d\pi_j(0,\theta)}{d\theta}$. The former inequality again reflects the strategic advantage of employing a new skilled manager, while the latter inequality reflects the strategic disadvantage of seeing the skilled manager go to a rival firm. Note, finally, that Lemma 2 will apply to both $S_j(\theta)$ and $S_k(\theta)$—so that the right-hand side (RHS) in (A.3), will again be U-shaped in competition, given a sufficiently high θ.

From the RHS of (A.3), we then note that if women and men can extract surplus in the same way, i.e., if $\delta = \psi$, the disutility cost for women D again gives rise to the glass-ceiling effect, $\theta^{\mathcal{F}} > \theta^{\mathcal{M}}$. However, if women extract less surplus than men in wage bargaining, i.e., if $\psi < \delta$, even more talent is needed for women to make a career worthwhile, strengthening the glass ceiling effect. However, from the left-hand side (LHS) of (A.3), we also note that the outside option of working for firm k can weaken the glass ceiling effect: if women have lower bargaining power than men, they will have a lower disagreement wage in firm k (i.e., a smaller outside option), which—ceteris paribus—gives women a larger net surplus from an agreement with firm j. The empirical results where female managers, on average, experience an increase in their wage from increasing competition, while male managers, on average, see their wage unaffected by competition, suggest that this latter effect is limited.

A.5.4. Competition between trainees in a firm

In the benchmark model, only one trainee is assigned to each firm. Yet another interesting extension is then to allow for competition between a male and a female trainee within the firm. Is such a setting also compatible with our empirical results?

Consider the benchmark model with investment in firm-specific skills. Suppose that firm j now has two talented workers—a male and a female. Both individuals can invest in a career as a manager but need to take the other's decision to invest into account. For simplicity, consider pure Nash equilibria in career investments. Then, there exists no equilibrium where both invest if both have the same innate talent, θ—if both would invest, the firm would then play them against each other, and the wage would be bid down to the outside wage, $w(0)$. All other possible equilibria can occur depending on the drawn talent pair: only the female trainee invests when she has talent $\theta \geq \theta^{\mathcal{F}}$ and the male trainee has talent $\theta < \theta^{\mathcal{M}}$; only the male trainee invests when he has talent $\theta \geq \theta^{\mathcal{M}}$ and she has talent $\theta < \theta^{\mathcal{F}}$; and neither invests when $\theta < \theta^{\mathcal{M}}$. When both have a talent $\theta \geq \theta^{\mathcal{F}}$, there is an asymmetric equilibrium, but we cannot predict who will invest without further assumptions.

However, if we again apply the sequential framework in Anton and Yao (1994), the firm would first bargain with the trainee that it wants to hire, using the other trainee as its outside option. The firm would then select the trainee that creates the highest net surplus. The two trainees would see through this procedure and—in equilibrium—only one of the trainees would invest. Since the female trainee is subject to a higher hurdle, she would need to have a significantly higher ability to create the necessary surplus to be chosen, and hence the glass ceiling effect would again be present. The reasoning in the benchmark model would apply, and the glass ceiling effect and the skill-biased competition effect would yet again produce a pattern where female managers see their wages increase in competition while male managers do not.

A.5.5. Different ability distributions

In the benchmark model, we assumed that men and women have identical talent distributions. We believe that this is a reasonable assumption. While there is some evidence pointing to greater variance in ability test scores in the male population (see, for instance, Machin and Pekkarinen, 2008), there is to our knowledge, no evidence suggesting that the ability test scores of females and males differ in the way suggested by the estimated spell fixed effects in Figure 4.1.

Women do outnumber men in university attendance rates in most OECD countries (Goldin, Katz, and Kuziemko, 2006). This difference is partly because females outperform males in compulsory and high school grade point averages (GPAs) and are also less likely to drop out of high school (OECD, 2017). On the other hand, males tend to perform at least as well as females on standardized aptitude tests (see, for instance, Duckworth and Seligman, 2006) and typically outperform females on tests measuring quantitative skills (see, for instance, Fryer Jr and Levitt, 2010). Graetz and Karimi (2022), use administrative data on the Swedish population and document that females, on average, outperform males on both compulsory school and high school GPAs by approximately one-third of a standard deviation but that the reverse is true for the Swedish SAT, where females underperform by one-third of a standard deviation relative to males.

How would results then change if we allowed the distribution of talent to differ between men and women? Suppose that the talent distribution of women is $f(\theta)$ and the talent distribution of men is $m(\theta) \neq f(\theta)$. While assuming different distributions for males and females will have an impact on the gender pay gap in (3.10) and (3.11) as well as the change in the expected wage when competition increases as given in (3.14) and (3.13), Proposition 2 is still valid: in particular, if the female talent distribution, $f(\theta)$, has support over the full range $\theta \in [0, \theta^{\max}]$, the average wage for female managers will always increase in competition if women face a sufficiently high hurdle.

A.5.6. "Greedy work"

Goldin (2014) argues that the gender wage gap at the top can emerge when marginal working hours during evenings and weekends or on a stand-by basis are important for firms. This results in convexities in pay where marginal hours increase the wage more than linearly, which Goldin (2021) labels "greedy work". If women—due to entrenched cultural norms related to family and children—refrain from taking up such inflexible but highly paid work, they will fall behind men. Extending the model to "greedy work", we can reconcile the empirical findings in Section 4.2.1 of a female skill premium at the bottom of the skill distribution (the skill-biased glass ceiling effect) with a male skill premium at the top of the skills distribution. We can also show that even when females are constrained in their labor supply, the positive selection of women into management can result in average wages increasing more in competition than the average wage of male managers (the skill-biased competition effect).

To show this, assume that hurdle cost D now solely represents the disutility for women to take up inflexible work (i.e., $\alpha = 0$ in the benchmark model). Suppose further that this hurdle cost is so high that $\theta^{\mathcal{F}} = \theta^{S}$, that is, $D = \tilde{D}$. We thus have[43]

$$\begin{cases} S_j(\theta^{\mathcal{F}}) = I + \frac{\tilde{D}}{2}, \\ S'_{j,C}\left(\theta^{\mathcal{F}}\right) = 0. \end{cases} . \tag{A.4}$$

From Lemma 2, the wage for female managers must then unambiguously increase in competition, i.e., $S'_{j,C}(\theta) > 0$ whenever $\theta > \theta^{\mathcal{F}}$.

Then, introduce a variable loss for the firm from hiring a female manager. To this end, assume that the combination of family concerns and an inflexible workplace implies that a female manager can only use a share $\beta \in (0,1)$ of her firm-specific skills, θ. It is useful to think of β as the share of the full work day of a male manager that a female manager will be available. The surplus from hiring a female manager is then $S_j\left(\beta\theta\right)$. It then follows that (A.4) becomes

$$\begin{cases} S_j(\beta\tilde{\theta}^{\mathcal{F}}) = I + \frac{\tilde{D}}{2}, \\ S'_{j,C}\left(\beta\tilde{\theta}^{\mathcal{F}}\right) = 0. \end{cases} \tag{A.5}$$

Compare the LHS in (A.4) and (A.5). From these expressions, it follows that we must have $\theta^{S} = \theta^{\mathcal{F}} = \beta\tilde{\theta}^{\mathcal{F}}$, and hence, $\tilde{\theta}^{\mathcal{F}} = \frac{\theta^{\mathcal{F}}}{\beta} > \theta^{\mathcal{F}}$. Thus—ceteris paribus—women need an even greater innate talent to invest into a career as manager, $\tilde{\theta}^{\mathcal{F}} > \theta^{\mathcal{F}}$. However, given this higher innate talent, female managers' wages will still increase in competition, since the surplus must increase in competition, i.e., $S'_{j,C}\left(\beta\theta\right) > 0$ for $\theta \in (\tilde{\theta}^{\mathcal{F}}, \theta^{\max}]$. Now, note that we have made no change in assumptions for male managers. Hence, it follows that this extended model—where the gender-specific career hurdle is variable and type dependent— is still compatible with male managers' wages, on average, being unaffected by competition—while female managers' wages from positive selection, on average, increase in competition.

We can summarize with the following corollary:

Corollary 1. *Suppose that the hurdle cost D solely represents the disutility a female talent associates with choosing a managerial career, i.e., $\alpha = 0$. Assume that the gender-specific career hurdle is variable and type dependent such that the female manager can only use a share $\beta \in (0,1)$ of her firm-specific talent or skill, θ. Then, if β is not too low, Propositions 1 and 2 are still valid.*

This extended model also sheds light on the empirical finding in Section 4.2.1 of a large skill gap in favor of men at the top of the skills distribution of managers. If women can

[43] For simplicity, we retain the assumption that the fixed hurdle cost is shared by the firm and the female manager. However, since the investment decision in (3.7) is independent of how the fixed hurdle cost is split, the results do no hinge on how the fixed cost is split.

only use a share $\beta \in (0,1)$ of their firm-specific talent or skill, θ, women are less productive. It follows directly that the gender-skill gap must increase in ability. This will also hold for wages. To see this, we first denote full surplus for the parties S_j in firm j. The increase in surplus S_j from higher ability will then be smaller with a female manager than with a male manager of the same skill, i.e., for $\hat{\theta} = \beta\theta < \theta$, $S_j'(\theta) > \beta \cdot S_j'(\hat{\theta})$.[44]

Goldin (2021) also discusses how firms may reorganize their organization and reduce the disadvantage for women in jobs with to low flexibility. The development of new technologies and organizational setups during the COVID-19 pandemic have made it easier to undertake top executive tasks from home. Attitudes toward allowing work from home may also have changed. An interesting result in this extended model is then that such investments may be beneficial for both female employees and their employers, particularly when competition increases. To see this, suppose that a firm can invest in a technology or into a new work environment at a cost T that allows a female manager to make use of her full firm-specific skills, i.e., allows for $\beta = 1$. We then have the following result:

Corollary 2. *Suppose that the hurdle cost D solely represents the disutility that a female talent associates with choosing a managerial career, i.e., $\alpha = 0$. Assume that a female manager can only use a share $\beta \in (0,1)$ of her firm-specific talent or skill, θ. Stronger product market competition can then increase the incentive to invest in a technology or working environment that allows female managers to make use of their full skill, $\beta = 1$.*

This follows directly from Lemma 2 by noting that the firm and the female manager share in the increased surplus generated when competition increases under a skilled manager that can make use of her full capacity.

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[44] As with the extension of weaker bargaining power for women in Section A.5.1, this implies that the gender wage gap will be highest at the top. Azmat and Ferrer (2017) examine estimated gender coefficients from quantile regressions at different points in the distribution and find that for client revenue, there is some evidence that the gender gap is indeed largest at the top of the distribution.

Online Appendix: Tables and figures

Table A1: O*Net characteristics. Means (normalized) by occupational group. Table 2 in Goldin (2014) but with additional information on managers and on chief executives and legislators.

O*Net characteristics	Technology and Science	Business	Health	Law	Managers	Chief executives and legislators
Time pressure	-.571	.055	.107	1.510	.640	.833
Contact with other	-.888	-.079	.788	.483	.429	.520
Establishing and maintaining interpersonal relationships	-.699	.574	.216	.781	.454	1.426
Structured vs. Unstructured work	-.610	.089	.419	1.220	.491	.979
Freedom to make decisions	.523	-.209	.743	.764	.290	1.108
Number of occupations	29	18	14	1	16	1

Notes: This table shows O*Net characteristics for the original four occupational groups presented in Table 2 in Goldin (2014), but where we separate out managerial occupations and chief executives and legislators.

Table A2: O*Net characteristics differences between managers and non-managers.

O*Net characteristics	Time pressure	Contact with other	Establishing and maintaining interpersonal relationships	Structured vs. Unstructured work	Freedom to make decisions
	0.77***	0.52***	0.55**	0.59**	0.35*
Manager	(0.23)	(0.17)	(0.27)	(0.23)	(0.18)
Observations (occupations)	94	94	94	94	94
R^2	0.09	0.04	0.04	0.05	0.02

Notes: This table shows estimated coefficients from regressions by O*Net characteristics. Each specification has an O*Net characteristics (normalized) as dependent variable and Manager is an indicator variable equal to one if the occupation is a manager occupation. Robust standard errors, where ***, **, * show significance at the 1%, 5%, and 10% levels, respectively.

Figure A1(i):

Figure A1(ii)

Figure A1(iii)

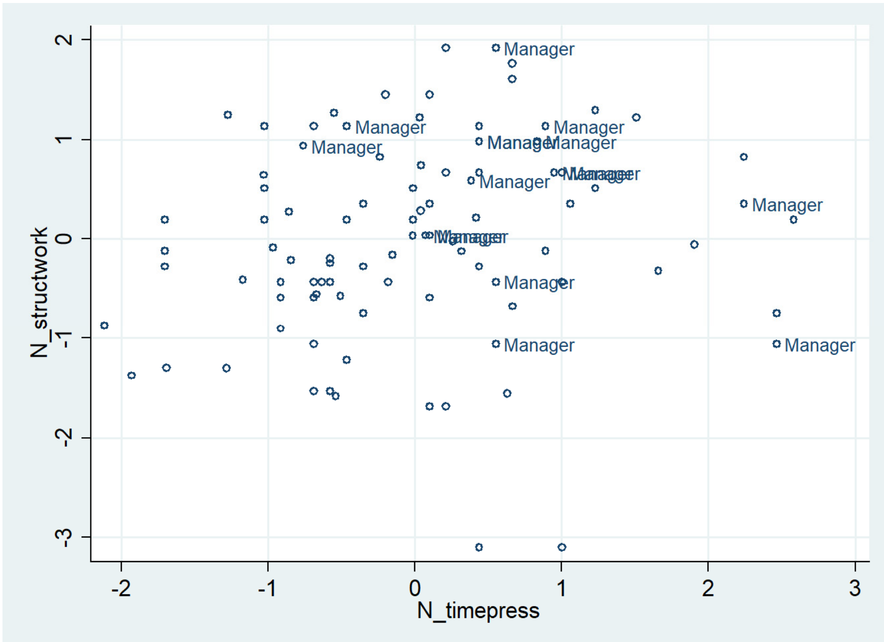


Figure A2(iv)

Notes: Figure A1 plots "Time pressure" at the horizontal axis against (i) "Contact with other" , (ii) "Establishing and maintaining interpersonal relationships", (iii) "Structured vs. Unstructured work" and (iv) "Freedom to make decisions. The figure is based on the same 94 occupations as in Goldin (2014).

:

Figure A2(i)

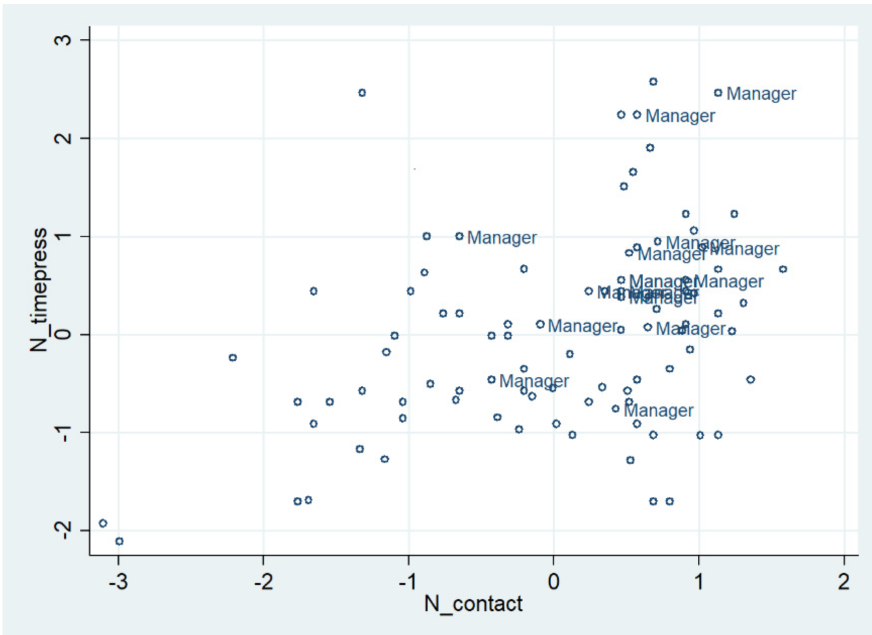


Figure A2(ii)

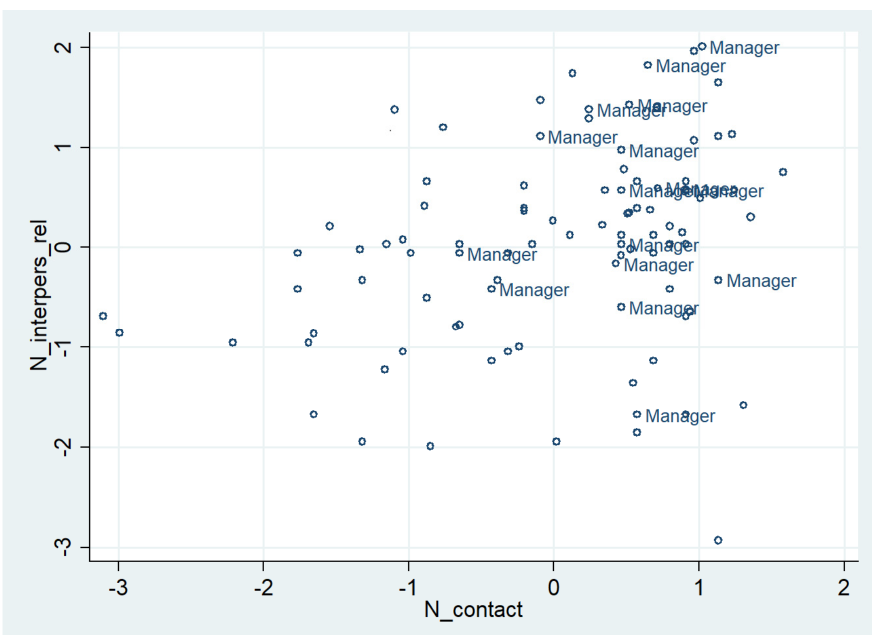


Figure A2(iii)

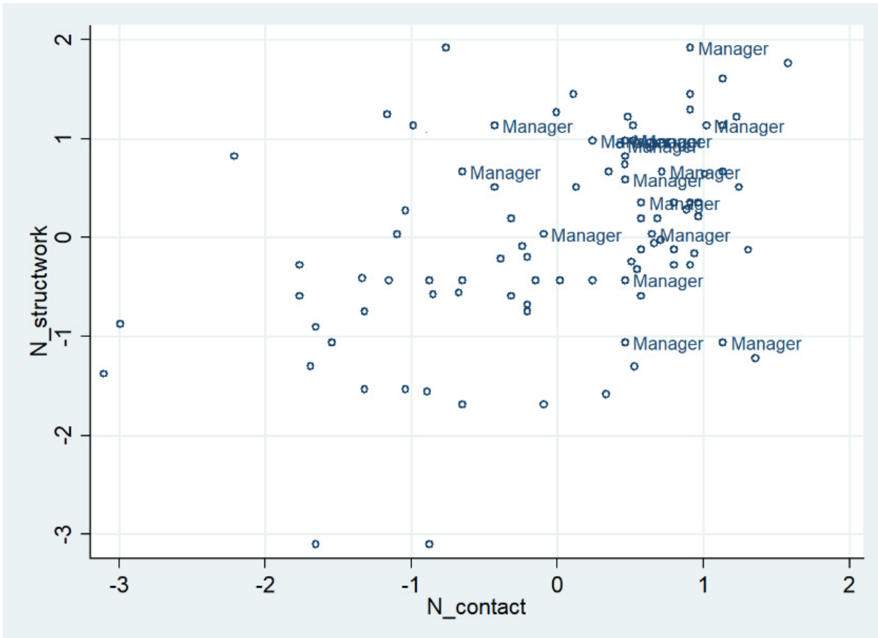
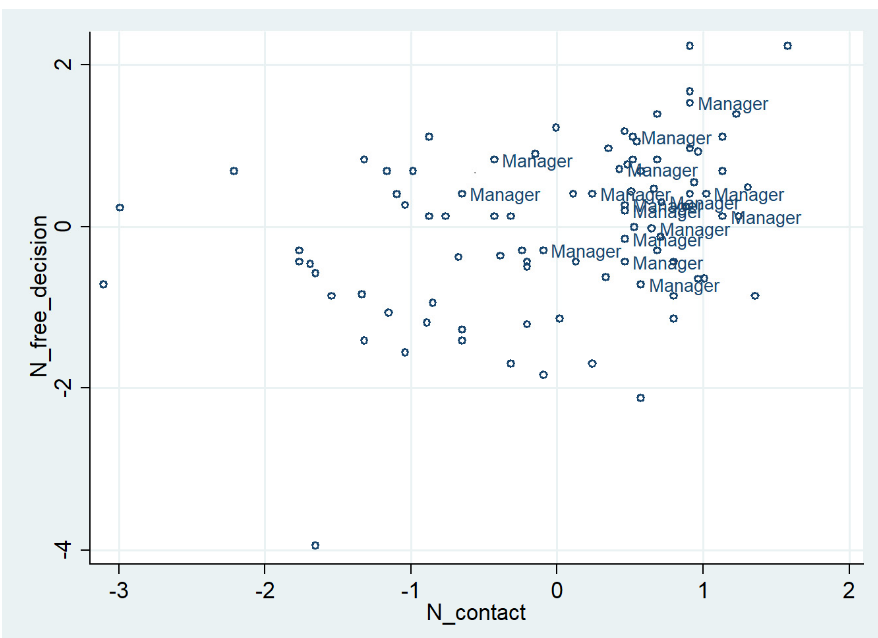


Figure A2(iv)



Notes: Figure A2 plots "Contact with other" at the horizontal axis against (i) "Time pressure", (ii) "Establishing and maintaining interpersonal relationships", (iii) "Structured vs. Unstructured work" and (iv) "Freedom to make decisions. The figure is based on the same 94 occupations as in Goldin (2014).

Table A3a. Gender differences in wages, 1996-2009 (all employees)

	1	2	3	4	5	6
=1 if female	-0.147***	-0.156***	-0.144***	-0.105***	-0.092***	-0.094***
	(0.006)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
=1 if finished 9 years		0.013***	0.041***	0.015***	0.017***	0.016***
of primary school		(0.004)	(0.005)	(0.003)	(0.003)	(0.002)
=1 if 2 years of		0.058***	0.075***	0.028***	0.031***	0.027***
secondary school		(0.007)	(0.010)	(0.004)	(0.004)	(0.003)
=1 if 3 years of		0.110***	0.218***	0.092***	0.093***	0.087***
secondary school		(0.012)	(0.012)	(0.005)	(0.004)	(0.004)
=1 if 4 years of		0.227***	0.281***	0.103***	0.115***	0.097***
secondary school		(0.013)	(0.011)	(0.007)	(0.005)	(0.005)
=1 if college degree		0.430***	0.518***	0.241***	0.248***	0.229***
		(0.015)	(0.014)	(0.009)	(0.007)	(0.007)
=1 if doctoral degree		0.683***	0.767***	0.436***	0.431***	0.407***
		(0.026)	(0.025)	(0.022)	(0.015)	(0.016)
Experience			0.026***	0.018***	0.017***	0.017***
			(0.001)	(0.001)	(0.001)	(0.001)
Experience/100^2			-0.040***	-0.028***	-0.026***	-0.026***
			(0.002)	(0.001)	(0.001)	(0.001)
Capital intensity						0.001
						(0.001)
Log firm size						0.003
						(0.002)
Share skill high						0.191***
						(0.030)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Occupation fixed effects	No	No	No	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	Yes	Yes
R^2	0.12	0.30	0.40	0.56	0.59	0.60
No. of obs.	12,982,189	12,901,343	12,901,343	12,604,820	12,558,919	12,558,918

Notes: The estimates in this table are based on the following regression: $logw_{ijt} = \gamma_0 + \gamma_1 * wom + X_{it}\eta + Z_{jt}\lambda + \delta_t + \theta_h + \varepsilon_{ijt}$, where $logw_{ijt}$ is the log wage of worker *i* in firm *j* at time *t*, measured as full-time equivalent wages, X_{it} is a vector of observable time-varying worker characteristics, Z_{jt} is a vector of observable time-varying firm characteristics, δ_t is a year fixed effect, and ε_{ijt} is the error term. Time-varying worker characteristics include experience, experience squared, and dummy variables for educational attainment and occupation. Firm, time-varying characteristics include capital intensity, firm size (number of employees), and the share of high-skill workers (i.e., the share of the labor force with at least 3 years of post-secondary education). Standard errors are clustered at the individual level. ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

Table A3b. Gender differences in wages, 1996-2009 (executive positions)

	Type of position					
	All managerial		Managerial below CEO		CEOs only	
=1 if female	-0.167***	-0.148***	-0.125***	-0.127***	-0.454***	-0.219***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.007)	(0.005)
=1 if finished 9 years of primary school		0.050***		0.041***		0.058***
		(0.005)		(0.005)		(0.015)
=1 if 2 years of secondary school		0.078***		0.065***		0.094***
		(0.004)		(0.004)		(0.014)
=1 if 3 years of secondary school		0.239***		0.211***		0.300***
		(0.004)		(0.004)		(0.015)
=1 if 4 years of secondary school		0.296***		0.259***		0.353***
		(0.005)		(0.005)		(0.017)
=1 if college degree		0.555***		0.486***		0.665***
		(0.005)		(0.004)		(0.016)
=1 if doctoral degree		0.678***		0.612***		0.795***
		(0.009)		(0.008)		(0.028)
Experience		0.043***		0.039***		0.048***
		(0.000)		(0.000)		(0.001)
Experience/100^2		-0.064***		-0.059***		-0.069***
		(0.001)		(0.001)		(0.002)
Capital intensity		0.005***		0.005***		0.001*
		(0.000)		(0.000)		(0.001)
Log firm size		-0.008***		-0.002***		-0.007***
		(0.000)		(0.000)		(0.002)
Share skill high		0.383***		0.381***		0.478***
		(0.006)		(0.006)		(0.019)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Occupation fixed effects	No	Yes	No	Yes	No	Yes
Industry fixed effects	No	Yes	No	Yes	No	Yes
No. of obs.	794,298	794,298	692,707	692,707	101,591	101,591
R^2	0.13	0.47	0.17	0.49	0.12	0.54

Notes: The estimates in this table are based on the following regression:

$$logw_{ijt} = \gamma_0 + \gamma_1 * wom + X_{it}\eta + Z_{jt}\lambda + \delta_t + \theta_h + \varepsilon_{ijt}$$

where $logw_{ijt}$ is the log wage of worker *i* in firm *j* at time *t*, measured as full-time equivalent wages, X_{it} is a vector of observable time-varying worker characteristics, Z_{jt} is a vector of observable time-varying firm characteristics, δ_t is a year fixed effect, and ε_{ijt} is the error term. Time-varying worker characteristics include experience, experience squared, and dummy variables for educational attainment and occupation. Firm, time-varying characteristics include capital intensity, firm size (number of employees), and the share of high-skill workers (i.e., the share of the labor force with at least 3 years of post-secondary education). Standard errors are clustered at the individual level. ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

Table A4. Decomposition of managers' (below CEO) wages, 1996-2009

	Log wage			Predicted wage from observables			Individual-firm fixed effects ("spell FE")		
	Female	Male	Gender gap (%)	Female	Male	Gender gap (%)	Female	Male	Gender Gap* (%)
1%	11.27	11.45	20.01	10.92	11.29	45.54	1.04	1.22	32.3
5%	10.93	11.06	13.78	10.84	11.16	37.34	0.71	0.85	27.1
10%	10.78	10.89	12.17	10.78	11.05	30.52	0.53	0.66	25.9
25%	10.53	10.63	10.76	10.63	10.8	18.44	0.24	0.33	20.9
50%	10.23	10.32	8.8	10.39	10.45	6.14	-0.09	-0.05	15.0
75%	9.98	10.05	7.85	10.1	10.06	-3.5	-0.39	-0.45	4.1
90%	9.82	9.89	7.87	9.81	9.73	-7.7	-0.64	-0.75	-1.0
95%	9.74	9.82	8.01	9.64	9.54	-9.6	-0.77	-0.91	-3.9
99%	9.61	9.69	8.76	9.36	9.21	-13.36	-0.98	-1.17	-8.6
Mean	10.27	10.37		10.34	10.41		-0.06	-0.05	12.4
Std Dev.	0.38	0.4		0.37	0.5		0.45	0.54	
Variance	0.14	0.16		0.14	0.25		0.2	0.29	
Skewness	0.58	0.67		-0.66	-0.35		0.27	0.14	
Kurtosis	3.33	3.59		3	2.52		2.91	2.69	
	Shapiro Wilk test for normality								
W	0.98	0.97		0.96	0.98		0.99	1.00	
V	454.96	1352.96		711.55	776.11		101.07	152.55	
z	16.98	20.34		18.23	18.77		12.81	14.18	
Prob > z	0.000	0.000		0.000	0.000		0.000	0.000	
No. of spells (CEO-firm)	51,881	180,077		51,881	180,077		51,881	180,077	

Note: Numbers in this table are based on the specifications for managers below CEOs in Table 5, calculated from gender-specific means. For example, the implied gender-wage gap from estimated CEO-firm fixed effects at the 99 % percentile is given as $100 \times \frac{e^{10.37-1.17} - e^{10.27-0.98}}{e^{10.27-0.98}}$ = -8.6%.

Table A5. Decomposition of non-managers' wages, 1996-2009

	Log wage			Predicted wage from observables			Individual-firm fixed effects ("spell FE")		
	Female	Male	Gender gap (%)	Female	Male	Gender gap (%)	Female	Male	Gender Gap* (%)
1%	10.61	10.83	24.6	10.26	11.41	16.9	0.77	0.96	36.9
5%	10.29	10.5	23.2	10.22	11.37	16	0.48	0.61	29.4
10%	10.13	10.32	21.1	10.18	11.32	15.2	0.35	0.45	24.7
25%	9.93	10.06	14.8	10.07	10.19	12.3	0.13	0.18	18.7
50%	9.75	9.87	12.1	9.9	10.01	11.4	-0.11	-0.1	14.1
75%	9.62	10.72	10.6	9.71	9.82	11.4	-0.31	-0.34	10.4
90%	9.5	9.59	9	9.52	9.6	8.6	-0.47	-0.53	6.6
95%	9.44	9.51	7.8	9.39	9.47	8.1	-0.56	-0.64	3.8
99%	9.31	9.37	6	9.18	9.25	7.5	-0.69	-0.81	0.5
Mean	9.79	9.92	13.23	9.87	9.98	11.67	-0.08	-0.06	16.12
Std Dev.	0.26	0.30		0.25	0.27		0.32	0.39	
Variance	0.07	0.09		0.06	0.07		0.10	0.15	
Skewness	1.01	1.01		-0.65	-0.601		0.49	050	
Kurtosis	5.06	4.96		3.01	2.96		3.33	3.37	
	Shapiro Wilk test for normality								
W	0.95	0.95		0.96	0.97		0.99	0.99	
V	5974.79	7069.25		4621.23	4433.90		1750.97	1956.66	
z	24.69	25.12		23.96	23.80		21.20	21.48	
Prob > z	0.000	0.000		0.000	0.000		0.000	0.000	
No. of spells (CEO-firm)	1,388,023	2,111,681		1,388,023	2,111,681		1,388,023	2,111,681	

Note: Numbers in this table are based on the specifications for non-managers in Table 5, calculated from gender-specific means. For example, the implied gender-wage gap from estimated CEO-firm fixed effects at the 99 % percentile is given as

$$100 \times \frac{e^{9.92-0.81} - e^{9.79-0.69}}{e^{9.79-0.69}} = 0.5\%$$

Table A6. Wage regressions with individual-firm spell fixed effects by gender and firm size, 1996-2009

	Type of position and firm size group																	
	All managerial, 50+		All managerial, 100+		All managerial, 250+		Managerial below CEO, 50+		Managerial below CEO, 100+		Managerial below CEO, 250+		CEOs only, 50+		CEOs only, 100+		CEOs only, 250+	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Competition	0.150	0.498**	0.140	0.504**	0.148	0.542**	0.099	0.348*	0.084	0.343	0.076	0.353	0.308	0.689***	0.277	0.657**	0.295	0.727**
	(0.112)	(0.228)	(0.119)	(0.237)	(0.135)	(0.267)	(0.113)	(0.203)	(0.120)	(0.208)	(0.136)	(0.239)	(0.293)	(0.245)	(0.289)	(0.269)	(0.333)	(0.291)
Experience/	-0.064***	-0.046***	-0.065***	-0.046***	-0.066***	-0.047***	-0.064***	-0.049***	-0.065***	-0.049***	-0.066***	-0.050***	-0.049***	-0.026***	-0.048***	-0.026***	-0.046***	-0.027***
100^2	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Capital int.	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.000	0.001	0.000	0.001	0.002	0.003	0.003	0.002	0.001
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)	(0.001)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
Log firm size	0.001	0.004***	0.005	0.003	0.002	0.003	0.000	0.005***	0.003	0.006	0.000	0.004	0.013	0.011***	0.027	0.011	0.017	0.009
	(0.004)	(0.001)	(0.012)	(0.006)	(0.014)	(0.006)	(0.004)	(0.001)	(0.013)	(0.005)	(0.014)	(0.006)	(0.009)	(0.004)	(0.019)	(0.011)	(0.021)	(0.011)
Share skill	0.076***	0.081**	0.074**	0.103**	0.069*	0.128***	0.060**	0.099***	0.057*	0.113**	0.048	0.117**	0.303***	0.075	0.367***	0.097	0.408***	0.157**
high	(0.027)	(0.035)	(0.035)	(0.042)	(0.040)	(0.042)	(0.025)	(0.035)	(0.030)	(0.043)	(0.035)	(0.044)	(0.052)	(0.065)	(0.061)	(0.087)	(0.077)	(0.069)
R^2	0.496	0.469	0.504	0.470	0.513	0.475	0.515	0.487	0.521	0.487	0.530	0.491	0.299	0.284	0.306	0.283	0.310	0.287
No. spells	191,006	56,802	173,805	52,116	148,827	45,091	172,199	49,572	157,662	45,500	135,389	39,415	28,358	10,623	24,895	9,823	21,149	8,401
No. obs.	608,729	155,560	561,052	144,072	490,081	126,977	539,204	130,984	499,484	121,052	437,460	106,686	69,525	24,576	61,568	23,020	52,621	20,291

Notes: Dependent variable is log full-time equivalent wages. Competition is based on Boone measure (see Section 3 for details). Capital intensity is Capital stock/Number of employees, Firm size is number of employees, Share skill high is share of the labor force with at least 3 years of post-secondary education. Standard errors are clustered by industry. ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

Table A7. Product market competition (Boone), share of female managers and profits: Firm-level estimates 1996-2009 on different parts of the productivity distribution

	Part of the productivity distribution									
	All obs	All obs	Below median	Above median	Below median	Above median	Bottom 25%	Top 25%	Bottom 25%	Top 25%
Competition	-7.607***	-2.452*	-4.889**	-2.354	-5.006**	-3.362**	-8.322*	-1.950	-11.660**	-1.238
	(2.227)	(1.235)	(2.250)	(1.568)	(2.235)	(1.551)	(4.172)	(2.094)	(4.475)	(2.483)
Share female managers									-1.086***	-0.059
									(0.387)	(0.248)
Comp.*Share fem. Managers									17.686**	-2.933
									(7.997)	(5.481)
Capital intensity		0.074***			0.033	-0.002	0.067	-0.036	0.015	-0.017
		(0.018)			(0.028)	(0.023)	(0.045)	(0.028)	(0.050)	(0.029)
Log firm size		0.592***			0.812***	0.611***	0.829***	0.580***	0.748***	0.610***
		(0.035)			(0.059)	(0.052)	(0.113)	(0.097)	(0.142)	(0.089)
Share skill high		0.405*			0.328	-0.151	0.971	0.380	0.735	0.277
		(0.241)			(0.439)	(0.268)	(0.794)	(0.386)	(1.025)	(0.344)
R^2	0.003	0.060	0.038	0.048	0.070	0.080	0.066	0.087	0.066	0.087
No. of obs.	30,505	30,085	12,583	17,547	12,359	17,367	4,725	8,721	4,725	8,721

Notes: Dependent variable is log profits. Competition is based on Boone measure (see Section 3 for details). Capital intensity is Capital stock/Number of employees, Firm size is number of employees, Share skill high is share of the labor force with at least 3 years of post-secondary education. Productivity is measured as value added per employee. Grouping of firms are based on the within-industry productivity distribution. Standard errors are clustered by industry. ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

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