Diversity is More than Numbers: The Wage Effects of Supervisor-Worker Gender Match

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Abstract

This study explores the relationship between workers' wages and the gender of supervisors, conditioning on the occupational gender composition. It develops a theoretical model suggesting that supervisors' task assignment accuracy is affected disparately in occupations of different gender types, leading to varying degrees of skill mismatch among workers. This leads to average wage differences between workers with same-gender supervisors and those with opposite-gender supervisors in different occupations. Consistent with our theoretical predictions, the empirical evidence suggests that workers have better occupation-skill matches and higher average wages if they work with same-gender supervisors in occupations dominated by same-gender workers. Although not significant at the early career stage, supervisor wage effects emerge as a worker's career develops. These findings emphasize the importance of supervisors' task assignment accuracy in workplace gender wage disparity, and underscore the necessity of integrating minority managers to the "gendered" organizational contexts.

Keywords: Same-gender supervisor, occupational gender composition, skill mismatch, wage effects

JEL Codes: J16, J24, J30, J7

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1. Introduction

Does the gender of supervisor matter with respect to the wages of the subordinate? The answer to this question has important policy implication; specifically, can the workplace gender wage gap be narrowed by imposing gender quotas[2] in managerial positions (e.g. Hultin and Szulkin 2003; Gorman 2005; Hensvik 2014; Ridgeway 1997).

However, the existing evidence on the direction and the significance of the relationship is mixed. Although the literature has documented that same-gender supervisors have positive effects on workers' career outcomes (Beckman and Phillips 2005; Cohen and Huffman 2007; Flabbi, Macis, Moro and Schivardi 2014; Hultin and Szulkin 2003; Matsa and Miller 2011)[3], this pattern is challenged by other empirical findings. For instance, some research finds that women earn higher wages when working with a male supervisor (Rothstein 1997). Evidence also shows that female supervisors devaluate women even more than do male supervisors (Heilman and Haynes 2005; Mavin 2006; Maume 2011): a pattern referred to as the "Queen-Bee Syndrome" in sociology (Cooper 1997; Staines, Tavris, and Jayaratne 1974). In addition, some researchers argue that the gender of supervisor simply has no effect on workers' wages when unobserved characteristics are controlled for (Bednar and Gicheva 2014; Hensvik 2014; Fadlon 2010; Sicilian and Grossberg 2014; Penner and Toro-Tulla 2010; Marianne, Black, Jensen and Lleras-Muney 2014; Penner, Toro-Tulla and Huffman 2012). These mixed findings, however, cannot be reconciled using the traditional taste-based discrimination or statistical discrimination models,[4] pointing to previously unexplored mechanisms.

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[2] Imposing gender quotas in top management groups has been a common practice in most European countries. Countries such as Germany, France, Belgium, Iceland, and Italy impose mandatory quotas of female board members. Countries like Austria, Finland, the Netherlands, Spain, Sweden, and the UK adopt voluntary goals for female representation (25%-40%). Currently, the US has no voluntary or mandatory quotas of female board members. There is a discussion on whether it is necessary to adopt such quota in the US. (Source: Margarethe Wiersema and Marie Louise Mors "What Board Directors Really Think of Gender Quotas" Harvard Business Review, Nov. 14, 2016. https://hbr.org/2016/11/what-board-directors-really-think-of-gender-quotas).

[3] Within this particular literature, some researchers use the proportion of female managers as exploratory variable, indicating that greater representation of females in powerful positions would result in higher average wages (Bell 2005; Hultin and Szulkin 1999; Kunze and Miller 2014; Maume and Ruppanner 2015; Tate and Yang 2015) and better career outcomes for female employees (Bell, Smith, Smith, and Verner 2008; Gorman 2005; Matsa and Miller 2011). Another literature matches employees with their direct supervisors (Gorman 2005; Hensvik 2011; Lucifora and Vigani 2016). For a summary of literature, see Appendix A.

[4] According to the taste-based discrimination theory (Becker 1957) supervisors favor same-gender workers against opposite-gender ones. Statistical discrimination theory (Phelps, 1972; Aigner and Cain 1977) indicates that incomplete information and workers' exogenous group differences contribute to employment disparities, even if supervisors do not have subjective preferences. Following this, some theoretical models suggest that supervisors are better informed of workers' unobserved productivity when they share the same cultural group (e.g., gender, race, and ethnicity) (Athey, Avery, and Zemsky 2000, Altonji and Pierret 1997, Cornell and Welch 1996, Oettinger 1996). Whichever theory applies, one may expect to observe empirically that workers are more likely to receive higher wages when working with a same-gender supervisor than with a supervisor of the opposite-gender. However, this pattern is not consistently observed in the aforementioned empirical literature.

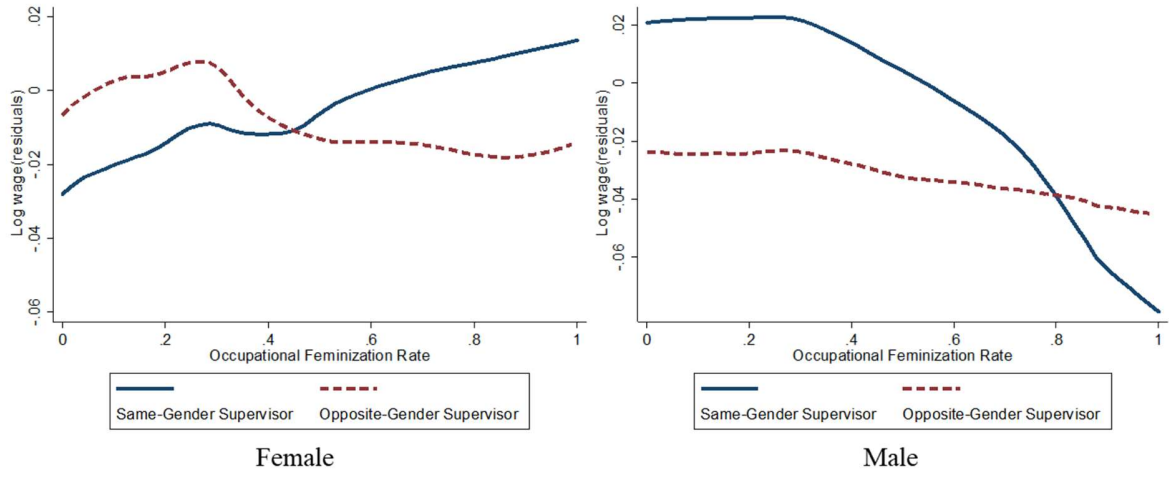

Figure 1 Workers with same-gender supervisors earn higher than would be predicted in occupations predominantly populated by same-gender workers.[5]

Figures 1 presents the stylized facts from basic wage regressions that motivates this research. I divided workers in the NLSY97 core sample into two groups: workers with same-gender supervisor (blue solid line) and workers with opposite-gender supervisor (red dashed line); then I plot the residual wages along the spectrum of occupational female employment rate (a.k.a. occupational feminization rate). A pattern emerges: in occupations predominantly populated by same-gender workers, workers with same-gender supervisors earn higher wages than would be expected based on their demographic and occupational characteristics, compared to workers with opposite-gender supervisors; the opposite is true for workers in occupations predominantly populated by opposite-gender workers. These suggest that the same-gender-supervisor wage effects may vary conditioning on occupational gender composition.

Occupational gender composition not only affects the interaction between male and female supervisors within the managerial group, but also influences the gender-based interaction between supervisors and subordinates across organizational hierarchies (Gagliarducci and Paserman 2015; Ridgeway and England 2007, 199-200). The literature has documented that male and female supervisors are attached disparately to the gendered culture and social networks in different

5 To obtain the residual wages, I regress one's natural log of real hourly wages (in 2002's dollar value) on a set of demographic characteristics (race, highest years of education, experience, average percentile ranks of ASVAB scores, employer tenure, occupational tenure as well as their polynomials) and a set of occupational characteristics (average percentile ranks of O*NET occupation skill requirements, one-digit occupation groups, one-digit industry groups). Details on variables and definition of match measures is given in Section 3. To construct the lines shown in the figure, I ran local polynomial regressions with residual wages on occupational feminization rate for each group of workers.

occupations. For example, female managers are found to be marginalized in predominantly male occupations;[6] this excludes them from getting access to vital information on inner-organization resource allocation. In predominantly female occupations, although men have benefited from their minority status in terms of better career development (Bradley 1993), the contradictions between their masculinity and the feminized occupational sub-culture alienate them from the female staff (Williams 1993; Simpson 2004). Therefore, in occupations populated by opposite-gender workers, supervisors may themselves be the victims of information distortion which will compromise their effectiveness in staffing decisions (Kanter 1977; Ely 1995, Cohen and Huffman 2007). Figure 2 illustrates this point by showing that workers have better match qualities with the same-gender supervisor in occupations populated by same-gender workers, compared to their counterparts with opposite-gender supervisors; the opposite is true for workers in occupations populated by opposite-gender workers. We would therefore anticipate supervisors' task assignment accuracy is affected disparately in occupations of different gender types, leading to varying degrees of skill mismatch among workers. Greater skill mismatch is associated with productivity loss (Guvenen, Kuruscu, Tanaka and Wiczer 2016), which may explain the stylized wage facts in Figure 1.

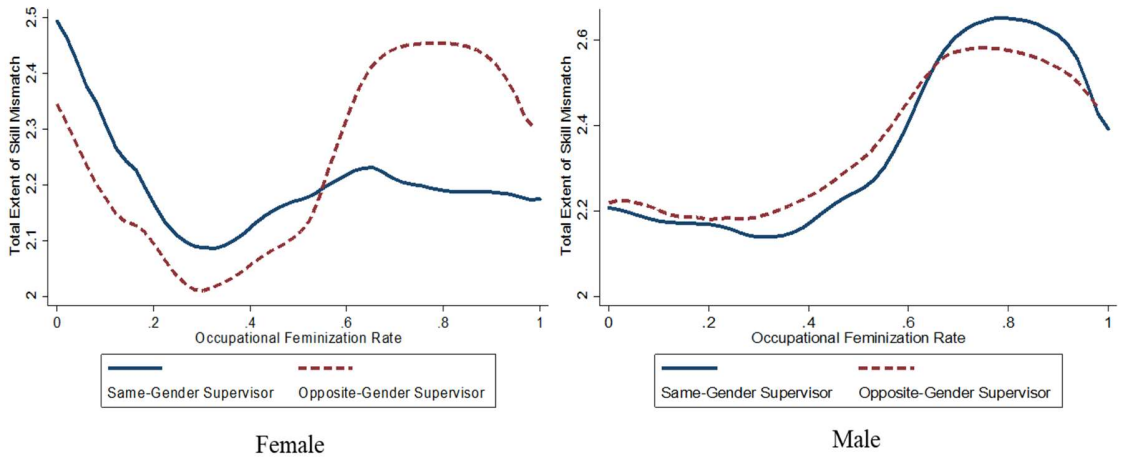

Figure 2 Worker-job match quality varies conditioning on gender of supervisor and occupational gender composition

The present study explores the relationship between workers' wages and the gender of workers' supervisors, conditioning on occupational gender composition. I extend the theoretical

[6] The marginalization is mainly reflected as the exclusion from the "old boy networks". The "old boy network" is an informal male social system that stretches within and across organizations, and excludes all women from membership (Lipman-Blumen, 1976). Kanter's (1977) early work on 'token' women point to systems of bias and discrimination whereby the dominant (male) group controls the group culture and through various processes marginalizes and excludes the minority of women.

models in Phelps (1972), Cornell and Welch (1996) and Oettinger (1996), assuming male and female supervisors are affected disparately by information distortion in occupations comprising different gender types. This information distortion affects how workers (with premarket "skill" attributes) are matched to occupations (defined as their task and skill requirements). Supervisors' information bias, skill mismatch and job changes contribute to the observed supervisor wage effects that emerge as individuals' occupational experience accumulates. Empirical results indicate that in occupations with larger proportion of same-gender workers, a worker with a same-gender supervisor has a smaller extent of skill mismatch and higher wages on average, compared to their counterparts with opposite-gender supervisors. Further, even if not apparent initially, wage disparities emerge as one's career develops. The latter result reflects the fact that workers with same-gender supervisors receive a higher return to occupational tenure in occupations with larger proportion of same-gender workers. The empirical evidence also indicates that the observed same-gender supervisor wage pattern does not come from the gender-based skill sorting across occupations; and there is no evidence to suggest that same-gender supervisors influence workers' wages through affecting workers' promotion prospects.

The main lesson conveyed by this study is that gender diversity is not just workforce composition but also interaction as well. Although gender quotas in managerial positions do help to "break the glass ceilings," the empirical evidence presented in this study shows that supervisors' task evaluation accuracy is substantially weakened in occupations predominantly populated by opposite-gender workers, which impose negative wage effects on workers in subordinate groups. Therefore, imposing a gender quota in managerial positions is not an elixir to address workplace gender wage disparities. [7] Rather, if female managers are not working coordinately with other male staff, the benefit of diversity may be lost. In this sense, to achieve workplace gender equality, policies are also needed to increase the information share and network building within and between firm hierarchies, which characteristics help to create a diverse and inclusive workplace environment.

The rest of the paper proceeds as follows: section 2 presents the theoretical model and empirically testable predictions. Section 3 introduces the data and how the key measurements are defined and constructed, followed by statistical descriptions of main variables. Section 4 offers

[7] The finding in this present study also resonates with the findings in Marianne et al (2014), which suggests that the "quotas of female managers" has no statistically significant effect on gender wage gap in Norway.

main empirical results. Section 5 discusses other possible mechanisms. Section 6 summarizes the results and discusses related implications.

2. Theoretical Model

This section presents a theoretical model in supportive of the main argument in this study. The theoretical model in this study extends the models in Phelps (1972), Oettinger (1996) and Cornell and Welch (1996) by considering the gender of supervisor, information distortion conditioning on occupational gender composition, as well as workers' skill mismatch. This section only presents how the empirically testable implications are derived from the theoretical model. For details of proofs, please refer to the **Appendix-B.**

Assume a group of risk-neutral workers, each belonging to one gender type i (male/female, $\mathrm{i} = f, m$). Each worker is endowed with a set of skill attainments unobservable to supervisors. I assume that workers' skill attainments are denoted as $\mathrm{A_i}$, and the distribution is identical to males and females.

Based on the share of female workers (p), occupations can be divided into two types ($\mathrm{k} = \mathrm{f}, \mathrm{m}$). Occupations with larger share of female workers ($\mathrm{p} > 0.5$) are predominantly female occupations, and otherwise, predominantly male occupations ($\mathrm{p} < 0.5$). Each occupation has a set of skill requirements $\mathrm{R_k}$. $\mathrm{R_k} \sim N(R, \sigma_R^2)$ In each occupation, there are two types of risk neutral supervisors, male and female ($j = f, m$). The share of female supervisors in occupation k is denoted as π_k.

This model changes the assumption in usual statistical discrimination models (e.g. Phelps 1972, Cornell and Welch 1996) in the following two ways.

(1) Assumptions about skill mismatch and productivity. This model assumes that workers' productivity u_i in a filled vacancy depends on how their skills are matched to the occupational requirements. This builds upon a long list of literature suggesting that worker-job match plays an important role in determining workers' productivity (Jovanovic, 1979; Mortensen and Pissarides, 1994; Kalleberg 2008; Lise and Postel-Vinay, 2015; Guvenen et al. 2016). Skill mismatch (either over-match or under-match) generates negative productivity[8]. In usual statistical discrimination

[8] It is easy to understand that when workers' skill attainments fall short of occupational requirements, their productivity will be lower than the productivity if their skill attainments are well matched to the occupational requirements. What needs to be explained here is that over-qualification may also lower workers' productivity. Literature in industrial psychology indicates that overqualified workers tend to be more dissatisfied with their jobs, exhibit more absenteeism, turnover and even sabotage behavior (Sheppard and Herrick, 1972; Quinn and Shepard. 1974; Quinn and Mandilovitch, 1975; Chevalier 2003, Green and McIntosh 2007, and Green

models, expected productivities depend only on workers' skill attainments, which ignores the importance of match-specific[9] productivity.

$$u_i = \mathrm{f}(\mathrm{A_i}, \mathrm{R_k}) = R_k - |R_k - A_i|,$$

where $Q_i = |R_k - A_i|$ denotes the extent of skill mismatch. The productivity is maximized when $Q_i = 0$.The productivity u_i can be normalized to follow a normal distribution $u_i \sim N(m, \eta^2)$, which is identical for men and women.

(2) Assumptions about supervisors' information noise. To evaluate workers' productivity $u_{i,k}$ in a job vacancy (a.k.a., worker-job match), supervisors draw a set of information $I_{i,k}^j$ about workers' skill attainments[10] and occupational requirements[11].

$$I_{i,k}^j = u_{i,k} + \epsilon_{i,k}^j,$$

where $\epsilon_{i,k}^j$ denotes the information noise for supervisor of gender j, who evaluates productivity for worker of gender i in occupation k. In this model, supervisors are assumed to draw more accurate information in occupations with larger share of same-gender workers[12]. That is, $\epsilon_i^m \sim N(0, p^2\sigma^2)$, $\epsilon_i^f \sim N(0, (1-p)^2\sigma^2)$. Also, for simplicity, it is assumed that $\epsilon_{i,k}^j$ and $\epsilon_{i,k}^j$ are independent variables.

2.1 Without job changes

For simplicity, I first consider a situation in which there's no job changes, and in section 2.2, I consider a situation with job changes. In this world, each worker lives for three stages:

Stage 0: A worker of gender i observes the gender composition of supervisors π_k and workers p_k in each occupation. Based on this information, he/she applies for one type of occupation.

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and Zhu 2010), which lead to reduced work effort, inflicting additional cost of production beyond the cost of workers' compensation. Tsang and Levin (1985) develop a model that formally establishes the negative relationship between over-qualification and productivity (Tsang 1984; Tsang and Levin 1985; Guvenen et al 2016).

[9] In Oettinger (1996), workers' productivity is also assumed to be specific to different worker-supervisor matches. In this study, "match-specific" refers to how workers' skill attainments are matched to occupational requirements.

[10] Signals of workers' skill attainments have been well discussed in the literature of statistical discrimination. It involves results from interviews, pre-hiring tests on various skills, reference letters, etc.

[11] Information related to occupational requirements refers to information about firms' organizational structure, as well as any important and relevant conditions in the marketplace and other external factors that must be considered in the staffing decision.

[12] The assumption of $\epsilon_{i,k}^j$ is different from those in usual statistical discrimination models. For example, in Phelps (1972) and Oettinger (1996), employers receive less accurate signal of skill attainments for workers from the minority groups than workers from the majority groups. In Cornell and Welch (1996) and Fadlon (2010), the information is noisier for workers matched to supervisors in different culture groups. In our study, however, the source of information bias comes from the gender interaction across firms' hierarchies.

Stage 1: Supervisors draw information about workers' skill attainments and occupational requirements. Workers are recruited based on their expected productivity, and they are paid based on the "starting wage offers" [13]. Following Oettinger (1996), workers' starting-wage offer is a weighted sum of the expected productivity and the true productivity:

$$w_{i,k,1}^{j} = \theta\widehat{u_{\iota,k}^{J}} + (1-\theta)u_{i,k},$$

where θ denotes the weight on workers' expected productivity[14]. When $\theta = 0$, workers receive a piece-rate wage, which depends solely on the realized productivity.

Stage 2: Each worker's true productivity in stage 1's occupation $u_{i,k,1}$ is revealed to supervisors, and to themselves. Workers' wages in this stage are determined by their true productivity.

$$w_{i,k,2}^{j} = u_{i,k}$$

2.1.1 Workers' expected productivity and skill mismatch.

At the recruiting stage, the expected productivity for type i workers with supervisor j in occupation k is:

$$\widehat{u_{\iota,k}^{J}} \equiv E\left(u_{i,k}\middle|I_{i,k}^{j}\right) = \left(\rho_{k}^{j}\right)^{2} I_{i,k}^{j} + [1-\left(\rho_{k}^{j}\right)^{2}]m,$$

Where for male supervisor, $\rho_{k}^{m} = \frac{\eta^{2}}{\eta^{2}+p_{k}^{2}\sigma^{2}}$; for female supervisors, $\rho_{k}^{f} = \frac{\eta^{2}}{\eta^{2}+(1-p_{k})^{2}\sigma^{2}}$.

It is easy to show that supervisors put higher weights on same-gender workers' true productivity in occupations with larger share of same-gender workers, and they put lower weights on the productivity of same-gender workers in occupations with larger share of opposite-gender workers.

Recall that to maximize workers' productivity, supervisors only hire workers whose skill attainments are perfectly matched to occupational requirements ($\widehat{Q_{\iota,k,1}^{J}} = \left|R_{k,1}^{j} - A_{i}\right| = 0$). Therefore, worker i will receive wage offers from supervisor j in occupations with requirements $R_{k,1}^{j} = \widehat{u_{\iota,k,1}^{J}}$.

[13] In stage 1, all workers are new to the supervisors. The wage offers they receive are starting wage offers. The starting wage is a weighted sum of workers' expected productivity and the true productivity. In stage 2, only workers who move to new supervisors are offered the starting wage contracts.

[14] For simplicity and without loss of generality, θ is assumed to be the same for male and female workers across stages 1 and 2. However, this model also allows θ to be different between men and women, and in different time periods.

For workers with skill attainments A_i, the average extent of skill mismatch if working with a female supervisor is: $E(Q_{i,k}^f) = \left[1 - (\rho_k^f)^2\right]|m - A_i|$. The average extent of skill mismatch if working with a male supervisor is: $E(Q_{i,k}^m) = [1 - (\rho_k^m)^2]|m - A_i|$.

Proposition 1:

For each worker, the extent of skill mismatch depends on gender of supervisor and occupational gender composition: 1) In occupations with larger share of same-gender workers, a worker has smaller extent of skill mismatch if matched to a same-gender supervisor, compared to the situation if matched to an opposite-gender supervisor. 2) In occupations with larger proportion of opposite-gender workers, a worker has smaller extent of skill mismatch if matched to an opposite-gender supervisor, compared to the situation if matched to a same-gender supervisor.

2.1.2 Workers' wages in stage 1

When workers' true productivities are not revealed, the average wages for female workers with female supervisors in predominantly female occupation is $E\left(w_{f,f,1}^f\right) = \theta\widehat{u_{f,f,1}^f} + (1-\theta)u_{f,f,1} = m$. The average wages for female workers with male supervisors in predominantly female occupation is: $E\left(w_{f,f,1}^m\right) = \theta\widehat{u_{f,f,1}^m} + (1-\theta)u_{f,f,1} = m$. Thus, we have $E\left(w_{f,f,1}^f\right) = E\left(w_{f,f,1}^m\right)$. Similarly, we can obtain that $E\left(w_{f,m,1}^f\right) = E\left(w_{f,m,1}^m\right)$, $E\left(w_{m,f,1}^f\right) = E\left(w_{m,f,1}^m\right)$ and $E\left(w_{m,m,1}^f\right) = E\left(w_{m,m,1}^m\right)$. Even though workers' skill attainments are matched disparately to occupations at the entry of labor market, skill mismatch does not immediately translate to the average wage differences.

Proposition 2:

Initially, there is no average wage gap between workers with same-gender supervisors and workers with opposite-gender supervisors.

2.1.3 Workers' wages in stage 2

In stage 2, workers' true productivities are revealed. Since there's no job changes at this stage, workers' wages are determined by the true productivity, which depends on their skill match qualities.

$$w_{i,k,2}^j = u_{i,k} = R_k - Q_{i,k}^j$$

Thus, for female workers with skill attainment A, working with male supervisors in predominantly female occupation generates an average stage-2 wage as: $E\left(w_{f,f,2}^{m}\right) = E(R_f - Q_{f,f}^{m}) = R - \left[1 - (\rho_f^m)^2\right]|m - A|$, but working with female supervisors in predominantly female occupation generates an average stage-2 wage as: $\left(w_{f,f,2}^{f}\right) = E(R_f - Q_{f,f}^{f}) = R - \left[1 - (\rho_f^f)^2\right]|m - A|$. It is easy to show that $E\left(w_{f,f,2}^{m}\right) < E\left(w_{f,f,2}^{f}\right)$. Similarly, $E\left(w_{f,m,2}^{m}\right) > E\left(w_{f,m,2}^{f}\right)$, $E\left(w_{m,f,2}^{m}\right) < E\left(w_{m,f,2}^{f}\right)$, $E\left(w_{m,m,2}^{m}\right) < E\left(w_{m,m,2}^{f}\right)$. As workers' true productivities reveal, wage losses associated with skill-mismatch leads to different wage earnings for supervisor-worker gender match in different occupations.

Proposition 3:

As workers' occupational tenure accumulates, workers with same-gender supervisors earn higher wages on average compared to workers with opposite-gender supervisors, in occupation with larger share of same-gender workers.

2.2 With job changes

The model in section 2.1 assumes that once hired, workers stick to the same supervisor in a same occupation. However, this assumption is somewhat counter intuitive: workers with greater skill mismatch would suffer greater wage declines if they choose to stay with the old supervisors. Intuitively, they tend to change jobs and take advantage of new supervisors' information bias to avoid wage decline in stage 2. Thus, in this section, I consider job changes in stage 2.

Assume each worker receives a wage offer from a new supervisor[15] in stage 2. Workers make the decision of whether to stay or to move. Stayers are paid based on their true productivity, but movers are paid based on the "starting wage offer" issued by the new supervisor (see wage schedules below). **Table 1** summarizes 6 possible cases of mobility decisions.

$$w_{i,k,2}^{j} = \begin{cases} u_{i,k,1}, & if\ u_{i,k,1} \geq \widehat{u_{i,k,2}^{J}}\ \ (stayers), \\ \theta\widehat{u_{i,k,2}^{J}} + (1-\theta)u_{i,k,2}, & u_{i,k,1} < \widehat{u_{i,k,2}^{J}}\ \ (movers) \end{cases}$$

[15] For simplicity, we assume workers do not receive offers from occupations of different gender type at stage 2. For instance, female workers working in predominantly female occupations only receives new wage offers from supervisors in predominantly female occupations. This assumption is justified since we believe that the occupational requirements differ a lot between the predominantly female occupations and predominantly male occupations. Workers' skill attainments have been acquired at the time they decide to apply for either male or female occupations. Therefore, it is unlikely that a worker changes occupation type at later career stages. However, different task assignments imply that the true productivity may vary for the same worker in different stages $\left(u_{i,k,1} \neq u_{i,k,2}\right)$.

Table 1 Cases of job mobility at the second stage.

#	Supervisor t = 1	Selection	Supervisor t = 2	Condition of Selection
1	Female	Stay	Female	$u_{i.1} > \widehat{u_{i,2}^{m}}$ *or* $u_{i,1} > \widehat{u_{i,2}^{f}}$
2	Male	Stay	Male	$u_{i.1} > \widehat{u_{i,2}^{m}}$ *or* $u_{i,1} > \widehat{u_{i,2}^{f}}$
3	Female	Move	Male	$u_{i,1} < \widehat{u_{i,2}^{m}}$
4	Female	Move	Female	$u_{i,1} < \widehat{u_{i,2}^{f}}$
5	Male	Move	Female	$u_{i,1} < \widehat{u_{i,2}^{f}}$
6	Male	Move	Male	$u_{i,1} < \widehat{u_{i,2}^{m}}$

2.2.1 Inter-period wage gains conditioning on mobility decisions

The inter-period wage gains conditioning on the decision of "stay" is: $\Delta w_{i,k} = w^{j}_{i,k,1} - w^{j}_{i,k,2} = \theta(\widehat{u^{J}_{i,k,1}} - u_{i,k,1})$. The expectation of inter-period wage gains for a stayer is:

$$\pi_k \times E\left(\theta\left(\widehat{u^{f}_{i,k,1}} - u_{i,k,1}\right) \middle| \widehat{u^{f}_{i,k,2}} - u_{i,k,1} \le 0\right) + (1-\pi_k)\times$$
$$E\left(\theta\left(\widehat{u^{m}_{i,k,1}} - u_{i,k,1}\right) \middle| \widehat{u^{m}_{i,k,2}} - u_{i,k,1} \le 0\right)$$

Workers decide to move if $\widehat{u^{J}_{i,k,2}} > u_{i,k,1}$. For movers, the inter-period wage gains conditioning on moving is: $\Delta w_{i,k} = w^{j}_{i,k,1} - w^{j}_{i,k,2} = \theta\left(\widehat{u^{J}_{i,k,1}} - \widehat{u^{J}_{i,k,2}}\right) + (1-\theta)(u_{i,k,1} - u_{i,k,2})$, that is, $E\left[\theta\left(\widehat{u^{J}_{i,k,1}} - \widehat{u^{J}_{i,k,2}}\right) + (1-\theta)(u_{i,k,1} - u_{i,k,2}) \middle| \widehat{u^{J}_{i,k,2}} - u_{i,k,1} > 0\right]$. The inter-period wage gains conditioning on workers' mobility decision summarized in **Table 2**, based on which two propositions can be derived.

Proposition 4:

(1) Stayers with the same-gender supervisors obtain lower inter-period wage gains compared to stayers with the opposite-gender supervisors, in occupations with larger proportion of same-gender workers. (2) Stayers with the same-gender supervisors obtain higher inter-period wage gains compared to stayers with the opposite-gender supervisors, in occupations with larger proportion of opposite-gender workers.

Proposition 5:

In occupations with larger proportion of same-gender workers, movers with the same-gender supervisors in both stages earn the highest inter-period wage gains; movers with opposite-gender supervisors in both stages earn the lowest inter-period wage gains; other movers earn inter-period wage gains in between.

Table 2 Summary of Inter-Period Wage Gains Conditioning on Mobility Decision

Case #	Supervisor's gender (t=1)	Decision	Supervisor's gender (t=2)	Inter-period Wage Gains Conditioning on Job Mobility
2-1	Female	Stay	Female	$\{\boldsymbol{\pi_k} \times \boldsymbol{\theta} \times \left[\frac{1-(\rho_k^f)^2}{\sqrt{1+(\rho_k^f)^2}}\right] + (\mathbf{1}-\boldsymbol{\pi_k}) \times \boldsymbol{\theta} \times \left[\frac{1-(\rho_k^f)^2}{\sqrt{1+(\rho_k^m)^2}}\right]\} \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$
2-2	Male	Stay	Male	$\{\boldsymbol{\pi_k} \times \boldsymbol{\theta} \times \left[\frac{1-(\rho_k^m)^2}{\sqrt{1+(\rho_k^f)^2}}\right] + (\mathbf{1}-\boldsymbol{\pi_k}) \times \boldsymbol{\theta} \times \left[\frac{1-(\rho_k^m)^2}{\sqrt{1+(\rho_k^m)^2}}\right]\} \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$
2-3	Female	Move	Male	$\{\frac{[\boldsymbol{\theta}\left(\rho_k^f\right)^2 + (\rho_k^m)^2 + \mathbf{1} - \boldsymbol{\theta}]}{\sqrt{\mathbf{1}+(\rho_k^m)^2}}\} \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$
2-4	Female	Move	Female	$\{\frac{\boldsymbol{\theta}\left(\rho_k^f\right)^2 + (\rho_k^f)^2 + \mathbf{1} - \boldsymbol{\theta}}{\sqrt{\mathbf{1}+(\rho_k^f)^2}}\} \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$
2-5	Male	Move	Female	$\left[\frac{\boldsymbol{\theta}(\rho_k^m)^2 + (\rho_k^f)^2 + \mathbf{1} - \boldsymbol{\theta}}{\sqrt{\mathbf{1}+(\rho_k^f)^2}}\right] \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$
2-6	Male	Move	Male	$\left[\frac{\boldsymbol{\theta}(\rho_k^m)^2 + (\rho_k^m)^2 + \mathbf{1} - \boldsymbol{\theta}}{\sqrt{\mathbf{1}+(\rho_k^m)^2}}\right] \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$

2.2.2 Conditional expectation of the stage-2 wage and returns to labor market experience

For stayers, the conditional expectation of second period wage for stayers is: $\pi_k E\left(u_{i,k,1} \middle| u_{i,k.1} - \widehat{u_{i,k,2}^f} > 0\right) + (1-\pi_k) E\left(u_{i,k,1} \middle| u_{i,k.1} - \widehat{u_{i,k,2}^m} > 0\right)$. For movers, the conditional expectation of the second-period wage for movers is:

$E\left(\theta\widehat{u^{J}_{i,k,2}} + (1-\theta)u_{i,k,2}\middle|\, u_{i,k.1} - \widehat{u_{i,k,2}} < 0\right)$. The average second-period wages conditioning on workers' mobility are summarized in **Table 3**. From stage 1 to stage 2, workers gain 1 years of occupational tenure. Proposition 6 characterizes the differences in return to occupational tenure.

Proposition 6:

(1) Stayers' return to one-year occupational tenure generates higher return than movers' one-year occupational tenure. (2) In occupations with larger proportion of same-gender workers, workers move to same-gender supervisors have higher return to occupational tenure. In occupations with larger proportion of opposite-gender workers, workers move to same-gender supervisors have lower return to occupational tenure.

Table 3 Summary of Average Second-period Wage Conditioning on Mobility Decision.

Case #	Supervisors (t=1)	Decision	Supervisors (t=2)	Second Stage Wage Conditioning on Mobility Decision
1	Female	Stay	Female	$m + [\frac{1-\pi_k}{\sqrt{1+(\rho_k^m)^2}} + \frac{\pi_k}{\sqrt{1+(\rho_k^f)^2}}] \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$
2	Male	Stay	Male	$m + [\frac{1-\pi_k}{\sqrt{1+(\rho_k^m)^2}} + \frac{\pi_k}{\sqrt{1+(\rho_k^f)^2}}] \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$
3	Female	Move	Male	$m + [\frac{(\rho_k^m)^2}{\sqrt{1+(\rho_k^m)^2}}] \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$
4	Female	Move	Female	$m + [\frac{(\rho_k^f)^2}{\sqrt{1+(\rho_k^f)^2}}] \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$
5	Male	Move	Female	$m + [\frac{(\rho_k^f)^2}{\sqrt{1+(\rho_k^f)^2}}] \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$
6	Male	Move	Male	$m + [\frac{(\rho_k^m)^2}{\sqrt{1+(\rho_k^m)^2}}] \times \left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$

2.3.4 Unconditional Wage Expectation in Stage 2.

The stage-2 unconditional wage expectations are summarized in **Table 4**. Supervisors' wage effects emerge and enlarge as workers' occupational tenure accumulates.

Proposition 7:

As occupational tenure accumulates, (1) in occupations with larger proportion of same-gender workers, workers with same-gender supervisors receive higher wages on average, compared to workers with opposite-gender supervisors; (2) in occupations with larger proportion of opposite-gender workers, workers with same-gender supervisors receive lower wages on average, compared to workers with opposite-gender supervisors.

Table 4 Unconditional wage expectations for workers in stage 2.

Case #	Worker	Supervisor (t=2)	Unconditional Expectation of Wage (t=2)
1	Female	Female	$m + [\frac{1-\pi_k}{\sqrt{1+(\rho_k^m)^2}} + \frac{\pi_k + (\rho_k^f)^2}{\sqrt{1+(\rho_k^f)^2}}] \times \left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}}$
2	Female	Male	$m + [\frac{1-\pi_k + (\rho_k^m)^2}{\sqrt{1+(\rho_k^m)^2}} + \frac{\pi_k}{\sqrt{1+(\rho_k^f)^2}}] \times \left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}}$
3	Male	Female	$m + [\frac{1-\pi_k}{\sqrt{1+(\rho_k^m)^2}} + \frac{\pi_k + (\rho_k^f)^2}{\sqrt{1+(\rho_k^f)^2}}] \times \left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}}$
4	Male	Male	$m + [\frac{1-\pi_k + (\rho_k^m)^2}{\sqrt{1+(\rho_k^m)^2}} + \frac{\pi_k}{\sqrt{1+(\rho_k^f)^2}}] \times \left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}}$

Since workers receive the same average wages at stage 1, therefore, their life-time expected wages depend on wage expectations at stage 2. Compared to their counterparts with opposite gender supervisors, workers with same-gender supervisors earn higher expected life-time earnings in occupations with larger proportion of same-gender workers, but they earn less in occupations with larger proportion of opposite-gender workers.

2.4 Summary of empirically testable predictions:

The above theoretical predictions lead to the following empirically testable implications.

1. In occupations with larger proportion of same-gender workers, a worker has less extent of skill mismatch with a same-gender supervisor, compared to the situation with an opposite-gender supervisor. In occupations with larger proportion of opposite-gender workers, a worker has less extent of skill mismatch with an opposite-gender supervisor, compared to the situation with a same-gender supervisor.
2. Initially, there is no average wage gap between workers working with same-gender supervisors and those with opposite-gender supervisors.
3. As workers' occupational tenure accumulates, workers with same-gender supervisors earn higher wages on average compared to workers with opposite-gender supervisors, in occupation with larger share of same-gender workers.
4. In occupations with larger proportion of same-gender workers, stayers with the same-gender supervisors have lower average wage growth rates, compared to movers with the same-gender supervisors; movers with the opposite-gender supervisors have lower wage growth rate, compared to movers with the same-gender supervisors.
5. In occupations with larger proportion of same-gender workers, workers with same-gender supervisors have higher return to occupational tenure. In occupations with larger proportion of opposite-gender workers, workers with same-gender supervisors have lower return to occupational tenure.

3. Data

3.1 NLSY97 data

The empirical tests are based on the data from National Longitudinal Survey of Youth 97 (NLSY97)[16], which contains a nationally representative panel of youth who were aged 12-16 as of December 1996. The NLSY97 data has the following major advantages. First, it covers workers in early career stages, which allows us to examine how the same-gender supervisors' wage effect emerge and enlarge, starting from the labor market entry. Second, the data contains detailed

[16] Bureau of Labor Statistics, U.S. Department of Labor. National Longitudinal Survey of Youth 1997 cohort, 1997-2011 (rounds 1-15). Produced by the National Opinion Research Center, the University of Chicago and distributed by the Center for Human Resource Research, The Ohio State University. Columbus, OH: 2013.

information on workers' working history, which enables us to construct accurate measures on workers' job tenure, occupation tenure and cumulative total labor market experience[17]. Third, the data includes information about the supervisors' gender from 1997-2008, with which I can create a variable that matches respondents' gender with the gender of their direct supervisors. In addition, NLSY data allows us to control for cognitive and non-cognitive skills of the individuals across several dimensions, using the Armed Services Vocational Aptitude Battery (ASVAB) test scores and the *Big 5 Personality Scale*. These measures are unavailable in other panel data sets of a similar nature. These advantages make NLSY97 data suitable for this study.

The sample includes workers aged above 20, therefore, the earliest year included is 2000. As our research interest focuses only on workers' wage earnings, respondents who are self-employed, serving in military, as well as over-sampled Hispanic or Latino and Black people are excluded. I also exclude those who work full-time in the first year they were observed, since it is impossible to identify the point of labor market entry for these people. Table 5 presents the sample selection process for this study.

[Table 5 near here]

The wage is measured using workers' real hourly wage payment in 2002's dollar value. Samples with missing information on hourly payment, or reporting hourly wages less than $1 or over $1000[18] are excluded. After excluded those with missing information on any of the variables used in the analysis, our main sample comprises 27820 person-year observations over 9 waves of the survey (2000-2008).

The NLSY97's occupations are coded by the 2002 Census Occupational Classification (COC)[19]. I mapped these occupational codes using a unified code so that I can merge the O*NET occupational knowledge, skills and ability (KSA) requirements and female employment rates obtained from ACS data to our sample. The 2002 COC were first converted to 2000 COC (occ2000)

[17] In this study, job tenure is defined as number of years that individual respondent works for the same employer. The same employer is identified in NLSY 97 data with the same "employer unique id". Occupation tenure is defined as number of years that individual respondent works in a typical 3-digit occ1990dd occupation. Cumulative labor market experience is defined as cumulative number of years that individual respondents spent working full-time, starting from the labor market entry.

[18] The hourly payment information in NLSY97 also contains entry errors, to avoid this potential problem, we trace individual workers' wage growth rate. Those having a more than 400% wage growth rate in one year followed by an 80% wage decline the next year are identified as "mistyped". In the sample, there're 16 observations' wage information are labeled as "mistyped". These wage observations are adjusted to match the record in other years.

[19] NLSY97Attachment 1: Census Industrial & Occupational Classification Codes (https://www.nlsinfo.org/content/cohorts/nlsy97/other-documentation/codebook-supplement/attachment-1-census-industrial), time of visiting Aug. 1st, 2016

and then mapped to the 3-digit occupation code occ1990dd[20] suggested in Dorn (2009), using the crosswalks downloaded from http://www.ddorn.net/data.htm on Sep.24, 2015[21]. After mapping, the occupations are divided into 6 aggregate occupation groups[22] using do-file downloaded from http://www.ddorn.net/data.htm on Sep.24, 2015, as are used in Autor and Dorn (2013).

Table 6 provides basic descriptive statistics for the NLSY97 sample.

[Table 6 near here]

3.2 Constructing skill mismatch measurement

This study defines an individual workers' skill mismatch as the discrepancy between one's premarket skill attainments and the requirements of the occupations in which they are employed.[23] This skill mismatch measurement goes beyond one's educational attainments and reveal more in-depth views on the extent and consequences of multi-dimensional skill mismatch even for individuals with the same level of education.

In linking the skill supply side (viz. workers' endowments) with the demand side (occupational requirements), I exploit the tools developed by the ASVAB (Armed Services Vocational Aptitude Battery) Career Exploration Program. The ASVAB Career Exploration Program is administered by the Department of Defense (DoD) with a view to helping ASVAB participants identify and explore suitable career possibilities in the private, public, or military

[20] According to Dorn (2009), the "occ1990dd" system provides a new unified occupational category system containing 330 occupation codes, which helps constructing "a balanced panel of occupations covering the 1980, 1990, and 2000 Censuses and the 2005 ACS" (Dorn 2009, p122). Although there's another cross work provided by Meyer and Osborne (2005) with 386 "occ1990" occupation codes, one limitation with this code system is, according to Dorn (2009, p122), "the occupation panel is unbalanced". "occ1990dd" system is also widely used in recent literature on skill and occupations, such as Autor (2010), Autor and Dorn (2013), Shim and Yang (2016) etc. In view of these, this study chooses "occ1990dd" code system to obtain a time-consistent and balanced occupation panel.

[21] When mapping the 2000 COC code to occ1990dd, 11 occupations are not worked by NLSY97 respondents, 21 occupations cannot be mapped to occ1990dd, and 2 occupations are miscoded. Depending on Dorn (2009), we assigned the approximate 1990dd code to the un-mapped 21 Census 2000 occupations to minimize observation loss. Details of the code-matching are available upon request.

[22] The 6 aggregated occupation groups are: (1) Managers/professionals/ technicians/finance/public safety occupations; (2) administrative support and retail sales occupations; (3) low-skill services; (4) precision production and craft occupations; (5) machine operators, assemblers and inspectors; (6) transportation/construction/mechanics/mining/agricultural occupations.

[23] A review of literature suggests that measurements of skill mismatch are constructed in following ways, each bares some disadvantages. First, dummies indicating self-reported mismatch (Hersch 1991), which may be biased when respondents have misperception of their situations of skill mismatch. Second, mismatch measurements defined as deviations from the average (or median) level of education (or skill intensity) in one's occupation (Verdugo and Verdugo 1989). This measurement is usually used in the absence of occupational skill requirement data, which provides more objective indicators than self-reported mismatch dummies. However, this measurement tends to be biased since the average educational/skill level in a particular occupation may be affected by the distribution of skill mismatch in this occupation. For instance, the average level of education (skill attainment) in an occupation may be biased upwards if most of workers in this occupation are over-qualified. The opposite situation applies to the case when most of workers in this occupation are under-matched.

sectors. About 80 percent of the NLSY97 sample participated in the computer adaptive test of the Armed Services Vocational Aptitude Battery (CAT-ASVAB).[24]

Four categories of skills are included in this study: Mathematical, Verbal, Science/Technological/Mechanical (STM) and Social. For the first three skills, I construct composite measures using percentile ranks on select ASVAB subtests[25]. Specifically, for verbal skills I use the percentile scores on *Word Knowledge* and *Paragraph Comprehension*, for mathematical skills the scores on *Arithmetic Reasoning* and *Mathematical Knowledge*, and for STM skills the scores on *General Science*, *Mechanical Comprehension*, and *Electronics Information*.[26] Next, using the weights provided by the NLS,[27] I create a comparable composite skills measure from these subtest scores for each NLSY respondent. I then standardize these skill percentile ranks to be between 0 and 1. For the social skill measurement, I use two questions on *extroversion* and two questions on *conscientiousness* in the *Big 5 Personality Scale* to construct a social skill rank, following Deming (2017a). I download the standardized measurements from Deming's (2017b) data file, and then converted the scores to percentile ranks for NLSY97 respondents.

In this study, each occupation is considered as a combination of KSAs (Knowledge, Skills and Ability) it requires. For each of the ASVAB math/verbal and STM test scores, there is a corresponding occupational task in O*NET database which utilizes that KSA. [28] This mapping is provided in Appendix C. After merging the O*NET KSA extracts to NLSY97, I calculated the percentile rank scores of occupational math/verbal/STM) requirements. For each of the three-dimension ASVAB categories, I created an O*NET analog by averaging the corresponding

[24] For details of the administration of the CAT-ASVAB tests, the reader is referred to the NLSY97 web pages: https://www.nlsinfo.org/content/cohorts/nlsy97/topical-guide/education/administration-cat-asvab-0.

[25] CAT-ASVAB test measures respondents' knowledge and skills through the following subtests: Arithmetic Reasoning, Assembling Objects, Auto Information, Coding Speed, Electronics Information, General Science, Mathematics Knowledge, Mechanical Comprehension, Numerical Operations, Paragraph Comprehension, Shop Information, Word Knowledge. For the explanation of each sub-tests and the score calculation, please refer to the Appendix 10 of NLSY97: Administration and Scoring of the CAT-ASVAB https://www.nlsinfo.org/content/cohorts/nlsy97/other-documentation/codebook-supplement/appendix-10-cat-asvab-scores.

[26] This approach is similar to that used by Guvenen et al. (2016) other than for the inclusion of STM scores. There is no consensus in the literature on construction of the ability measures, and even though almost all studies utilize ASVAB test scores, they select different ability dimensions or different subtests for measurement of these dimensions. We have checked the robustness of our results to variation in measurements, such as the exclusion of STM skills by Guvenen et al. (2016) and the restriction of ASVAB measured abilities to *cognitive* and *manual* by Lise and Postel-Vinay (2016) who also analyze mismatch by separate ability dimensions as opposed the use of an aggregate measure.

[27] We thank the NLS program staff for their help in this connection.

[28] I use the 2007 version of the O*NET database, after Hirsh and Manzella (2015). We are indebted to Barry Hirsch for kindly providing these data.

descriptors in each category. After that, I convert the three-dimension O*NET occupational requirements into percentile ranks among occupations.

The extent of skill-mismatch is measured as the absolute value of the differences between one's percentile-rank scores of skill endowments and the percentile-rank scores of corresponding occupational requirements. Specifically, let A_{ij} represents individual i's percentile-rank-scores in ASVAB test for skill endowment j (j denotes mathematics, verbal, as well as STM and social skills). Recall that A_{ij} does not vary by year or an individual's occupation. Let R_{ijky}denotes an individual i's O*NET occupational requirements for skill j, in occupation k, in year y. Individuals' ASVAB scores are mapped to O*NET occupational requirements based on the method developed by the Department of Defense (DOD) (see Appendix C for details). The degree of skill mismatch for individual i for skill j, in year y and occupation k is:

$$\mathrm{Q_{ijky}} = |A_{ij} - R_{ijky}|.$$

The lower the value of Q, the better the skill is matched. I scaled each dimension of Q to have a standard deviation of 1.

[Table 7 near here]

Table 7 provides a description of mismatch measures used in this study, by worker-supervisor gender matches and occupational gender composition. Statistics show that workers have greater amount of skill mismatch in predominantly female occupations, compared to their counterparts in predominantly male occupations. Moreover, for most of the cases in our sample, workers have less extent of skill mismatch with same-gender supervisors in occupations populated by same-gender workers.

3.3 Measurement of jobs' gender-type: occupational share of female workers

The gender composition (FEM) is measured using the ratio of female workers to the sum of total workers in an occ1990dd occupation. The FEM measurements are generated from the American Community Survey (ACS) data from 2000-2008[29]. The occupations are obtained in a simplified version of occ1990 codes used by IPUMS and I use the crosswalk provided by IPUMs to map them into the standard occ1990 codes. Then I use Dorn's crosswalk to obtain the FEM in each occ1990dd occupations and merge them to the main NLSY97 data set.

[29] The data is downloaded from Integrated Public Use Microdata Series (IPUMS): Steven Ruggles, Katie Genadek, Ronald Goeken, Josiah Grover, and Matthew Sobek. Integrated Public Use Microdata Series: Version 6.0 [dataset]. Minneapolis: University of Minnesota, 2015. http://doi.org/10.18128/D010.V6.0.

4. Empirical Results

4.1 Same-gender supervisors and the extent of skill mismatch

This section presents empirical tests on whether having a same-gender supervisor leads to better skill match in occupations with greater proportion of same-gender workers. The results are reported in Tables 8 and 9.

Table 8 checks same-gender supervisors' effect on extent of skill mismatch in occupations of different gender compositions[30]. The dependent variable is the standardized total amount of mismatch. The Columns (1) report OLS estimation including only the same-gender supervisor dummy. Columns (2) add the occupational female employment share (FEM) and its interaction with same-gender supervisor dummy in the OLS regression, controlling for demographic variables such as race, completed years of schooling, average measures of individual's skills and occupational requirements, as well as tenure variables such as total labor market experience, tenure with current employer, occupational tenure and their quadratic terms, also included are the interaction term of skills and occupational tenure and the interaction term of occupational requirements and occupational tenure. Columns (3) report the panel fixed effect estimation based on specifications in Columns (2). We see that, female workers with female supervisors are 8%-9% standard deviation more mismatched in all-male occupations compared to their counterparts with male supervisors, but they are 9-10% standard deviation less mismatched in all-female occupations. This pattern is highly in-line with our theoretical predictions. For male workers, the same-gender supervisor effect on mismatch is less prominent. We see that male workers with male supervisors are 4% standard deviation less mismatched in all-male occupations, but male workers with male supervisors are not significantly more mismatched in all-female occupations.

Considering that better match qualities may lead to longer tenures and working experience, the tenure and experience measurements are endogenous. Following Altonji and Shakotko (1987) and Guvenen et al. (2016), I instrument individuals' employer/ occupational tenure/total experience with their relative position in the tenure hierarchy with a given employer or occupation, controlling for the possibility of multiple spells of employment with the same employer or in the

[30] Columns (1), (3) and (5) report estimated coefficients on same-gender supervisor dummy for math, verbal and STM skills, respectively. Columns (2), (4) and (6) report the estimation after adding the interaction terms of same-gender supervisor and FEM. All estimations include control variables in the "standard" specification.

same occupation.[31] The IV-fixed effect estimations are reported in Columns (4), and there's no significant changes in terms of sign or magnitude.

[Table 8 near here]

For multi-skill mismatch, the IV-fixed effect estimations are reported in Table 9. Though some of the estimated coefficients are not significant, the signs of the estimated coefficients are consistent as predicted in theory. When significant, estimated coefficients reveal the following patterns. In all male occupations, male workers with male supervisors are 4-5% less mismatched in math and verbal skills, compared to their counterparts with female supervisors; in all-female occupations, they are 12% standard deviation more mismatched in verbal skills, compared to male workers with female supervisors. In all male occupations, female workers with female supervisors are more mismatched in social skills, but they are less mismatched in terms of verbal skills.

[Table 9 near here]

Summing up the findings in Tables 8 and 9, empirical evidence generally support the theoretical predictions: same-gender supervisor leads to better skill match in occupations with greater proportion of same-gender workers. However, this same-gender supervisor effect is less prominent for male workers.

4.2 The wage effects of same-gender supervisors

Given that workers with same-gender supervisors may be better matched to occupations where same-gender workers accounting for a larger proportion, we expect that the same-gender supervisors' effects on skill mismatch would translate to corresponding wage effects. Table 10 reports estimation of the same-gender supervisors' wage effects.

[Table 10 near here]

[31] $IV_{emp} = T_{emp} - \overline{T_{emp}}$ and $IV_{occ} = T_{occ} - \overline{T_{occ}}$, where $\overline{T_{emp}}$ is the average duration for individual i with the same employer k and $\overline{T_{occ}}$ is the average duration for individual i with the same occupation j. $\overline{T_{emp}} = \frac{1}{T}\sum_{t=1}^{T} T_{emp_{i,k,t}}$, where T is the total number of spells that an individual is observed with the same employer. $\overline{T_{occ}} = \frac{1}{N}\sum_{t=1}^{N} T_{occ_{i,j,t}}$, where N is the total number of spells that an individual is observed with the same occupation j. Total experience is also instrumented in the same way, with an instrument $IV_{exp} = T_{exp} - \overline{T_{exp}}$, where $\overline{T_{exp}}$ is the average duration that individual i stays in the labor market $\overline{T_{exp}} = \frac{1}{S}\sum_{t=1}^{S} T_{exp_{i,j,t}}$, where S is the total number of spells that an individual is observed to be in the labor market.

When no other controls are added (Columns labeled [1]), same-gender supervisor is associated with wage premium for females in predominantly female occupations and with wage penalties for males and females in predominantly male occupations. When including the full set of control variables, OLS estimation suggests that female workers with same-gender supervisors tend to receive around 7% wage premium in all-female occupations and no significant wage effects in all-male occupations; for male workers, working with a same-gender supervisor is associated with 3% wage premium in all-male occupations and 5% wage penalties in all-female occupations (Columns labeled [2]). In fixed-effect models and IV-fixed effect models (Columns labeled [3]and [4]), the patterns stay consistent for male workers; for female workers working with a same-gender supervisor, they suffer from around 4% wage penalty in all-male occupations, and they receive 6% wage premium in all-female occupations.

Previous research emphasizes that only men benefit from their same-gender supervisor, and the occupational share of female workers fully explains the negative association between women's wages and female supervisors. Different from this argument, our results suggest that people benefit from the same-gender supervisor in occupations dominated by the same-gender co-workers.

4.3 Same-gender supervisor effects along career path.

As are predicted in the theoretical model, same-gender supervisors' wage effects are insignificant initially, and the effects accumulates as workers' experience accumulates. As workers' occupational tenure accumulates, returns to job mobility differ conditioning on supervisors' gender and occupational gender composition, which lead to different returns to occupational tenure conditioning on supervisors' gender and occupational gender composition. In this section, these predictions are tested.

First, we explore how the same-gender supervisors wage effects develop as workers' occupational tenure accumulates. Table 11 reports the estimated coefficients of "same gender supervisor" and its interaction term with FEM for a subsample[32] of individual with "less than 1 year" "1-3 years" "more than 3 years" of occupational tenure. The coefficients are estimated using the cross-sectional fixed-effect model and IV-fixed effect model including full set of control variables. As are shown in the tables, the estimated same-gender supervisor wage effects and its

[32] Following Oettinger (1996), the subsample contains individuals who have 3 consecutive years of full-time working experience in the main job. The subsample also rejects individuals who work full-time in the first year in which they were observed.

interaction term with FEM is statistically insignificant for workers at the immediate entry into an occupation. These findings generally support one of the theoretical predictions: "*At the entry of labor market, there should be no wage gap on average between individuals with same-gender supervisor and those with opposite-gender supervisor, ceteris paribus.*"

[Table 11 near here]

As workers' occupational tenure accumulates, for both male and female workers, the same-gender supervisor wage effects emerge and remain the same pattern as are described in section 4.2. This generally support the theoretical prediction: *"As workers' labor market experience accumulates, the average wage gap may emerge for workers with same-gender supervisor and those with opposite-gender supervisor, ceteris paribus."*

Table 12 reports the estimation on differences in return to job-motilities. The signs of coefficients are consistent with theoretical predictions: compared to female stayers with same-gender supervisors in predominantly female occupations, female movers with same-gender supervisors in these occupations have higher wage growth rate; in predominantly female occupations, compared to female movers with opposite-gender supervisors, female movers with same-gender supervisors have higher wage growth rate. In predominantly male occupations, however, female movers with male supervisors receive the highest wage growth rate, followed by female stayers, and female movers with female supervisors have the lowest wage growth rate.

[Table 12 near here]

For male workers, the patterns are also consistent with theoretical predictions. In predominantly male occupations, the inter-period wage growth rate is the highest for male movers with male supervisors, followed by male stayers, and the lowest for male movers with female supervisors; in predominantly female occupations, the wage growth rate is the highest for male movers with female supervisors, followed by male stayers, and the lowest for male movers with male supervisors.

Table 13 examines the last group of theoretical predictions on return to occupational tenure. Estimations are based on fixed-effect and IV-fixed effect models. For female workers, the fixed-effect estimation suggests that the return to one-year occupational tenure is higher with female supervisors in predominantly female occupations, but it is lower for those with female supervisors in non-predominantly female occupations. For male workers, the return to one-year occupational

tenure is lower for those with same-gender supervisors in predominantly female occupations. In the IV fixed-effect estimation, for both male and female workers, the return to occupational tenure is lower with same-gender supervisors in occupations populated by opposite-gender workers. This is consistent with the theoretical prediction that "*women with male supervisors have higher return to occupational tenure than women with female supervisors in occupations with smaller proportion of female workers*".

[Table 13 near here]

5. Robustness Checks and Discussions

In addition to the information bias, two other mechanisms may also lead to the afore-mentioned same-gender wage effects, which will be discussed respectively in this section.

5.1 Whether the same-gender supervisor wage effects are due to skill sorting?

It is likely that the above-mentioned stylized same-gender supervisors' wage effects capture the gender skill sorting across occupations, rather than the information bias. For instance, it is possible that female supervisors are more capable in predominantly female occupations, so that they are associated with positions with higher skill requirements. Therefore, higher average wages for workers with female supervisors in predominantly female occupations may be attributable to higher occupational skill requirements. The same argument may apply to male supervisors in predominantly male occupations. If these arguments hold, then empirically, one may expect to see the following two patterns: (1) Female supervisors are associated with positions of higher skill requirements in predominantly female occupations. Male supervisors are associated with positions of higher skill requirements in predominantly male occupations. (2) Initially, the stylized facts about same-gender supervisors' wage effects should be prominent. As are indicated in section 4.3, when workers just enter the labor market, the same-gender supervisor wage effects are not prominent, which does not support pattern (2). As are shown in **Table 14**, the probability of working with a same-gender supervisor does not significantly associated with the occupational skill requirements. This indicates that pattern (1) is also not supported empirically. Therefore, the argument that the observed same-gender supervisor wage effects are due to skill sorting is not supported by empirical evidence.

[Table 14 near here]

5.2 Whether the gender of supervisor affects workers' wages via influencing workers' promotion prospect?

The empirical results show that the same-gender wage effects are not prominent at the entry of labor market, which emerge as workers' occupational tenure accumulates. This pattern could also emerge if the gender of supervisor affects subordinates' promotion prospects.

Literature suggests that compared to men, women are less likely to engage in competitive activities such as bargain, and are more likely to be at a bargaining disadvantage (Babcock and Laschever 2003; Croson and Greezy 2009). Given these, it is likely that female supervisors are associated with fewer promotion probability for subordinates, because they fail to bargain sufficiently or successfully for their subordinates, especially in predominantly male occupations. This, in turn, may lead to lower average wages for those working with female supervisors in predominantly male occupations. Similar story may hold for male supervisors in predominantly female occupations.

NLSY97 data contains information on "whether the respondent has been promoted since the last date of interview" in the year 2006-2008, based on which the above argument can be tested. **Table 15** presents the results for the logit regression estimates on the effects of having a female supervisor on promotion probability. No evidence is found to support the argument that the gender of supervisor is associated with workers' promotion prospect. This indicates that the gender of supervisor does not affect workers' wages via influencing workers' promotion prospect.

[Table 15 near here]

6. Conclusions

The study starts with a screening-bias model, which allows information distortion to interact with supervisor-worker gender match, as well as occupational gender composition. In addition, workers' productivity is assumed to be maximized when their skills are well matched to task requirements. Based on these assumptions, information distortion leads to different extent of skill mismatch for workers with different supervisors in different occupations. When workers are paid according to the expected productivities at the entry of an occupation, there's no average wage gap between those with same-gender supervisors and those with opposite-gender supervisors. However, when workers' true productivities are revealed as their occupational tenure accumulates, job changes lead to different returns to occupational tenure. In this way, the average wage gaps between

workers with same-gender supervisors and workers with opposite-gender supervisors emerge and enlarge, which vary in occupations of different gender types.

Consistent with theoretical predictions, empirically, workers benefit from the same-gender supervisors, in terms of better match and higher average wages, in occupations populated by same-gender workers. These effects remain robust when individual and time fixed effects are controlled for. Same-gender supervisors' wage effects are insignificant for workers initially (less than 1-year occupation tenure), and it emerges as a worker's career develops. In addition, evidence supports that workers with same-gender supervisors receive lower return to occupational tenure in occupations with larger share of opposite-gender workers, compared to their counterparts with opposite-gender supervisors.

This study contributes to current literature in three ways. First, the empirical evidence, to some extent, reconciles the mixed empirical results. "Women benefit women" is more likely to be associated with predominantly female occupation, and "Queen Bee Syndrome" predominantly male occupation. Similar effects are found to be associated with male supervisors. As the supervisor's wage effects go in opposite directions in predominantly male and female occupations, the opposite effects may cancel out in pooled sample regression, leading to insignificant effects (Hultqvist 2015; Sicilian and Grossberg 2014). Studies restricted to specific occupations or industries (i.e. large grocery retailers in Penner, Toro-Tulla and Huffman, 2012; athletic teams in Bednar and Gicheva 2014; financial occupations on Wall Street in Roth 2004; law firms in Beckman and Phillips 2005; small businesses in Penner and Toro-Tulla 2010) only provide partial depictions of this effect under certain circumstances.

Second, this study reveals that supervisors' task assignment accuracy not only exert one-time wage effects on the subordinates, but also affects subordinates' decision on job mobility, the return to occupational tenure, as well as their earnings in later career stages. Previous research suggests that men and women receive different returns to tenure because of the differences in human capital investment, in anticipated career interruptions, and in training and promotion opportunities (Hersch and Reagan 1997, Munasinghe and Reif 2008, O'Neill and Polachek 1993). This study adds to this literature from a new perspective, revealing how gender difference in returns to occupational tenure can be influenced by the interaction between supervisor's gender and occupational gender composition.

Finally, this study sheds light on whether the pervasive workplace gender wage disparity will be attenuated through promoting women's access to powerful positions. On one hand, this study suggests that the same-gender supervisor does matter with respect to workers' wages, but the effects vary in occupations of different gender types. As are suggested in this paper, the managerial staff, either men or women, in occupations dominated by opposite-gender workers may themselves be the victims of information distortion and compromise their effectiveness in understanding and implementing staffing policies. Thus, imposing gender quotas in managerial positions, *per se*, is not sufficient to narrow the workplace gender wage gap. A possible policy implication is, minority managerial staffs should not be isolated, while instead policies (e.g. increasing gender diversities in all ranks of organization, promoting information flow within organizations) are needed to enhance their integration in "gendered" workplace contexts.

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Appendix A- Tables of Literature

Table A-1 Summary of Empirical Literature on Wage Effects (Fraction of Females in Top Positions)

Author/s	Year	Country	Data		Period of Study	Sectors	Methods	Explanatory variable	All Workers	Female Workers	Male Workers
Gagliarducci and Paserman	2015	GM	IAB Establishment Panel	Panel	1993-2012	Multi-Sector	OLS+FE	% Females in the top management	N/A	Insignificant	Insignificant
Bertrand, Black, Jensen and Lleras-Muney	2014	NO	Norwegian Registry Data	Panel	1998-2010	Multi-Sector	OLS+FE+ IV	% Female board members	N/A	Insignificant for all women; negative for women with MBA	N/A
Hensvik	2011	SW	Administrative registers collected by Statistics Sweden	Panel	1996-2008	Multi-Sector	OLS+FE	% Female top (or medium) managers	N/A	Female workers receive 1.4% higher wages in female-led firms compared to male-led firms. The wage premium shrinks to only 0.3% when accounting for worker finxed effects	Male workers receive 3.6% lower wages in female-led firms compared to male-led firms. The wage penalty shrinks to only 0.4% after accounting for worker fixed effects.
Cohen and Huffman	2007	US	2000 Census 5- and 1-percent Public Use Microdata Samples (PUMS)	Cross-Sectional	2000	Multi-Sector	OLS	% Female managers	N/A	(1) In an all-male job with no female managers, the predicted male wages at mean is 2.762 in logged dollars or $15.83 per hour. (2) In an all-male job and 50 percent of the managers in that local industry are women, the predicted hourly wage is 2.747 in logged dollars, or $14.11.	(1) In an all-male job with no female managers, the predicted male wages at mean is 2.888 in logged dollars or $17.96 per hour. (2) In an all-male job, if 50 percent of the managers are women in that local industry of equal status as the male managers, then the predicted wage for men would be: 2.788 in logged dollars, or $16.25.
Cardoso and Winter-Ebmer	2007	PO	Employer-Employee matched data from Ministry of Employment in Portugal	Longitudinal	1987-2000	Manufacturing and Services	OLS+FE	Female owners or female top-paid managers	N/A	Women in female-led firms earn 5.4% higher wages on average, but the advantage shrinks with greater proportion of female workers (Female led* share of female:-3.9%)	Men in female-led firms earn 0.6 % lower wages on average, the disadvantage amplifies with greater proportion of female workers (Female led* share of female:-3.7%)
Hultin and Szulkin	2003	SW	Swedish Establishment Survey	Cross-Sectional	1995	Private Sector	Multi-level Models	% Male managers	The estimated effect of the proportion of male managers on women's relative wage is -0.0872 for blue collar workers, and -0.0516 for white collar workers, accounting for individual ability sorting.	N/A	N/A
Bertrand and Hallock	2001	US	Standard and Poor's ExecuComp	Panel	1992-1997	Multi-Sector	OLS/O-B Decomp.	% Female CEO/Chair/vice chair and president	Nearly half of the unconditional executive yearly wage gap can be explained by the scarcity of women as Chair, CEO, Vice Chair, and President	N/A	N/A

Table A-2 Summary of Empirical Literature on Wage Effects (Gender of Immediate Managers/Supervisors)

Author/s	Year	Country	Data		Period of Study	Sectors	Methods	Explanatory variable	Female Workers	Male Workers
Tate and Yang	2015	US	Longitudinal Employer-Household Dynamics (LEHD) program	Panel	1993-2001	Multi-Sector	OLS+FE	Women hold positions of leadership in hiring firms	Displaced women suffer a wage loss of 4–5% compared with men. However, the gap is significantly reduced when women hold positions of leadership in the hiring firm.	N/A
Maume and Ruppanner	2015	US	National Study of the Changing Workforce (NSCW)	Cross-Sectional	1997-2002	Multi-Sector	Multi-level Models	Female immediate supervisor	Women with female supervisor earn less wages on average compared to women with male supervisors, but the penalty decreases in more liberalized states	Men with female supervisor earn less wages on average compared to men with male supervisors, but the penalty decreases in more liberalized states
Sicilian and Grossberg	2014	US	NLSY79 and CPS	Panel	1996-1998	Multi-Sector	OLS+FE	Female immediate supervisor	The wage effect of working for a female supervisor is -3.3% in OLS, and insignificant in FE	The wage effect of working for a female supervisor is -7.6% in OLS, and -0.0494 in FE
Penner, Toro-Tulla and Huffman	2012	US	Private data from a large retailer	Panel	1977-1985	Grocery Retailer	OLS+FE	Female immediate manager	Insignificant	Insignificant
Bell	2005	US	Standard and Poor's ExecuComp	Panel	92-03	Multi-Sector	OLS	Female CEO or chair	Women executives in women led firms earn 15%-20% higher compensation than women in other firms.	Men executives in women led firms earn lower compensation than men in male-led firms.
Hultqvist	2015	SW	European social survey (ESS)	Cross-Sectional	04-10	Multi-Sector	OLS	Female immediate manager	A woman in white-collar work with a female manager earns 5.4% lower wage on average than a woman in white-collar work with a male manager. A women in blue-collar work with a female manager earns 13.1% higher wages than a woman with a male manager.	A men with a female manager earns 6.25 lower wages on average than a men with a male manager. No significant differences between blue collar job and white collar job.

Table A-3 Summary of Empirical Literature on Career Outcomes

Author/s	Year	Country	Data Source	Data Type	Period of Study	Industries	Methods	Outcome Variable	Exploratory Variable	All Workers	Female	Male
Bednar and Gicheva	2014	US	Dataset for members of the NCAA.	Panel	1993-2011	Women Sports	OLS+FE	The propensity to hire and retain female employees	% Females coaching the teams	Insignificant	N/A	N/A
Matsa and Miller	2011	US	Standard and Poor's ExecuComp database	Panel	1997-2009	N/A	OLS+FE	The share of women in top five executives	% Females among directors in the previous year	N/A	The long-run effect of 10% increase in female board menbership is 21%-36% increase of the avergae female executive share.	N/A
Bell, Smith, Smith, and Verner	2008	DM	Largest private Danish firms	Panel	1993-2003	N/A	Probit	Promotion probability	% Females directors	N/A	Women in a women-led firm have higher probability of promotion, the marginal effect is 0.004	Insignificant
Gorman	2005	US	National Directory of Legal Employers (the NALP Directory)	Cross-sectional	1996	Law	Logit	Proportion of women in new hires/entry-level and lateral hires	(1) % Female hiring partner; (2) Female hiring partner	N/A	A female hiring partner increases the odds that a women will fill a position by 13 percent. The positive effect of a female hiring partner diminishes as the female proportion of partners increases.	N/A
Lucifora and Vigani	2016	EU	European Working Conditions Survey (EWCS)	Cross-sectional	(1995, 2000, 2005 and 2010)	N/A	Probit model	Self-perceived gender discrimination	Female Supervisor	Having a female supervisor implies an average reduction of 0.6% of reporting gender discrimination.	Having a female supervisor is associated with 1.5% overall reduction of reporting discrimination. Female supervisors are associated with lower perceived discrimination by female employees across all type of jobs	Having a female supervisor is associated with 0.4% overall increase of reporting discrimination. Male employees perceive to be discriminated by a female boss mainly when the share of females in the job is higher.
Maume	2011	US	National Study of the Changing Workforce (NSCW).	Cross-sectional	2002	N/A	OLS	1) Job-related support from supervisor; 2) Advancement opportunities	Female Supervisor	N/A	Career support: insignificant; Negative advancement opportunity (-0.482)	Positive career support: 0.637; More advancement opportunity:1.540
Campione	2014	US	NLSY97	Cross-sectional	2007	N/A	Ordered Logit	Job satisfaction	Supervisor's gender	Supervisors'gender do not significantly affect job satisfaction of Millenials	N/A	N/A
Blau and Devaro	2007	US	Multi-City Study of Urban Inequality (MCSUI) employer survey	Cross-sectional	1992-1995	N/A	Probit /OLS	Probability of promotion /Wage growth associated with promotion	Male Immediate supervisor	Insignificant	Insignificant	Insignificant
Giuliano, Levine, and Leonard	2005	US	Daily personnel records of a large retail employer	Cross-sectional	1996-1998	Retail	Cox Proportional Hazard Model	Number of quilts and dismissals; the number of days after hire until the first time an employee is promoted a new job title	Gender of managers	Employees with different-sex managers have on average 3-5 % higher quit rates, 3-8 % higher dismissal rates, and 8-11 % lower promotion rates.	Male managers is associated with higher quits number of quites, dismissal and lower probability of promotion	Male employees with female managers have higher quit rates, lower dismissal rates, and higher rates of promotion.

Appendix B-Proof of Propositions

[Proof of Proposition 1]

1. In the starting wage contracts from type j supervisor to type i workers as follows:

$$w_{i,k,1}^{j} = \theta\widehat{u_{i,k,1}^{J}} + (1-\theta)u_{i,k,1}$$
$$= \theta\left[\left(\rho_k^j\right)^2\left(u_{i,k,1} + \epsilon_i^j\right) + \left(1-\left(\rho_k^j\right)^2\right)m\right] + (1-\theta)u_{i,k,1}$$

In this wage contract, the weight that type j supervisor put on type i worker's true productivity is

$$\theta\left(\rho_k^j\right)^2 + 1 - \theta$$

In predominantly male occupations ($p_m < 0.5$), $p_m^2 < (1-p_m)^2$, we have $\rho_m^m > \rho_m^f$, implying that male supervisors put more weight on workers' signal and less weight on workers' group average productivity, compared to female supervisors. In predominantly female occupations ($p_f > 0.5$), $p_f^2 > \left(1-p_f\right)^2$, we have $\rho_f^m > \rho_f^f$, implying that female supervisors put more weight on workers' signal and less weight on workers' group average productivity, compared to male supervisors.

For workers with skill attainments $\mathrm{A_i}$, the average extent of skill mismatch if working with a female supervisor is: $E(Q_{i,k}^f) = \left[1-(\rho_k^f)^2\right]|m - \mathrm{A_i}|$. The average extent of skill mismatch if working with a male supervisor is: $E(Q_{i,k}^m) = [1-(\rho_k^m)^2]|m - \mathrm{A_i}|$. In predominantly male occupations, $\rho_{i,m}^m > \rho_{i,m}^f$, we have $E(Q_{i,k}^f) > E(Q_{i,k}^m)$. In predominantly female occupations ($p_f > 0.5$), $p_f^2 > \left(1-p_f\right)^2$, we have $E(Q_{i,k}^f) < E(Q_{i,k}^m)$.

End of Proof.

[Proof of Proposition 2]

The average starting wage for female workers with female supervisors in predominantly female occupation is

$$E\left(w_{f,f,1}^f\right) = \theta\widehat{u_{f,f,1}^f} + (1-\theta)u_{f,f,1}$$
$$= \mathrm{E}\{\theta\left[\left(\rho_f^f\right)^2\left(u_{f,f,1} + \epsilon_{f,f}^f\right) + \left(1-\left(\rho_f^f\right)^2\right)m\right] + (1-\theta)u_{f,f,1}\} = \mathrm{m}$$

The average wages for male workers with male supervisors in predominantly female occupation is

$$E\left(w_{m,f,1}^m\right) = \theta\widehat{u_{m,f,1}^m} + (1-\theta)u_{m,f,1}$$
$$= E\left\{\left[\left(\rho_f^m\right)^2\left(u_{m,f,1} + \epsilon_{m,f}^m\right) + \left(1-\left(\rho_f^m\right)^2\right)m\right] + (1-\theta)u_{m,f,1}\right\} = \mathrm{m}$$

The average wages for male workers with female supervisors in predominantly female occupation is

$$E\left(w_{m,f,1}^f\right) = \theta\widehat{u_{m,f,1}^f} + (1-\theta)u_{m,f,1}$$
$$= \mathrm{E}\{\theta\left[\left(\rho_f^f\right)^2\left(u_{m,f,1} + \epsilon_{m,f}^f\right) + \left(1-\left(\rho_f^f\right)^2\right)m\right] + (1-\theta)u_{m,f,1}\} = \mathrm{m}$$

The average wages for female workers with male supervisors in predominantly female occupation is

$$E\left(w_{f,f,1}^{m}\right) = \theta\widehat{u_{f,f,1}^{m}} + (1-\theta)u_{f,f,1}$$

$$= E\left\{\left[\left(\rho_f^m\right)^2\left(u_{f,f,1} + \epsilon_{f,f}^{m}\right) + \left(1-\left(\rho_f^m\right)^2\right)m\right] + (1-\theta)u_{f,f,1}\right\} = \text{m}$$

The average wages for male workers with female supervisors in predominantly male occupation is

$$E\left(w_{m,m,1}^{f}\right) = \theta\widehat{u_{m,m,1}^{f}} + (1-\theta)u_{m,m,1}$$

$$= \text{E}\{\theta\left[\left(\rho_m^f\right)^2\left(u_{m,m,1} + \epsilon_{m,m}^{f}\right) + \left(1-\left(\rho_m^f\right)^2\right)m\right] + (1-\theta)u_{m,m,1}\} = \text{m}$$

The average wages for male workers with male supervisors in predominantly male occupation is

$$E\left(w_{m,m,1}^{m}\right) = \theta\widehat{u_{m,m,1}^{m}} + (1-\theta)u_{m,m,1}$$

$$= E\{\left[(\rho_m^m)^2\left(u_{m,m,1} + \epsilon_{m,m}^{m}\right) + (1-(\rho_m^m)^2)m\right] + (1-\theta)u_{m,m,1}\} = \text{m}$$

The average wages for female workers with male supervisors in predominantly male occupation is

$$E\left(w_{f,m,1}^{m}\right) = \theta\widehat{u_{f,m,1}^{m}} + (1-\theta)u_{f,m,1}$$

$$= E\{\left[(\rho_m^m)^2\left(u_{f,m,1} + \epsilon_{f,m}^{m}\right) + (1-(\rho_m^m)^2)m\right] + (1-\theta)u_{f,m,1}\} = \text{m}$$

The average wages for female workers with female supervisors in predominantly male occupation is

$$E\left(w_{f,m,1}^{f}\right) = \theta\widehat{u_{f,m,1}^{f}} + (1-\theta)u_{f,m,1}$$

$$= \text{E}\{\theta\left[\left(\rho_m^f\right)^2\left(u_{f,m,1} + \epsilon_{f,m}^{f}\right) + \left(1-\left(\rho_m^f\right)^2\right)m\right] + (1-\theta)u_{f,m,1}\} = \text{m}$$

End of Proof.

[Proof of Proposition 3]

In stage 2, workers' true productivity is realized, and each of them is paid according to the realized productivity u_i.

$$u_i = \text{f}(\text{A}_\text{i}, \text{R}_\text{k}) = R_k - Q_{i,k}^{j}$$

The average wage for workers of type i with female supervisors in occupation k is

$$\text{E}\left(u_{i,k}^{f}\right) = \text{f}(\text{A}_\text{i}, \text{R}_\text{k}) = \text{R}_\text{k} - \left[1-(\rho_k^f)^2\right]|m - \text{A}_\text{i}|$$

The average wage for workers of type i with male supervisors in occupation k is

$$\text{E}\left(u_{i,k}^{m}\right) = \text{f}(\text{A}_\text{i}, \text{R}_\text{k}) = \text{R}_\text{k} - [1-(\rho_k^m)^2]|m - \text{A}_\text{i}|$$

The proof of proposition 1 shows that in predominantly male occupations, $\rho_{i,m}^{m} > \rho_{i,m}^{f}$, we have $E(Q_{i,k}^{f}) > E(Q_{i,k}^{m})$. In predominantly female occupations ($p_f > 0.5$), $p_f^2 > \left(1-p_f\right)^2$, we have $E(Q_{i,k}^{f}) < E(Q_{i,k}^{m})$.

Therefore, we have: (1) in predominantly male occupations, $\text{E}\left(u_{i,k}^{f}\right) < \text{E}\left(u_{i,k}^{m}\right)$; (2) in predominantly female occupations, $\text{E}\left(u_{i,k}^{f}\right) > \text{E}\left(u_{i,k}^{m}\right)$. ***End of Proof.***

[Proof of Proposition 4]

In predominantly female occupations, for female stayers,

$$\left\{\boldsymbol{\pi_f}\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_f^f)^2}{\sqrt{1+(\rho_f^f)^2}}\right]+(\mathbf{1}-\boldsymbol{\pi_f})\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_f^f)^2}{\sqrt{1+(\rho_f^m)^2}}\right]\right\}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}<\boldsymbol{\pi_f}\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_f^m)^2}{\sqrt{1+(\rho_f^f)^2}}\right]+(\mathbf{1}-\boldsymbol{\pi_f})\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_f^m)^2}{\sqrt{1+(\rho_f^m)^2}}\right]\}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}.$$

The inter-period wage gains conditioning on staying with a male supervisor is higher than the gains conditioning on staying with a female supervisor.

For male stayers,

$$\left\{\boldsymbol{\pi_f}\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_f^f)^2}{\sqrt{1+(\rho_f^f)^2}}\right]+(\mathbf{1}-\boldsymbol{\pi_f})\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_f^f)^2}{\sqrt{1+(\rho_f^m)^2}}\right]\right\}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}<\{\boldsymbol{\pi_f}\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_f^m)^2}{\sqrt{1+(\rho_f^f)^2}}\right]+(\mathbf{1}-\boldsymbol{\pi_f})\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_f^m)^2}{\sqrt{1+(\rho_f^m)^2}}\right]\}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}.$$

The inter-period wage gain conditioning on staying with a male supervisor is higher than the gains conditioning on staying with a female supervisor.

Similarly, in predominantly male occupations, for female stayers,

$$\left\{\boldsymbol{\pi_m}\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_m^f)^2}{\sqrt{1+(\rho_m^f)^2}}\right]+(\mathbf{1}-\boldsymbol{\pi_m})\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_m^f)^2}{\sqrt{1+(\rho_m^m)^2}}\right]\right\}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}>\boldsymbol{\pi_m}\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_m^m)^2}{\sqrt{1+(\rho_m^f)^2}}\right]+(\mathbf{1}-\boldsymbol{\pi_m})\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_m^m)^2}{\sqrt{1+(\rho_m^m)^2}}\right]\}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}.$$

The inter-period wage gains conditioning on staying with a female supervisor is higher than the gains conditioning on staying with a male supervisor.

For male stayers,

$$\left\{\boldsymbol{\pi_m}\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_m^f)^2}{\sqrt{1+(\rho_m^f)^2}}\right]+(\mathbf{1}-\boldsymbol{\pi_m})\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_m^f)^2}{\sqrt{1+(\rho_m^m)^2}}\right]\right\}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}>\{\boldsymbol{\pi_m}\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_m^m)^2}{\sqrt{1+(\rho_m^f)^2}}\right]+(\mathbf{1}-\boldsymbol{\pi_m})\times\boldsymbol{\theta}\times\left[\frac{1-(\rho_m^m)^2}{\sqrt{1+(\rho_m^m)^2}}\right]\}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}.$$

The inter-period wage gains conditioning on staying with a female supervisor is higher than the gains conditioning on staying with a male supervisor.

To sum up, stayers with the same-gender supervisors obtain lower inter-period wage gains compared to stayers with the opposite-gender supervisors, in occupations with larger proportion of same-gender workers.

[Proof of Proposition 5]

In predominantly female occupation, the inter-period wage gains for movers with:

(1) female supervisors in both stages:

$$E\left(w_{i,f,1}^{f}-w_{i,f,2}^{f}\middle|u_{i,f,1}<\widehat{u_{i,f,2}^{f}}\right)=\{\frac{\boldsymbol{\theta}\left(\boldsymbol{\rho}_{f}^{f}\right)^{2}+\left(\boldsymbol{\rho}_{f}^{f}\right)^{2}+\mathbf{1}-\boldsymbol{\theta}}{\sqrt{\mathbf{1}+\left(\boldsymbol{\rho}_{f}^{f}\right)^{2}}}\}\times\left(\frac{\mathbf{2}\boldsymbol{\eta}^{2}}{\boldsymbol{\pi}}\right)^{\frac{\mathbf{1}}{\mathbf{2}}}$$

(2) female supervisors in stage 1 and male supervisors in stage 2:

$$\boldsymbol{E}\left(\boldsymbol{w}_{\boldsymbol{i},\boldsymbol{f},\mathbf{1}}^{\boldsymbol{f}}-\boldsymbol{w}_{\boldsymbol{i},\boldsymbol{f},\mathbf{2}}^{\boldsymbol{m}}\middle|\boldsymbol{u}_{\boldsymbol{i},\boldsymbol{f},\mathbf{1}}<\widehat{\boldsymbol{u}_{\boldsymbol{i},\boldsymbol{f},\mathbf{2}}^{\boldsymbol{m}}}\right)=\{\frac{[\boldsymbol{\theta}\left(\boldsymbol{\rho}_{\boldsymbol{f}}^{\boldsymbol{f}}\right)^{2}+(\boldsymbol{\rho}_{\boldsymbol{f}}^{\boldsymbol{m}})^{2}+\mathbf{1}-\boldsymbol{\theta}]}{\sqrt{\mathbf{1}+(\boldsymbol{\rho}_{\boldsymbol{f}}^{\boldsymbol{m}})^{2}}}\}\times\left(\frac{\mathbf{2}\boldsymbol{\eta}^{2}}{\boldsymbol{\pi}}\right)^{\frac{\mathbf{1}}{\mathbf{2}}}$$

(3) male supervisors in stage 1 and female supervisors in stage 2:

$$E\left(w_{i,f,1}^{m}-w_{i,f,2}^{f}\middle|u_{i,f,1}<\widehat{u_{i,f,2}^{f}}\right)=\left[\frac{\boldsymbol{\theta}\left(\boldsymbol{\rho}_{f}^{m}\right)^{2}+\left(\boldsymbol{\rho}_{f}^{f}\right)^{2}+\mathbf{1}-\boldsymbol{\theta}}{\sqrt{\mathbf{1}+\left(\boldsymbol{\rho}_{f}^{f}\right)^{2}}}\right]\times\left(\frac{\mathbf{2}\boldsymbol{\eta}^{2}}{\boldsymbol{\pi}}\right)^{\frac{\mathbf{1}}{\mathbf{2}}}$$

(4) male supervisors in both stages:

$$\mathrm{E}\left(w_{i,f,1}^{m}-w_{i,f,2}^{m}\middle|u_{i,f,1}<\widehat{u_{i,f,2}^{m}}\right)=\left[\frac{\boldsymbol{\theta}\left(\boldsymbol{\rho}_{f}^{m}\right)^{2}+\left(\boldsymbol{\rho}_{f}^{m}\right)^{2}+\mathbf{1}-\boldsymbol{\theta}}{\sqrt{\mathbf{1}+\left(\boldsymbol{\rho}_{f}^{m}\right)^{2}}}\right]\times\left(\frac{\mathbf{2}\boldsymbol{\eta}^{2}}{\boldsymbol{\pi}}\right)^{\frac{\mathbf{1}}{\mathbf{2}}}$$

It is easy to show that

$$E\left(w_{i,f,1}^{f}-w_{i,f,2}^{f}\middle|u_{i,f,1}<\widehat{u_{i,f,2}^{f}}\right)>\ \boldsymbol{E}\left(\boldsymbol{w}_{\boldsymbol{i},\boldsymbol{f},\mathbf{1}}^{\boldsymbol{f}}-\boldsymbol{w}_{\boldsymbol{i},\boldsymbol{f},\mathbf{2}}^{\boldsymbol{m}}\middle|\boldsymbol{u}_{\boldsymbol{i},\boldsymbol{f},\mathbf{1}}<\widehat{\boldsymbol{u}_{\boldsymbol{i},\boldsymbol{f},\mathbf{2}}^{\boldsymbol{m}}}\right)>\mathrm{E}\left(w_{i,f,1}^{m}-w_{i,f,2}^{m}\middle|u_{i,f,1}<\widehat{u_{i,f,2}^{m}}\right)$$

$$E\left(w_{i,f,1}^{f}-w_{i,f,2}^{f}\middle|u_{i,f,1}<\widehat{u_{i,f,2}^{f}}\right)>E\left(w_{i,f,1}^{m}-w_{i,f,2}^{f}\middle|u_{i,f,1}<\widehat{u_{i,f,2}^{f}}\right)>\mathrm{E}\left(w_{i,f,1}^{m}-w_{i,f,2}^{m}\middle|u_{i,f,1}<\widehat{u_{i,f,2}^{m}}\right)$$

The inter-period wage gains for movers with supervisors of different gender in different period depend on θ, the order of which cannot be listed unambiguously.

In predominantly male occupation, the inter-period wage gains for movers with:

(1) female supervisors in both stages:

$$E\left(w_{i,m,1}^{f}-w_{i,m,2}^{f}\middle|u_{i,m,1}<\widehat{u_{i,m,2}^{f}}\right)=\{\frac{\boldsymbol{\theta}\left(\boldsymbol{\rho}_{m}^{f}\right)^{2}+\left(\boldsymbol{\rho}_{m}^{f}\right)^{2}+\mathbf{1}-\boldsymbol{\theta}}{\sqrt{\mathbf{1}+\left(\boldsymbol{\rho}_{m}^{f}\right)^{2}}}\}\times\left(\frac{\mathbf{2}\boldsymbol{\eta}^{2}}{\boldsymbol{\pi}}\right)^{\frac{\mathbf{1}}{\mathbf{2}}}$$

(2) female supervisors in stage 1 and male supervisors in stage 2:

$$\boldsymbol{E}\left(\boldsymbol{w}_{\boldsymbol{i},\boldsymbol{m},\mathbf{1}}^{\boldsymbol{f}}-\boldsymbol{w}_{\boldsymbol{i},\boldsymbol{m},\mathbf{2}}^{\boldsymbol{m}}\middle|\boldsymbol{u}_{\boldsymbol{i},\boldsymbol{m},\mathbf{1}}<\widehat{\boldsymbol{u}_{\boldsymbol{i},\boldsymbol{m},\mathbf{2}}^{\boldsymbol{m}}}\right)=\{\frac{[\boldsymbol{\theta}\left(\boldsymbol{\rho}_{\boldsymbol{m}}^{\boldsymbol{f}}\right)^{2}+(\boldsymbol{\rho}_{\boldsymbol{m}}^{\boldsymbol{m}})^{2}+\mathbf{1}-\boldsymbol{\theta}]}{\sqrt{\mathbf{1}+(\boldsymbol{\rho}_{\boldsymbol{m}}^{\boldsymbol{m}})^{2}}}\}\times\left(\frac{\mathbf{2}\boldsymbol{\eta}^{2}}{\boldsymbol{\pi}}\right)^{\frac{\mathbf{1}}{\mathbf{2}}}$$

(3) male supervisors in stage 1 and female supervisors in stage 2:

$$E\left(w_{i,m,1}^{m}-w_{i,m,2}^{f}\middle|u_{i,m,1}<\widehat{u_{i,m,2}^{f}}\right)=\left[\frac{\boldsymbol{\theta}\left(\boldsymbol{\rho}_{\boldsymbol{m}}^{\boldsymbol{m}}\right)^{2}+\left(\boldsymbol{\rho}_{\boldsymbol{m}}^{\boldsymbol{f}}\right)^{2}+\mathbf{1}-\boldsymbol{\theta}}{\sqrt{\mathbf{1}+\left(\boldsymbol{\rho}_{\boldsymbol{m}}^{\boldsymbol{f}}\right)^{2}}}\right]\times\left(\frac{\boldsymbol{2\eta^{2}}}{\boldsymbol{\pi}}\right)^{\frac{\mathbf{1}}{\mathbf{2}}}$$

(4) male supervisors in both stages:

$$\mathrm{E}\left(w_{i,m,1}^{m}-w_{i,m,2}^{m}\middle|u_{i,m,1}<\widehat{u_{i,m,2}^{m}}\right)=\left[\frac{\boldsymbol{\theta}\left(\boldsymbol{\rho}_{\boldsymbol{m}}^{\boldsymbol{m}}\right)^{2}+\left(\boldsymbol{\rho}_{\boldsymbol{m}}^{\boldsymbol{m}}\right)^{2}+\mathbf{1}-\boldsymbol{\theta}}{\sqrt{\mathbf{1}+\left(\boldsymbol{\rho}_{\boldsymbol{m}}^{\boldsymbol{m}}\right)^{2}}}\right]\times\left(\frac{\boldsymbol{2\eta^{2}}}{\boldsymbol{\pi}}\right)^{\frac{\mathbf{1}}{\mathbf{2}}}$$

It is easy to show that

$$\mathrm{E}\left(w_{i,m,1}^{m}-w_{i,m,2}^{m}\middle|u_{i,m,1}<\widehat{u_{i,m,2}^{m}}\right)>\boldsymbol{E\left(w_{i,m,1}^{f}-w_{i,m,2}^{m}\middle|u_{i,m,1}<\widehat{u_{i,m,2}^{m}}\right)}>E\left(w_{i,m,1}^{f}-w_{i,m,2}^{f}\middle|u_{i,m,1}<\widehat{u_{i,m,2}^{f}}\right)$$

$$\mathrm{E}\left(w_{i,m,1}^{m}-w_{i,m,2}^{m}\middle|u_{i,m,1}<\widehat{u_{i,m,2}^{m}}\right)>E\left(w_{i,m,1}^{m}-w_{i,m,2}^{f}\middle|u_{i,m,1}<\widehat{u_{i,m,2}^{f}}\right)>E\left(w_{i,m,1}^{f}-w_{i,m,2}^{f}\middle|u_{i,m,1}<\widehat{u_{i,m,2}^{f}}\right)$$

The inter-period wage gains for movers with supervisors of different gender in different period depend on θ, the order of which cannot be listed unambiguously.

End of Proof.

[Proof of Proposition 6]

(1) In predominantly female occupations, the return to one-year labor market experience for stayers is $\left[\frac{1-\pi_f}{\sqrt{1+(\rho_f^m)^2}}+\frac{\pi_f}{\sqrt{1+(\rho_f^f)^2}}\right]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$; the return to one-year labor market experience for movers with supervisor j is $\frac{(\rho_f^j)^2}{\sqrt{1+(\rho_f^j)^2}}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$.

Since$(\rho_f^m)^2<(\rho_f^f)^2$, we have $\left[\frac{1-\pi_f}{\sqrt{1+(\rho_f^m)^2}}+\frac{\pi_f}{\sqrt{1+(\rho_f^f)^2}}\right]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}>\frac{1}{\sqrt{1+(\rho_f^f)^2}}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}>\frac{(\rho_f^j)^2}{\sqrt{1+(\rho_f^j)^2}}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$.

Stayers' one-year labor market experience has higher return compared to that of movers' one-year labor market experience.

In predominantly male occupations, the return to one-year labor market experience for stayers is $[\frac{1-\pi_m}{\sqrt{1+(\rho_m^m)^2}}+\frac{\pi_m}{\sqrt{1+(\rho_m^f)^2}}]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$; the return to one-year labor market experience for movers with supervisor j is $\frac{(\rho_m^j)^2}{\sqrt{1+(\rho_m^j)^2}}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$.

Since $(\rho_m^m)^2>(\rho_m^f)^2$, we have $\left[\frac{1-\pi_f}{\sqrt{1+(\rho_m^m)^2}}+\frac{\pi_f}{\sqrt{1+(\rho_m^f)^2}}\right]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}>\frac{1}{\sqrt{1+(\rho_m^m)^2}}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}>\frac{(\rho_m^j)^2}{\sqrt{1+(\rho_m^j)^2}}\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$. Stayers' one-year labor market experience has higher return compared to that of movers' one-year labor market experience.

(2)

In predominantly female occupations, return to one-year labor market experience for female workers moving to work with same-gender supervisors is $[\frac{(\rho_f^f)^2}{\sqrt{1+(\rho_f^f)^2}}]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$, which is higher than that of female workers who move to work with opposite-gender supervisors ($[\frac{(\rho_f^m)^2}{\sqrt{1+(\rho_f^m)^2}}]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$). The return to one-year labor market experience for male workers moving to work with opposite-gender supervisors is $[\frac{(\rho_f^f)^2}{\sqrt{1+(\rho_f^f)^2}}]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$, which is higher than that of male workers who move to work with same-gender supervisors ($[\frac{(\rho_f^m)^2}{\sqrt{1+(\rho_f^m)^2}}]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$).

In predominantly male occupations, return to one-year labor market experience for female workers moving to work with same-gender supervisors is $[\frac{(\rho_m^f)^2}{\sqrt{1+(\rho_m^f)^2}}]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$, which is lower than that of female workers who move to work with opposite-gender supervisors ($[\frac{(\rho_m^m)^2}{\sqrt{1+(\rho_m^m)^2}}]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$). The return to one-year labor market experience for male workers moving to work with opposite-gender supervisors is $[\frac{(\rho_m^f)^2}{\sqrt{1+(\rho_m^f)^2}}]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$, which is lower than that of male workers who move to work with same-gender supervisors ($[\frac{(\rho_m^m)^2}{\sqrt{1+(\rho_m^m)^2}}]\times\left(\frac{2\eta^2}{\pi}\right)^{\frac{1}{2}}$).

To sum up, in occupations with larger proportion of same-gender workers, workers move to same-gender supervisors have higher return to labor market experience. In occupations with larger proportion of opposite-gender workers, workers move to same-gender supervisors have lower return to labor market experience.

End of Proof.

[Proof of Proposition 7]

In predominantly female occupations, the unconditional expectation of second-stage wage for female workers with the same-gender supervisors is $\boldsymbol{m} + [\frac{1-\pi_f}{\sqrt{1+(\rho_f^m)^2}} + \frac{\pi_f+(\rho_f^f)^2}{\sqrt{1+(\rho_f^f)^2}}]\times\left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}}$, which is higher than that of female workers with the opposite-gender supervisors $(\mathbf{m} + [\frac{1-\pi_f+(\rho_f^m)^2}{\sqrt{1+(\rho_f^m)^2}} + \frac{\pi_f}{\sqrt{1+(\rho_f^f)^2}}]\times\left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}})$.

This is because: $\boldsymbol{m} + \left[\frac{1-\pi_f}{\sqrt{1+(\rho_f^m)^2}} + \frac{\pi_k+(\rho_f^f)^2}{\sqrt{1+(\rho_f^f)^2}}\right]\times\left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}} = \mathbf{m} + \left[\frac{1-\pi_f}{\sqrt{1+(\rho_f^m)^2}} + \frac{\pi_f}{\sqrt{1+(\rho_f^f)^2}} + \frac{(\rho_f^f)^2}{\sqrt{1+(\rho_f^f)^2}}\right]\times\left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}} > \mathbf{m} + \left[\frac{1-\pi_f}{\sqrt{1+(\rho_f^m)^2}} + \frac{\pi_f}{\sqrt{1+(\rho_f^f)^2}} + \frac{(\rho_f^m)^2}{\sqrt{1+(\rho_f^m)^2}}\right]\times\left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}}$.

In predominantly female occupations, the unconditional expectation of second-stage wage for male workers with the opposite-gender supervisors is $\boldsymbol{m} + [\frac{1-\pi_f}{\sqrt{1+(\rho_f^m)^2}} + \frac{\pi_f+(\rho_f^f)^2}{\sqrt{1+(\rho_f^f)^2}}]\times\left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}}$, which is higher than that of male workers with the same-gender supervisors $(\boldsymbol{m} + [\frac{1-\pi_f+(\rho_f^m)^2}{\sqrt{1+(\rho_f^m)^2}} + \frac{\pi_f}{\sqrt{1+(\rho_f^f)^2}}]\times\left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}})$.

This is because:

$$\boldsymbol{m} + \left[\frac{1-\pi_f}{\sqrt{1+(\rho_f^m)^2}} + \frac{\pi_f+(\rho_f^f)^2}{\sqrt{1+(\rho_f^f)^2}}\right]\times\left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}} = \boldsymbol{m} + \left[\frac{1-\pi_f}{\sqrt{1+(\rho_f^m)^2}} + \frac{\pi_f}{\sqrt{1+(\rho_f^f)^2}} + \frac{(\rho_f^f)^2}{\sqrt{1+(\rho_f^f)^2}}\right]\times\left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}} > \boldsymbol{m} + \left[\frac{1-\pi_f}{\sqrt{1+(\rho_f^m)^2}} + \frac{\pi_f}{\sqrt{1+(\rho_f^f)^2}} + \frac{(\rho_f^m)^2}{\sqrt{1+(\rho_f^m)^2}}\right]\times\left(\frac{\eta^2}{2\pi}\right)^{\frac{1}{2}}$$

The proposition with respect to predominantly male occupations can be proved in similar ways.

End of Proof.

Appendix C- Linking the ASVAB scores to O*Net KSA Composite[33]

ASVAB verbal composite		O*NET KSA Verbal Composite		O*NET Element ID
WK	Word Knowledge	Ability	Inductive Reasoning	1.A.1.b.5
PC	Paragraph Comprehension	Ability	Written Comprehension	1.A.1.a.2
		Ability	Oral Comprehension	1.A.1.a.1
		Knowledge	English Language	2.C.7.a
		Skill	Reading Comprehension	2.A.1.a
ASVAB Math Composite		O*NET KSA Math Composite		
AR	Arithmetic Reasoning	Ability	Deductive Reasoning	1.A.1.b.4
MK	Math Knowledge	Ability	Inductive Reasoning	1.A.1.b.5
		Ability	Written	1.A.1.a.2
		Ability	Number Facility	1.A.1.c.2
		Ability	Mathematical Reasoning	1.A.1.c.1
		Ability	Information Ordering	1.A.1.b.6
		Knowledge	Mathematics	2.C.4.a
		Skill	Science	2.A.1.f
		Skill	Mathematics	2.A.1.e
ASVAB Science and Technical Composite		O*NET KSA Science and Mechanical Composite		
GS	General Science	Ability	Deductive Reasoning	1.A.1.b.4
MC	Mechanical Comprehension	Ability	Inductive Reasoning	1.A.1.b.5
EI	Electronics Information	Ability	Written Comprehension	1.A.1.a.2
		Knowledge	Mechanical	2.C.3.e
		Knowledge	Biology	2.C.4.d
		Knowledge	Computers and Electronics	2.C.3.a
		Knowledge	Engineering and Technology	2.C.3.b
		Knowledge	Chemistry	2.C.4.c
		Knowledge	Physics	2.C.4.b
		Knowledge	Building and Construction	2.C.3.d
		Skill	Technology Design	2.B.3.b
		Skill	Science	2.A.1.f
		Skill	Installation	2.B.3.d
		Skill	Trouble Shooting	2.B.3.k
		Skill	Equipment Selection	2.B.3.c
		Skill	Operation and Control	2.B.3.h

[33] This table is listed in the "The ASVAB Career Exploration Program: Theoretical and Technical Underpinnings of the Revised Skill Composites and OCCU-Find" (2010, p23-24), which is downloaded from http://www.asvabprogram.com/downloads/Technical Chapter 2010.pdf. (Final version Feb,2011)

Appendix D Tables

Table 5: Sample Construction

	NLSY97			
	Remaining Individuals		Remaining Observations	
Criterion for sample selection	Male	Female	Male	Female
0 Entire Sample	4,599	4,385	73,584	70,160
1 In the Cross-sectional sample/ not oversampled	3,459	3,289	55,344	52,624
2 Not working before data sample period	3,276	3,172	52,416	50,752
3 Worked more than 1200 hours for the last 2 years	2,707	2,554	20,496	17,793
4 Not in the military for 2 years or more	2,707	2,554	20,492	17,793
5 Currently Working	2,706	2,554	20,447	17,783
6 Have valid occupation and industry information	2,695	2,530	18,439	16,106
7 Older than 20	2,636	2,497	16,708	14,788
8 Have valid wage information	2,609	2,474	14,920	13,387
9 Have no missing information on variables of interest	2,528	2,412	14,648	13,172

Notes: We are using annual data and not the monthly job arrays.

Table 6: Descriptive Statistics of the Sample

Variable	Definition	All	Male	Female
Female	0/1 Dummy (=1 if female)	0.47		
Age at date of interview	Age in years	24.9	24.9	24.9
Having a same-gender supervisor	0/1 Dummy	0.43	0.49	0.35
Highest education=high school	0/1 Dummy	0.24	0.28	0.19
Highest education>high school	0/1 Dummy	0.27	0.27	0.27
Highest education>=4-year college	0/1 Dummy	0.37	0.30	0.44
African-American	0/1 Dummy	0.14	0.13	0.16
Hispanic	0/1 Dummy	0.14	0.15	0.14
Have at least one child	0/1 Dummy	0.28	0.22	0.34
Ever married (married, divorced, widowed, seperated)	0/1 Dummy	0.30	0.28	0.33
Predominantly male occupation	< 33% female workers	0.35	0.55	0.10
Predominantly female occupation	> 66% female workers	0.31	0.13	0.55
Total labor market experience (mean)	Mean years worked	8.44	8.45	8.42
Total labor market experience (median)	Median years worked	8.00	8.00	8.00
Occupational tenure (mean)	Mean years worked in the same occupation	3.30	3.30	3.30
Occupational tenure (median)	Median years worked in the same occupation	3.00	3.00	3.00

Table 7: Extent and Size of Mismatch, by Gender, Gender of Supervisor and Occupational Gender Composition

			[1]	[2]	[3]	[4]	[5]
			Magnitude of Over-qualification	**Share of Over-qualified**	**Magnitude of Under-qualification**	**Share of Under-qualified**	**Total Mismatch (standardized)**
All	Predominantly Male Occupation	Male	0.17	45%	0.09	33%	2.14
		Female	0.16	42%	0.10	37%	2.14
	Predominantly Female Occupation	Male	0.26	63%	0.06	21%	2.65
		Female	0.21	53%	0.07	23%	2.40
	With Same-Gender Supervisor	Male	0.20	51%	0.08	28%	2.26
		Female	0.20	53%	0.07	23%	2.23
	With Opposite-Gender Supervisor	Male	0.19	48%	0.09	33%	2.24
		Female	0.19	49%	0.08	28%	2.23
Predominantly Male Occupation	With Same-Gender Supervisor	Male	0.18	48%	0.08	31%	2.17
		Female	0.17	46%	0.10	35%	2.19
	With Opposite-Gender Supervisor	Male	0.16	42%	0.10	36%	2.10
		Female	0.16	41%	0.10	38%	2.12
Predominantly Female Occupation	With Same-Gender Supervisor	Male	0.28	64%	0.05	18%	2.71
		Female	0.21	53%	0.06	22%	2.25
	With Opposite-Gender Supervisor	Male	0.25	63%	0.07	23%	2.62
		Female	0.21	53%	0.07	25%	2.33

Notes: "Magnitude of Over-qualification" is the average non-standardized measure of the distance between the worker's endowments and occupational requirements of the job when the worker's average skill endowment exceeds the average occupational skill requirements. “Share of over-qualified” on the other hand gives the share of workers who are more than one standard deviation more endowed than required. Measures of under-qualification are similarly constructed. “Total Mismatch (standardized)” is the standardized aggegated measure of the distance between the worker's endowments and occupational requirements.

Table 8: The Determinants of Skill Mismatch: Gender of Supervisor and Occupational Gender Composition

	(1) OLS		(2) OLS		(3) FE		(4) IV-FE	
	Male	Female	Male	Female	Male	Female	Male	Female
Same-Gender Supervisor	0.0399	-0.0125	0.0267	0.0382	-0.0379	0.0842	-0.0405	0.0936
	[0.0257]	[0.0296]	[0.0284]	[0.0646]	[0.0230]+	[0.0510]+	[0.0230]+	[0.0512]+
Same-Gender Supervisor* FEM			-0.0536	-0.1389	0.0164	-0.1756	0.0194	-0.19
			[0.0655]	[0.0877]	[0.0502]	[0.0702]*	[0.0503]	[0.0705]**
FEM			0.1203	0.0407	0.0251	-0.0429	0.0263	-0.0442
			[0.0460]**	[0.0490]	[0.0425]	[0.0487]	[0.0425]	[0.0489]
Observations	14648	13172	14648	13172	14648	13172	14648	13172

Notes: The dependent variable is individual's total extent of skill mismatch, which is normalized to have a standard deviation of 1. "FEM" indicates the proportion of female workers in occupations that individuals held at the time of interview. Columns labelled (1) include only the dummy of "same-gender supervisor". Columns labelled (2) include demographic variables such as race, completed years of schooling, average measures of individual's skills and occupational requirements, as well as tenure variables such as total labor market experience, tenure with current employer, occupational tenure and their quadratic terms, also included are the interaction term of skills and occupational tenure and the interaction term of occupational requirements and occupational tenure. Columns labelled (3) are the fixed-effect estimations based on the specification in Columns (2); In columns labelled (4) coefficients are estimated using the IV-fixed effect model with the specification in Columns (2), where employer tenure, occupational tenure, and total experience, as well as their quadratic forms and interaction terms are instrumented. Clustered standard errors are reported in brackets. **, *, + indicates significance at 0.01, 0.05 and 0.1 levels, respectively.

Table 9: The Determinants of Multi-Dimensional Skill Mismatch: Gender of Supervisor and Occupational Gender Composition

	(1) Math		(2) Verbal		(3) STM		(4) Social	
	Male	Female	Male	Female	Male	Female	Male	Female
Same-Gender Supervisor	-0.0425	0.0436	-0.0562	0.0833	0.0006	0.0188	-0.0033	0.0487
	[0.0237]+	[0.0505]	[0.0222]*	[0.0516]	[0.0248]	[0.0450]	[0.0207]	[0.0179]**
Same-Gender Supervisor* FEM	-0.0354	-0.0387	0.1237	-0.1482	0.0769	-0.0464	-0.082	0.0165
	[0.0517]	[0.0694]	[0.0485]*	[0.0709]*	[0.0542]	[0.0619]	[0.0452]+	[0.0476]
FEM	-0.0678	-0.1506	-0.3168	-0.2613	0.6161	0.0815	-0.173	-0.1064
	[0.0438]	[0.0482]**	[0.0410]**	[0.0492]**	[0.0458]**	[0.0430]+	[0.0381]**	[0.0655]
Observations	14648	13172	14648	13172	14648	13172	14648	13172

Notes: The dependent variable is the standardized amount of mismatch in math, verbal, STM and social skills, respectively. Columns labelled (1) include only the dummy of "same-gender supervisor". Columns labelled (2) include demographic variables such as race, completed years of schooling, average measures of individual's skills and occupational requirements, as well as tenure variables such as total labor market experience, tenure with current employer, occupational tenure and their quadratic terms, also included are the interaction term of skills and occupational tenure and the interaction term of occupational requirements and occupational tenure. Columns labelled (3) are the fixed-effect estimations based on the full specification; In columns labelled (4) coefficients are estimated using the IV-fixed effect model with full specification, where employer tenure, occupational tenure, and total experience, as well as their quadratic forms and interaction terms are instrumented. Clustered standard errors are reported in brackets. **, *, + indicates significance at 0.01, 0.05 and 0.1 levels, respectively.

Table 10: Same-Gender Supervisors' Wage Effects, Conditioning on Occupational Gender Composition

	[1] OLS		[2] OLS		[3] FE		[4] IV-FE	
	Male	Female	Male	Female	Male	Female	Male	Female
Same-Gender Supervisor	-0.0783	-0.1752	0.0274	-0.0407	0.0374	-0.0378	0.0341	-0.042
	[0.0136]**	[0.0306]**	[0.0133]*	[0.0252]	[0.0096]**	[0.0177]*	[0.0097]**	[0.0179]*
Same-Gender Supervisor* FEM	-0.0698	0.1391	-0.0505	0.0684	-0.0615	0.0569	-0.0595	0.0614
	[0.0357]+	[0.0423]**	[0.0289]+	[0.0347]*	[0.0211]**	[0.0244]*	[0.0213]**	[0.0246]*
FEM	-0.2668	-0.0838	-0.153	0.0141	-0.0847	-0.0658	-0.0821	-0.0702
	[0.0290]**	[0.0335]*	[0.0355]**	[0.0325]	[0.0221]**	[0.0203]**	[0.0223]**	[0.0205]**
Observations	14648	13172	14648	13172	14648	13172	14648	13172

Notes: The dependent variable is log hourly wage in 2002's dollar value. Columns labelled (1) include only the dummy of "same-gender supervisor". Columns labelled (2) include demographic variables such as race, completed years of schooling, average measures of individual's skills and occupational requirements, as well as tenure variables such as total labor market experience, tenure with current employer, occupational tenure and their quadratic terms, as well as dummies indicating 1-digit occupation groups and industry groups. We will henceforth refer to the set of variables in Column (2) specification as the specification with full set of controls. Columns labelled (3) are the fixed-effect estimations based on the full specification; In columns labelled (4) coefficients are estimated using the IV-fixed effect model with full specification, where employer tenure, occupational tenure, and total experience, as well as their quadratic forms and interaction terms are instrumented. Clustered standard errors are reported in brackets. **, *, + indicates significance at 0.01, 0.05 and 0.1 levels, respectively.

Table 11: Same-Gender Supervisor Wage Effects along the Career Path

	Fixed Effect Model			IV-Fixed Effect Model		
	Occupational Tenure (Years)			Occupational Tenure (Years)		
Female	0-1	1-3	3+	0-1	1-3	3+
Same-Gender Supervisor	-0.0561	-0.0632	-0.0756	-0.0864	-0.0717	-0.0733
	[0.0614]	[0.0305]*	[0.0311]*	[0.1266]	[0.0311]*	[0.0312]*
Same-Gender Supervisor* FEM	0.1216	0.1239	0.0903	0.2083	0.1365	0.0877
	[0.0879]	[0.0421]**	[0.0417]*	[0.1780]	[0.0430]**	[0.0418]*
FEM	-0.1291	-0.1002	-0.0142	-0.2131	-0.11	-0.0124
	[0.0627]*	[0.0323]**	[0.0390]	[0.1265]+	[0.0330]**	[0.0391]
Observations	2366	5650	5075	2366	5650	5075
Male	0-1	1-3	3+	0-1	1-3	3+
Same-Gender Supervisor	0.0378	0.0331	0.0338	-0.0705	0.0274	0.0348
	[0.0317]	[0.0196]+	[0.0179]+	[0.2413]	[0.0198]	[0.0179]+
Same-Gender Supervisor* FEM	-0.0449	-0.0724	-0.075	0.2476	-0.0611	-0.0751
	[0.0697]	[0.0380]+	[0.0318]*	[0.5522]	[0.0386]	[0.0318]*
FEM	-0.1834	-0.0944	-0.0221	-0.1708	-0.0985	-0.0199
	[0.0628]**	[0.0366]*	[0.0392]	[0.2289]	[0.0372]**	[0.0392]
Observations	2647	6120	5773	2647	6120	5773

Notes: The dependent variable is log hourly wage in 2002's dollar value. Estimations are based on the full set of controls. In IV-fixed effect models, coefficients are estimated using the IV-fixed effect model with full specification, where employer tenure, occupational tenure, and total experience, as well as their quadratic forms and interaction terms are instrumented. Clustered standard errors are reported in brackets. **, *, + indicates significance at 0.01, 0.05 and 0.1 levels, respectively.

Table 12: Same-Gender Supervisor and Returns to Job Mobility and Continuation

	FE		IV-FE	
	Male	Female	Male	Female
Same-Gender Supervisor*Movers	0.0251	-0.0221	0.0314	-0.0198
	[0.0189]	[0.0268]	[0.0189]+	[0.0269]
Same-Gender Supervisor*Movers*Female Occupation	-0.1023	0.0909	-0.1106	0.0944
	[0.0467]*	[0.0337]**	[0.0468]*	[0.0337]**
Same-Gender Supervisor	0.0104	-0.0125	0.0077	-0.014
	[0.0152]	[0.0182]	[0.0152]	[0.0182]
Same-Gender Supervisor*Female Occupation	-0.0049	0.0149	0.0025	0.0117
	[0.0298]	[0.0213]	[0.0299]	[0.0214]
Movers	0.0735	0.1498	0.0077	0.0779
	[0.0180]**	[0.0183]**	[0.0218]	[0.0215]**
Movers* Female Occupation	-0.0353	-0.1124	-0.0271	-0.1122
	[0.0292]	[0.0201]**	[0.0293]	[0.0202]**
Female Occupation	-0.0289	-0.0044	-0.0343	-0.0043
	[0.0219]	[0.0149]	[0.0220]	[0.0149]
Observation	13671	12419	13671	12419

Notes: The dependent variable is individuals' annual growth rate of real hourly wages. Estimations are based on the full set of controls. In IV-fixed effect models, coefficients are estimated using the IV-fixed effect model with full specification, where employer tenure, occupational tenure, and total experience, as well as their quadratic forms and interaction terms are instrumented. Female occupations are defined as the occupations with more than 67% of female workers. Clustered standard errors are reported in brackets. **, *, + indicates significance at 0.01, 0.05 and 0.1 levels, respectively.

Table 13: Same-Gender Supervisor and Returns to Occupational Tenure

	FE		IV-FE	
	Female	Male	Female	Male
Same-gender Supervisor	0.0244	0.0221	0.0168	0.0103
	[0.0092]**	[0.0100]*	[0.0097]+	[0.0105]
Same-gender Supervisor * Occ Tenure	-0.0193	0.0007	-0.0109	0.0044
	[0.0058]**	[0.0033]	[0.0065]+	[0.0036]
Same-gender Supervisor * Occ Tenure* FEM	0.016	-0.0131	0.0073	-0.011
	[0.0074]*	[0.0060]*	[0.0081]	[0.0065]+
Occ Tenure* FEM	0.0047	0.0106	-0.0041	0.0085
	[0.0054]	[0.0052]*	[0.0059]	[0.0056]
FEM	-0.0708	-0.1275	-0.0476	-0.1227
	[0.0231]**	[0.0238]**	[0.0241]*	[0.0247]**
Occ Tenure	0.0204	0.0469	0.0675	0.0974
	[0.0058]**	[0.0056]**	[0.0085]**	[0.0089]**
Observations	13172	14648	13172	14648

Notes: The dependent variable is log hourly wage in 2002's dollar value. Estimations are based on the full set of controls. In IV-fixed effect models, coefficients are estimated using the IV-fixed effect model with full specification, where employer tenure, occupational tenure, and total experience, as well as their quadratic forms and interaction terms are instrumented. Clustered standard errors are reported in brackets. **, *, + indicates significance at 0.01, 0.05 and 0.1 levels, respectively.

Table 14: Occupational skill requirements and the probability of having a same-gender supervisor

	Female			Male		
	Predominantly Male Occupation	Mixed Occupation	Predominantly Female Occupation	Predominantly Male Occupation	Mixed Occupation	Predominantly Female Occupation
Percentile ranks of Occupational Requirements	-3.4837	-0.9954	-0.6776	1.0335	0.5081	0.0036
	[5.4279]	[1.0625]	[0.5172]	[0.6548]	[1.0723]	[1.5180]
Number of Observations	300	2170	5329	5747	3255	1049

Notes: The estimations are made based on the fixed effect logit model with full set of control variables. Predominantly male occupations are occupations where female workers account for less than 33%; predominantly male occupations are occupations where female workers account for more than 67%; mixed occupations are occupations where female workers account for 33%-67%. Clustered standard errors are reported in brackets. **, *, + indicates significance at 0.01, 0.05 and 0.1 levels, respectively.

Table 15: Female supervisor and Promotion probability

	(1) Logit				(2) FE-Logit			
	Female		Male		Female		Male	
Female Supervisor	0.021	0.317	-0.051	-0.215	0.059	0.069	0.08	-0.191
	[0.086]	[0.261]	[0.111]	[0.25]	[0.19]	[0.513]	[0.223]	[0.513]
Female Supervisor*FEM		-0.481		0.354		-0.016		0.582
		[0.402]		[0.495]		[0.796]		[0.993]
FEM	-2.502	-2.535	0.8	0.895	0.846	0.847	3.379	3.556
	[1.091]*	[1.087]*	[0.861]	[0.862]	[3.224]	[3.224]	[2.46]	[2.476]

Notes: The dependent variable is a dummy that equals 1 if an individual have been promoted since the last date of interview. Estimations are made based on logit regression. The clustered standard errors are reported in . **, *, + denote statistical significance at the 0.01, 0.05 and 0.1 levels, respectively.