Gender Occupational Segregation in an Equilibrium Search Model[*]

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Abstract

This paper studies an equilibrium search model in which jobs are differentiated on both salary and working hours, and men and women have different preferences for hours. In particular, the marginal disutility of an additional work hour is higher for women than for men. Employers have different production technologies, and they post a tied salary/hours offer that maximizes their steady-state profit (or utility) flow. Even without the presence of discrimination, women crowd into short-hour, lower-paying jobs, whereas men are in long-hour, higher-paying jobs. There are fewer women on the job when employers have a taste for discrimination against women, since these employers make their job offer less appealing to women by requiring more working hours. On the other hand, when women have a disamenity value to working on a job, women choose not to work in that job because of a loss in utility. The prediction on segregation is similar to the case with employer discrimination.

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1 Introduction

There is a large variation in earnings and the number of hours worked across occupations and between men and women in the labor market. Women crowd into female-dominated jobs that require shorter hours and pay lower wages, whereas men tend to work in long-hour, higher paying jobs. To study these gender asymmetries and differentials in the labor market, this paper develops an equilibrium search model in which both wage and work hours are relevant job attributes.[1] On the demand side, employers have different production technologies, in which their input in production is hours of work. These employers post a take-it-or-leave-it tied salary/hours offer that maximizes their steady-state profit (or utility) flow. On the supply side, women have a higher marginal disutility of an additional work hour than men.[2] Due to labor market frictions, workers are unable to locate themselves in their desired jobs, and move between jobs to obtain a higher occupational utility. When an employer offers only one bundle of a salary and an hours requirement, the offer accounts for the probability of employing both men and women. I consider a situation in which an employer is constrained to post only one job description to fill a job vacancy because (1) it would be illegal to make job offers that differ systematically by gender and (2) it would be too costly for employers to monitor employees if employees were to work different number of hours on the same job.

Using simulations, I illustrate the offer that maximizes the employer's steady-state profit (or utility) flow conditional on the job offers by all the other employers and on workers' job search behaviors. Employers with a higher marginal productivity of an hour require more hours and pay a higher salary, and their offers are tailored to men's preferences because men are more heavily represented in their jobs. Even without the presence of discrimination against women, there are gender asymmetries in salary and hours of work.

Next, I consider a Becker (1971)-type employer discrimination in which employers have a disamenity value to employing women. The employers suffer a utility loss when hiring

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[1] See Altonji and Blank (1999) for a recent survey of gender occupational segregation. Johnson and Stafford (1998) provide a simple framework to understand the factors that affect segregation. In their model, workers are perfectly matched to their desired jobs. However, Altonji and Paxson (1998) and Kahn and Lang (1991, 1995) establish that firms place significant constraints on hours worked; many workers are not perfectly matched to their desired hours, and workers need to change employers in order to work in jobs that are more in line with their desired hours preferences.

[2] Usui (2005) finds that the probability of reporting overemployment is higher for women than for men in the Panel Study of Income Dynamics. Women are reluctant to work long hours relative to men because they tend to bear the primary family responsibilities of caring for children and relatives.

women, and thus they increase their hours to alter the packages away from women's preferences. Having made the offers unfavorable to women, segregation is reinforced. I show that employers can obtain a higher profit by being more discriminating. Discriminating employers regard women's productivity as low and pay them lower wages. This leads to a lower wage rate for both men and women because employers are constrained to post only one job offer. Women with a higher reservation utility find it better to be unemployed, but men remain on the job and suffer the wage loss. Since the wage rate is lower, employers decide to require more work hours. Discriminating employers, who have monopsony power, can realize greater monetary profits when the decline in the number of female employees is small.

I then consider an employee discrimination model in which women act as if there were nonpecuniary costs for working in certain jobs. The nonpecuniary costs vary across jobs. Women choose not to work in jobs that will lead them to suffer a loss in utility. Consequently, there are more men working these jobs. The predictions regarding segregation are similar regardless of whether discrimination is related to productivity (employer discrimination) or women's utility (employee preference). However, the prediction for employers' profitability is different. In the case for employee discrimination, employers lower their profits because they tailor their job packages to attract more workers.

Lastly, I consider a case in which employee discrimination against women increases with the proportion of men on the job, because male cultures in the workplace can adversely affect women's job satisfaction. According to Mansfield et al. (1991), women in traditionally male occupations reported significantly less satisfaction and more stress at work than women in traditionally female occupations. Using job satisfaction data from the National Longitudinal Survey of Youth (NLSY), women who quit and move to jobs where there are more men report that co-workers are less friendly and that their physical surroundings are less pleasant; but men report the opposite (Usui, 2006). When I set up the discrimination coefficient to be positively related to the composition of men on the job, there can be multiple equilibria. Discrimination is absent in one equilibrium, while it exists in the other. In the discriminatory equilibrium, the predictions regarding segregation and employers' profitability are similar to the case in which the employee discrimination parameter is set exogenously.

The job-offer distributions described above are computed using a three-step algorithm. The algorithm is based on the idea that employers post a tied salary/hours offer that accounts for the difference in preferences by gender, and the mix of men and women who typically

choose the particular job type. In the first step, employers choose hours so that the marginal productivity of an additional hour equals the weighted average of the marginal disutility for men and women, where the weights reflect the gender composition of the particular job type in equilibrium. In the second step, employers choose a salary to maximize the steady-state profit (or utility) flow, given the hours determined in the first step. The tied salary/hours offer here is not necessarily an optimal offer. Employers prefer workers with lower turnover rates, and value them more than the fraction of these workers on the job. In the third step, I start from the above tied salary/hours offer, and search for the tied salary/hours offer that maximizes the employer's steady-state profit (or utility) flow.

Black (1995), Bowlus and Eckstein (2002) and Flabbi (2005) are important studies on search models with taste discrimination, although these studies do not include work hours.[3] Almost all of the literature on the equilibrium search treats wage as the only relevant job attribute. However, Lang and Majumdar (2004) and Hwang, Mortensen, and Reed (1998) are exceptional studies that allow jobs to include another attribute in addition to wage. Lang and Majumdar (2004) (hereafter denoted as LM) consider a nonsequential model in which employers are homogeneous, but workers are heterogeneous in their preferences for job amenities. Employers do not know the types of workers they face, and make a take-it-or-leave-it offer. Each employer trades off the salary/hours package against the possibility that the offer may be rejected. LM develop a strategy to compute the equilibrium tied salary/hours profile, and show that the salary need not increase as the level of disamenity rises, which contradicts compensating differentials for negative job-characteristics.

My model has two differences from that of LM. First, I allow jobs to differ in production technologies. I show that jobs with a larger marginal productivity of an additional hour require more hours and pay a higher salary. High-productivity jobs may offer overall better job packages because they have a greater opportunity cost of going unfilled. Second, I characterize a dynamic sequential search model in which workers move between jobs to obtain a higher utility. The optimal tied salary/hours offer accounts for the different turnover rates between men and women. Employers prefer workers with a lower turnover rate and weight

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[3]Black (1995) constructs an equilibrium search model in which discriminatory employers refuse to hire black workers. The reservation wage for the black workers is lowered, and they receive a lower mean wage. In my model, discriminatory employers make identical offers to men and women. Since women have a larger degree of aversion to work hours, more women prefer unemployment (or working in short-hour jobs) to working with discriminatory employers that require long hours.

these workers more than the fraction of the workers on the job would suggest.

Hwang, Mortensen, and Reed (1998) (hereafter denoted as HMR) analyze a hedonic wage offer when workers have identical preferences for job amenities in a sequential search model. Specifically, HMR extend the Burdett and Mortensen's (1998) model to the case in which a job consists of a wage and an amenity, and the employers differ in the cost of producing the amenity. HMR show by simulation that jobs that offer better amenities can pay higher wages, which contradicts the theory of compensating differentials. Cost-efficient employers offer better amenities, and they may offer overall higher-valued job packages. Following HMR's framework, I construct a model in which employers post one tied salary/hours offer and workers differ in their preferences for job amenities.

The paper proceeds as follows: Section 2 sets up the model. Section 3 presents the algorithm to compute the equilibrium tied salary/hours offer. Section 4 displays the simulation results. The paper concludes in Section 5.

2   The Model

Consider that a large, fixed number of employers and workers (men and women) participate in a labor market. The measure of men and women in the labor force is n_m and n_f, respectively; the measure of employers is normalized to 1.

Workers are either employed or unemployed, and they value a job by its salary and hours of work. The utility of a job for a worker whose gender is g (m for men and f for women) is,

$$v^g\left(S,H\right) = S + \xi^g \phi\left(H\right),$$

where S is salary, H is hours of work, $\phi' < 0$, and $\phi'' < 0$. For simplicity, it is assumed that S and H enter additively into workers' utility functions, and their marginal (dis)utilities are independent of one another.

Men and women have different degree of aversion to work hours. Specifically, the marginal disutility of an additional hour is larger for women than men,

$$0 < \xi^m < \xi^f.$$

An unemployed worker receives a flow utility of b from non-market activities and searches for a job. There is a continuous distribution of heterogeneity in the flow utility of being

unemployed, b. Its distribution is denoted by K^g, and let $\underline{b}$ and $\bar{b}$ be the infimum and supremum of its support. Men and women have identical distribution of b.[4]

Example: The functional form for the utility of a job used in the simulation exercise is,

$$v^g(S, H) = S - \frac{\xi^g}{T - H}, \tag{1}$$

where $0 < \xi^m < \xi^f$, and $T > 0$.

There is a continuous distribution of heterogeneity in job productivity. The production function is $\rho_j(H)$ for a type-j job and satisfies $\rho'_j > 0$ and $\rho''_j < 0$. I consider that employers post only one tied salary/hours package to men and women, because anti-discrimination policies prohibit firms from making gender-specific offers. The cost per period of posting a vacancy also is assumed to be high enough that employers will not wait to employ a worker who can provide a higher profit. Therefore, employers treat each potential match as a separate profit opportunity, and employers will offer a package to a woman and not hold off for a man to fill the position.

Example: In the simulation exercise, the functional form for the production function is,

$$\rho_j(H) = -a_j(H - T)^2 + c_j, \tag{2}$$

where $a_j > 0$, $0 \leq H \leq T$, and (a_j, c_j) is distributed along $(\underline{a}, \underline{c})$ and $(\overline{a}, \overline{c})$.

Discrimination. Consider two types of discrimination: (1) Becker-type employer discrimination, in which employers have a disamenity value for employing women and (2) employee discrimination, in which women have a disamenity value for working certain jobs. It is possible to consider that these types of taste-based discrimination persist because employers (or employees) have culture-based gender concepts.

Type-j employers suffer a utility loss of d_j^{ER} for employing women in the model of employer discrimination; therefore, the employer's utility per female worker is $\rho_j(H) - S - d_j^{ER}$.

In the model of employee discrimination, women suffer a utility loss of d_j^{EE} for working in type-j jobs, so women's job value is $v^f(S, H) = S + \xi^f \phi(H) - d_j^{EE}$. When the discrimination coefficient is set as a function of the gender composition of jobs, women's job value becomes $v^f(S, H, \theta) = S + \xi^f \phi(H) - d^{EE}(\theta)$ where θ is the fraction of men on a job and $\frac{\partial d^{EE}(\theta)}{\partial \theta} < 0$.

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[4]Suppose that the utility flow from unemployment b is degenerate, and, as a result, all of the type-g workers have an identical reservation utility. Then, employers lose all these workers when they offer a package that is valued less than their reservation utility.

Labor market setup. Workers search for job offers that arrive at rate λ. A job offer is characterized by a random drawing from a utility distribution of job offers: F^m for men and F^f for women. Neither the arrival rate nor the utility distribution of job offers depends on the worker's current state (i.e., employed or unemployed). An employed worker faces job separation with an arrival rate of δ. Let $\kappa = \lambda/\delta$ represent the ratio of the arrival rate to the job separation rate.

Workers maximize the expected steady-state discounted (at rate r) present utility. The following results are well known, as proposed in Bontemps et al. (1999). When employed, the optimal job acceptance strategy is to accept all jobs having a greater value than the current one. The optimal strategy when unemployed is to accept all jobs having a value greater than or equal to the utility flow of being unemployed b.

Since the arrival rate is independent of employment status, the reservation utility equals to the flow utility of unemployment, b. Thus, the optimal job acceptance strategy of unemployed workers does not depend on F^g, and therefore, unemployed workers will not wait (or be impatient) to accept a better (or worse) offer.

Steady-state level of employment. In steady-state, the flow of workers into employment equals the flow from employment to unemployment. Let $u^g(x|F^g)$ denote the steady-state measure of unemployed workers whose reservation utility is less than or equal to x, conditional on the utility distribution of job offer F^g. Then,

$$u^g(x|F^g) = \int_{\underline{b}}^{x} \left(\frac{\delta n^g}{\delta + \lambda[1 - F^g(b)]} \right) dK^g(b),$$

since the unemployment rate of workers with a utility flow of b is $\frac{\delta}{\delta + \lambda[1 - F^g(b)]}$ and the density of these workers is $n^g dK^g(b)$.

Let the steady-state utility distribution of job offers received by type-g employed workers be G^g. Then, the steady-state measure of employed workers receiving utility no greater than v^g is: $G^g(v^g) \{n^g - u^g(\overline{b}|F^g)\}$ where $u^g(\overline{b}|F^g)$ is the total unemployment of the type-g workers in the economy. The flow of unemployed workers into jobs valued as v^g is: $\lambda \int_{\underline{b}}^{v^g} [F^g(v^g) - F^g(x)] du^g(x|F^g)$. The flow of employed workers who move out of these jobs into higher-valued jobs is: $\lambda[1 - F^g(v^g)] G^g(v^g) \{n^g - u^g(\overline{b}|F^g)\}$, and the flow of those who move out to unemployment is $\delta G^g(v^g) \{n^g - u^g(\overline{b}|F^g)\}$. In steady-state, the flow of workers into jobs valued no greater than v^g equals the flow from these jobs to unemployment

or higher v^g jobs. Thus, in the steady-state the proportion of employed workers receiving utility no greater than v^g is:

$$G^g\left(v^g\right)\left\{n^g - u^g\left(\overline{b}|F^g\right)\right\} = \frac{\lambda \int_{\underline{b}}^{v^g}\left[F^g\left(v^g\right) - F^g\left(x\right)\right] du^g\left(x|F^g\right)}{\delta + \lambda\left[1 - F^g\left(v^g\right)\right]}.$$

Let $l^g\left(v^g, F^g\right)$ represent the steady-state number of type-g workers available to an employer offering v^g, given the utility distribution of job offer F^g. Then,

$$l^g\left(v^g, F^g\right) = \frac{dG^g\left(v^g\right)}{dF^g\left(v^g\right)}\left\{n^g - u^g\left(\overline{b}|F^g\right)\right\}$$

$$= \frac{\kappa n^g K^g\left(v^g\right)}{\left\{1 + \kappa\left[1 - F^g\left(v^g\right)\right]\right\}^2},$$

when F^g is continuous (see the appendix for derivation). $l^g\left(v^g, F^g\right)$ is continuous and is strictly increasing on the support of F^g. There are two reasons why employers that offer a higher value of v^g attract more type-g workers. First, a job with a higher value of v^g attracts more unemployed workers whose reservation utility is high. Second, a job with a higher value of v^g attracts more workers currently employed in jobs with a lower value of v^g, and also retains these workers.

The distribution of the tied salary/hours offer in equilibrium. I characterize the equilibrium job offers in the model of employer discrimination.[5] The employer's steady-state utility given the tied salary/hours offer can be expressed as $\left[\rho_j\left(H\right) - S\right] l^m\left(v^m, F^m\right)$ for men and $\left[\rho_j\left(H\right) - S - d_j^{ER}\right] l^f\left(v^f, F^f\right)$ for women. Conditional on the job packages offered by all the other employers and on workers' search behaviors, a type-j employer posts a tied salary/hours offer that maximizes its steady-state utility flow. The optimal job offer solves the following problem,

$$\pi_j = \max_{(S,H)}\left[\rho_j\left(H\right) - S\right] l^m\left(v^m, F^m\right) + \left[\rho_j\left(H\right) - S - d_j^{ER}\right] l^f\left(v^f, F^f\right). \tag{3}$$

The first-order conditions for interior solutions for Equation (3) are,

$$\frac{\partial \pi_j}{\partial S} = -l^m\left(v^m, F^m\right) - l^f\left(v^f, F^f\right) + \left[\rho_j\left(H\right) - S\right]\frac{\partial\left[l^m\left(v^m, F^m\right) + l^f\left(v^f, F^f\right)\right]}{\partial S} - d_j^{ER}\frac{\partial l^f\left(v^f, F^f\right)}{\partial S} = 0,$$

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[5]The case without discrimination is depicted by eliminating the discrimination coefficient, and the case with employee discrimination is depicted by replacing the women's utility function with $v^f\left(S, H\right) = S + \xi^f\phi\left(H\right) - d_j^{EE}$.

and

$$\frac{\partial \pi_j}{\partial H} = \rho'_j (H) \left[l^m (v^m, F^m) + l^f (v^f, F^f)\right] + \left[\rho_j (H) - S\right] \frac{\partial \left[l^m (v^m, F^m) + l^f (v^f, F^f)\right]}{\partial H}$$
$$- d_j^{ER} \frac{\partial l^f (v^f, F^f)}{\partial H} = 0.$$

The second-order conditions are,

$$\frac{\partial^2 \pi_j}{\partial S \partial S} = \left[\rho_j (H) - S\right] \frac{\partial^2 \left[l^m (v^m, F^m) + l^f (v^f, F^f)\right]}{\partial S \partial S} - d_j^{ER} \frac{\partial^2 l^f (v^f, F^f)}{\partial S \partial S}$$
$$- 2 \frac{\partial \left[l^m (v^m, F^m) + l^f (v^f, F^f)\right]}{\partial S} < 0,$$

and

$$\frac{\partial^2 \pi_j}{\partial H \partial H} = \left[\rho_j (H) - S\right] \frac{\partial^2 \left[l^m (v^m, F^m) + l^f (v^f, F^f)\right]}{\partial H \partial H} - d_j^{ER} \frac{\partial^2 l^f (v^f, F^f)}{\partial H \partial H}$$
$$+ 2 \rho'_j (H) \frac{\partial \left[l^m (v^m, F^m) + l^f (v^f, F^f)\right]}{\partial H} + \rho''_j (H) \left[l^m (v^m, F^m) + l^f (v^f, F^f)\right] < 0.$$

A market equilibrium is defined such that: the equilibrium utility distributions of the job offer, F^m and F^f, satisfy the above first- and second-order conditions for all jobs, and the worker's reservation utility equals b.

3   The Algorithm to Solve for the Distribution of Tied Salary/Hours Offer in Equilibrium

I show the characteristics of the equilibrium numerically because it is impossible to derive the analytical characteristics of the equilibrium utility distribution of job offers. I restrict the offers to the case in which the same types of employers are constrained to post identical offers.[6] Below I provide an algorithm to solve for the equilibrium distribution of job offers. In posting an offer, employers account for the gender differences in job acceptance and turnover rates. In contrast to Hwang, Mortensen and Reed (1998), in which workers have identical preferences for hours of work and where high-productivity jobs offer a higher utility, this model shows that a high-productivity job is not necessarily associated with a higher utility. High-productivity jobs require more hours of work. Women may place a lower value on these

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[6]If employers of the same type are allowed to post different offers, then employers with a given job type may choose different strategies because different tied salary/hours offers could yield an identical profit.

types of jobs (even though the salary is higher) because they are more averse to working long hours. Men, in contrast, place a higher value on these jobs. Employers tailor their tied salary/hours offer to the workers they can hire more and retain longer.

The algorithm works in three steps. First, hours are determined so that the marginal productivity of an additional hour equals the weighted average of the marginal disutility for men and women, where the weights reflect the gender composition of the particular job type in equilibrium. Second, the salary is determined to maximize the steady-state profit (or utility) flow given the hours determined in the first step. The tied salary/hours offer derived from this two-step procedure may not necessarily be an optimal offer that maximizes the employer's profit (or utility). In a sequential search model, employers prefer workers with a lower turnover rate and may be willing to offer a package that would retain such workers. Employers may place a greater value than the gender composition of jobs on workers whose turnover rate is lower. In the third step, starting from the tied salary/hours offer derived using the first two steps, I search for an optimal offer that satisfies the first- and second-order conditions for Equation (3).

Step 1: Hours Choice

Employers set the hours of work so that the marginal productivity of an additional hour equals the weighted average of the marginal disutility of an additional hour for men and women. The weights reflect the gender composition of the particular job type in equilibrium. Let θ_j^* be the fraction of men on a type-j job in equilibrium. Then H solves,

$$\max_{\{H\}} \quad \theta_j^* \left[\rho_j(H) + v^m(S, H) \right] + \left(1 - \theta_j^*\right) \left[\rho_j(H) + v^f(S, H) - d_j^{ER} \right],$$

thus,

$$\rho_j'(H) + \left[\theta_j^* \xi^m \phi'(H) + \left(1 - \theta_j^*\right) \xi^f \phi'(H) \right] = 0.$$

Using the functional forms for $v^g(S, H)$ and $\rho_j(H)$ that are given in Equations (1) and (2), the hours are determined as,

$$H_j = T - \left(\frac{\theta_j^* \xi^m + \left(1 - \theta_j^*\right) \xi^f}{2a_j} \right)^{1/3}.$$

Step 2: Salary Choice

Let $\rho_j = \rho_j(H_j)$, where H_j is the hours determined in the first step. In the second step,

employers choose a salary that maximizes their steady-state utility flow, given the hours determined in the first step,

$$\pi_j = \max_{\{S\}} \left(\rho_j - S\right) l^m \left(S + \xi^m \phi(H_j), F^m\right) + \left(\rho_j - S - d_j^{ER}\right) l^f \left(S + \xi^f \phi(H_j), F^f\right).$$

The first-order condition for an interior solution is,

$$\frac{\partial \pi_j}{\partial S} = -l^m \left(v^m, F^m\right) - l^f \left(v^f, F^f\right) + \left(\rho_j - S\right) \frac{\partial \left[l^m \left(v^m, F^m\right) + l^f \left(v^f, F^f\right)\right]}{\partial S} - d_j^{ER} \frac{\partial l^f \left(v^f, F^f\right)}{\partial S} = 0,$$

and the second-order condition is,

$$\frac{\partial^2 \pi_j}{\partial S \partial S} = \left(\rho_j - S\right) \frac{\partial^2 \left[l^m \left(v^m, F^m\right) + l^f \left(v^f, F^f\right)\right]}{\partial S \partial S} - d_j^{ER} \frac{\partial^2 l^f \left(v^f, F^f\right)}{\partial S \partial S}$$
$$- 2 \frac{\partial \left[l^m \left(v^m, F^m\right) + l^f \left(v^f, F^f\right)\right]}{\partial S} < 0.$$

Two-Step Calculation: I compute the tied salary/hours offer and the fraction of men on jobs from Step 1 and Step 2. The algorithm first chooses the initial guess θ^0. Then the hours are computed using the first step and the salary using the second step. Based on the solution derived from these two steps, I calculate the fraction of men on jobs $\theta^1 = \frac{l^m(v^m, F^m)}{l^m(v^m, F^m) + l^f(v^f, F^f)}$. I update the fraction of men on jobs to θ^1 and repeat the two-step procedure until (S, H, θ) converges for each job.

Step 3: Direction Method

The solution derived from the above two-step calculation will not necessarily be optimal because turnover behavior differs between men and women. Employers tailor their package to the group that remains on the job longer. Essentially, the solution from the two-step procedure satisfies $\frac{\partial \pi}{\partial S}|_{two-step} = 0$ but $\frac{\partial \pi}{\partial H}|_{two-step} \gtreqless 0$ for $\theta \gtreqless 1/2$. Optimal hours are longer than the hours determined in the two-step calculation in jobs where men are more prevalent, but hours are shorter in jobs where women are more prevalent.

Optimal Calculation: Starting from the solutions derived in the two-step calculation, I update hours by $H^{k+1} = H^k + \lambda \frac{\partial \pi}{\partial H^k}$ where λ is the negative of the inverse of the second-order derivative. Then, I solve for the salary and the fraction of men on jobs. I repeat this procedure till (S, H, θ) in all jobs converges and satisfies the first-order conditions, $\frac{\partial \pi}{\partial S} = 0$ and $\frac{\partial \pi}{\partial H} = 0$, and the second-order conditions, $\frac{\partial^2 \pi}{\partial S \partial S} < 0$ and $\frac{\partial^2 \pi}{\partial H \partial H} < 0$, for all jobs.

4   Simulation Exercises

I use simulations to illustrate the equilibrium distribution of job offers. The purpose of the simulations is to obtain qualitative, comparative statistical results; these simulations are not intended to assess quantitative magnitude.

Table 1 lists the parameter values used in the simulations. I follow the specifications by Bontemps et al. (1999) for the productivity distribution and the distribution of b. The productivity parameters (a, c) are Pareto-distributed along the segments $a = [.05, .3]$ and $c = [600, 1100]$, $\left[\Gamma\left(x\right) = 1 - \left(3000 \diagup x\right)^{2.8}\right]$. One hundred jobs are chosen at regular intervals along the segment $x = [3000, 7000]$, and an equilibrium job offer is derived for each of these jobs. The distribution of b follows a normal distribution. The summary results for the simulation exercises are presented in Table 2, which reports the outcomes for the least productive, mid-productive, and the most productive jobs.[7] For the major simulation results, I report the outcomes for all jobs in Figures 1-3.

4.1   Models without Discrimination

First, I derive the equilibrium distribution of job offers when men and women are identical in all aspects. Next, I consider a case in which the job-offer arrival rate is lower for women than men. Lastly, I consider a case in which women are more averse to working longer hours than men.

Case 1: Men and women are identical in all aspects. (Figure 1)

Employers with a larger marginal productivity of an additional hour require more working hours and pay a higher salary. Men and women place a greater value on high-productivity jobs. They quit and move to these jobs at the same rate; and therefore men and women are equally distributed across all job types ($\theta = .5$).

Case 2: The job-offer arrival rate is lower for women than men. (Figure 1)

When women are discouraged from searching for jobs because of discrimination or because of greater family responsibilities, the arrival rate of job offers can be lower for them. Although

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[7]I refer to a job with productivity parameters $(\underline{a}, \underline{c})$ as a least productive job, a job with productivity parameters $\left(\frac{a+\overline{a}}{2}, \frac{\overline{c}+c}{2}\right)$ as a mid-productive job, and a job with productivity parameters $(\overline{a}, \overline{c})$ as a most productive job.

men and women equally place greater value on high-productivity jobs, women are slower in moving to these jobs because they receive fewer job offers than men. The fraction of men on a job increases with job productivity from $\theta = .434$ for the least productive job, to $\theta = .750$ for the most productive. In comparison with Case 1 (in which men and women have identical job-offer arrival rates), employers obtain a higher profit in low-productivity jobs, but a lower profit in high-productivity jobs (in Case 2). This is because low-productivity jobs can retain female employees, whereas high-productivity jobs have a lower probability of meeting potential female employees.

Case 3: The marginal disutility of an additional hour is higher for women than men, $\xi^m < \xi^f$. (Figure 2)

Men place a greater value on high-productivity jobs, but women place a lower value on these jobs. In Figure 2, the composition of men on jobs θ increases sharply with job productivity, from .062 to .945. High-productivity jobs require more hours, and their offers are tailored to men's preferences. Conversely, low-productivity jobs require fewer hours, which appeals to women.[8] Women obtain low job value in high-productivity jobs, which can be lower than their reservation utility; 8 percent of women prefer unemployment to working in high-productivity jobs, whereas the corresponding percentage for men is 0. Women crowd in short-hour, lower-paying jobs, and men in long-hour, higher-paying jobs, even without discrimination.

4.2 Employer Discrimination

The rest of the simulation exercise incorporates discrimination. I study discrimination in an environment that has gender asymmetries in preferences for work hours. Thus, it is always assumed that the marginal disutility of an additional hour is higher for women than men.

Case 3ER: Employers obtain higher profits with discrimination. (Figure 2)

Using the same parameters as in Case 3, the discrimination parameter is set as $d_j^{ER} = j$, where $0 \leq j \leq 100$; the disamenity value of employing women increases with job productivity. Discriminating employers suffer a loss in utility by employing women. Therefore, they

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[8]In contrast to Cases 1 and 2, the solutions between the optimal and two-step calculations are different. The first-order condition with respect to hours in the two-step calculation $\left(\frac{\partial \pi}{\partial H}|_{two-step}\right)$ is positive when $\theta > .5$, but it is negative when $\theta < .5$. Hence, the optimal hours are longer in high-productivity jobs where men are more prevalent, but they are shorter in low-productivity jobs where there are more women.

make their offers uninviting to women by requiring more work hours while not considerably increasing the salary. As the job value for women declines, women with a higher reservation utility prefer unemployment to working in these jobs; as a result, the fraction of men increases. This increase in the fraction of men on a job is modest, because the job offers already have been tailored toward men in the absence of discrimination.

Next, I examine the employer's profitability. An employer's profit is defined as $\left[\rho_j\left(H\right) - S\right]$ $\left[l^m\left(v^m, F^m\right) + l^f\left(v^f, F^f\right)\right]$, which excludes the discrimination coefficient. Becker (1971) predicts that discriminating employers may be competed out of business with free entry or constant returns to scale, because discrimination is indulged at a positive cost to them. In this monopsony model that is based on Burdett and Mortensen (1998), discriminating employers can obtain a higher profit. The mid-productivity jobs obtain a profit of 38.4, and the high-productivity jobs 169.7. Their profits in the absence of discrimination are 36.7 and 168.0, respectively.[9] Due to the discrimination coefficient in women's productivity, employers regard women's productivity as being low. As a result, the wages $(= S/H)$ are less and work hours are more. Constrained to make only one offer to heterogeneous groups, employers hire both males and females at a lower wage rate and require them to work longer. Therefore, the profit per employee is greater. Men remain on the job, but women, with a higher reservation utility, find it better to remain unemployed. The overall decline in the number of female employees is small, and therefore, the discriminating employers obtain higher overall profits.

Case 4ER: Some employers lower their profits with discrimination. (Figure 3)

I increase the mean of the distribution of b compared to Cases 3 and 3ER to show that there can be a greater difference between the fraction of men on jobs with discrimination and without the presence of discrimination. Job offers are made unappealing to women by increasing work hours. With discrimination, more women prefer to remain unemployed, as the job value is less than their reservation utility. The number of females employed on the job therefore declines, and the fraction of men on the job increases.

A higher profit is obtained in less-productive jobs, compared to the case in which discrimination is absent from the model. Female employees are considered to be less productive, so the employers decrease wages and increase work hours, without a decline in the total

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[9]Employers do not hold a taste for discrimination against women for the least-productive jobs, and their profit is 6.87, which is the same as in Case 3.

employee size because women still place a high value on these jobs. Consequently, a higher profit is obtained. In contrast, profit in more productivity jobs is lower because there is a large reduction in the number of female employees.

4.3 Employee Discrimination

4.3.1 The Discrimination Parameter is Exogenous

Case 3EE: Gender occupational segregation exists, when there is no discrimination.

The discrimination parameter is set as $d_j^{EE} = j$, where $0 \leq j \leq 100$. Women do not choose the high-productivity jobs because they incur a disamenity value d_j^{EE} while also working longer hours. The utility of work for women declines in high-productivity jobs, and the composition of men on such jobs increases. This increase is small, however, as the job offers already are tailored toward men.

The employers realize less profit compared to the case in which discrimination is absent. Women dislike working in jobs in which they are treated poorly, and therefore employers offer packages that attract more workers to maintain the employee numbers. The utility of work for women in high-productivity jobs is -439.3 (the disamenity value $d^{EE} = 100$ is included in computing the utility of work in Column 5 of Table 2). The utility women derive from just the salary/hours package is $-339.3 \left(= v^f + d^{EE}\right)$, which is greater than the utility women receive in the absence of discrimination, -357.8.

Case 5EE: Men and women are equally distributed across all job types in the absence of discrimination.

Men and women prefer more productive jobs, and are equally distributed across all job types, when no discrimination is present (Column 9 in Table 2). Now, the discrimination parameter is set as $d_j^{EE} = 3j$, where $0 \leq j \leq 100$. The utility of work for women largely decreases in high-productivity jobs, due to the large disamenity value incurred. Men, however, being offered a higher salary and longer hours, find these same positions the most appealing. The fraction of men on jobs increases as job productivity increases from $\theta = .062$ to $.941$.

Jobs in which there are more men $(\theta > .5)$ have been tailored to require more hours, which leads to a greater output per worker $\rho_j(H)$ and a larger profit per worker. The number of women employed decreases with longer working hours and the disamenity value.

This decrease is greater than the increase in profit per worker, and therefore, the overall profit of the employers is less. In contrast, in jobs where there are more female employees ($\theta < .5$), fewer working hours are required. This leads to less output per worker $\rho_j(H)$ and a smaller profit per worker. However, because women find these jobs more attractive, the number of female employees increases. This increase is larger than the reduction in the profit per worker. Therefore, the employers' overall profit increases.

4.3.2 The Discrimination Parameter is a Function of the Gender Composition of Jobs

I assume a functional relation between the discrimination coefficient d^{EE} and the gender composition of jobs θ, because women's disamenity value of working on jobs can be related to the fraction of men on these jobs. The algorithm to solve for the equilibrium solution is to first choose the initial guess on θ, and then use the two-step and optimal calculations to solve for the (S, H, θ) that converges.

Case 3EEE: Gender occupational segregation exists when there is no discrimination.

Using the parameter values as in Case 3, the discrimination parameter is set as $d^{EE}(\theta) = 150\left(\theta - \frac{1}{2}\right)$. When the fraction of men on the job θ is greater (or less) than $\frac{1}{2}$, the discrimination parameter d^{EE} is greater (or less) than 0. Thus, women are treated poorly in jobs where there are more men, but better where there are more women. The predictions for segregation and welfare are similar to the case in which the discrimination parameter is exogenous (Case 3EE). Women suffer a utility loss from working on high-productivity jobs with greater hours requirements and where there are more men. Consequently, the number of women employed on these jobs drops, leading to a lower profit for the employers.

Case 5EEE: Men and women are equally distributed across all job types in the absence of discrimination.

Using the parameter values in Case 5, I set the discrimination parameter as $d^{EE}(\theta) = 500\left(\theta - \frac{1}{2}\right)$. When the initial guess on θ takes values close to .5 on all jobs, the distribution of job offers converges to a case in which discrimination is absent. Hence, men and women are equally distributed across all job types, $\theta = .5$ (Column 9 in Table 2). In contrast, when the initial guess on θ takes values that increase with job productivity, the job offers converge

to a discriminatory equilibrium (Column 11 in Table 2). The prediction for segregation is similar to those in which the discrimination parameter is exogenous.

5   Conclusions

In this paper, I analyze an equilibrium search model in which salary and hours of work are job attributes and workers differ in their working hour preferences. The simulations indicate that employers with a larger marginal productivity of an additional hour require more working hours. When women are more averse to longer hours of work than men, females predominate in the less-productive jobs, which offer fewer hours and pay a lower salary. When employers have a taste for discrimination against women, they require more working hours and exclude women from their jobs. Employers can control the types of workers they hire by choosing to offer certain job amenities, because different types of workers have different job-amenity preferences. When women have a disamenity value for working on jobs in which they are treated poorly, however, employers adjust their offers to have more men on the job. The prediction for segregation is similar between employer and employee discrimination. The implication for welfare is somewhat different. Employers can obtain higher profits with employer discrimination. This occurs because employers regard women as less productive, and lower their wage rate and require more working hours, while not considerably lowering the number of employees they hire. In Burdett and Mortensen's (1998) equilibrium search model, employers have monopsony power, and therefore they can continue obtaining higher profits. In contrast, employers lower their profits in the model of employee discrimination, because they post job offers that attract more workers.

6   Appendix

Derivation of the steady-state employment size

$$
\begin{aligned}
l^g\left(v^g, F^g\right) &= \frac{dG^g\left(v^g\right)\left\{n^g - u^g\left(\overline{b}\middle|F^g\right)\right\}}{dF^g\left(v^g\right)} \\[2ex]
&= \frac{dG^g\left(v^g\right)\left\{n^g - u^g\left(\overline{b}\middle|F^g\right)\right\}}{dv^g}\frac{dv^g}{dF^g\left(v^g\right)} \\[2ex]
&= \frac{dv^g}{dF^g\left(v^g\right)}\cdot\left[\frac{\kappa\int_{\underline{b}}^{v^g}\frac{dF^g\left(v^g\right)}{dv^g}du^g\left(x\middle|F^g\right)\left\{1 + \kappa\left[1 - F^g\left(v^g\right)\right]\right\}}{\left\{1 + \kappa\left[1 - F^g\left(v^g\right)\right]\right\}^2}\right. \\[2ex]
&\quad\left. + \frac{\kappa^2\frac{dF^g\left(v^g\right)}{dv^g}\int_{\underline{b}}^{v^g}\left[F^g\left(v^g\right) - F^g\left(x\right)\right]du^g\left(x\middle|F^g\right)}{\left\{1 + \kappa\left[1 - F^g\left(v^g\right)\right]\right\}^2}\right] \\[2ex]
&= \frac{\kappa\int_{\underline{b}}^{v^g}\left[1 + \kappa\left[1 - F^g\left(x\right)\right]\right]du^g\left(x\middle|F^g\right)}{\left\{1 + \kappa\left[1 - F^g\left(v^g\right)\right]\right\}^2}.
\end{aligned}
$$

Use $\left\{1 + \kappa\left[1 - F^g\left(x\right)\right]\right\}du^g\left(x\middle|F^g\right) = n^g dK^g\left(x\right)$, which is derived from the first steady-state condition. Then, $l^g\left(v^g, F^g\right)$ is simplified to,

$$
\begin{aligned}
l^g\left(v^g, F^g\right) &= \frac{\kappa\int_{\underline{b}}^{v^g}n^g dK^g\left(x\right)}{\left\{1 + \kappa\left[1 - F^g\left(v^g\right)\right]\right\}^2} \\[2ex]
&= \frac{\kappa n^g K^g\left(v^g\right)}{\left\{1 + \kappa\left[1 - F^g\left(v^g\right)\right]\right\}^2}.
\end{aligned}
$$

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Table 1
Parameter Values Used in the Simulation Exercises

	(1) Case 1	(2) Case 2	(3) Case 3	(4) Case 3ER	(5) Case 3EE	(6) Case 3EEE	(7) Case 4	(8) Case 4ER	(9) Case 5	(10) Case 5EE	(11) Case 5EEE
Preference parameter											
ξ^m for men	3500	3500	3000	3000	3000	3000	3000	3000	250	250	250
ξ^f for women	3500	3500	22500	22500	22500	22500	22500	22500	7000	7000	7000
Arrival rate of jobs											
κ for men	3	3	3	3	3	3	3	3	3	3	3
κ for women	3	1	3	3	3	3	3	3	3	3	3
Discrimination coefficient											
$d^{ER} =$	-	-	-	1.0j	-	-	-	1.0j	-	-	-
$d^{EE} =$	-	-	-	-	1.0j	150 $(\theta$-½$)$	-	-	-	3.0j	500 $(\theta$-½$)$
Distribution of utility flow of unemployment b, $N(\mu,\sigma)$											
mean, μ	0	0	-500	-500	-500	-500	-350	-350	-500	-500	-500
standard deviation, σ	200	200	100	100	100	100	100	100	100	100	100

Notes: The utility of a job is $v^g = S - \xi^g/(T$-$H)$ where S is salary, H is hours of work, and T = 70. The discrimination coefficient d^{ER} varies from 0 ≤ j ≤ 100 and d^{EE} varies from 0 ≤ j ≤ 100. θ is the fraction of men on jobs. The distribution of b follows a normal distribution.

Table 2
Summary of Results in the Simulation Exercises

	Job	(1) Case 1	(2) Case 2	(3) Case 3	(4) Case 3ER	(5) Case 3EE	(6) Case 3EEE	(7) Case 4	(8) Case 4ER	(9) Case 5	(10) Case 5EE	(11) Case 5EEE
		Figure 1	Figure 1	Figure 2	Figure 2			Figure 3	Figure 3			
Job value for men, v^m	L	423.7	419.9	363.0	363.0	363.0	363.0	363.0	363.0	521.8	505.6	505.6
	M	563.0	552.6	579.2	580.0	579.3	579.3	580.1	583.6	711.6	754.3	754.3
	H	705.9	685.5	730.4	729.3	732.1	731.4	733.2	732.6	884.3	941.9	941.9
Job value for women, v^f	L	423.7	419.9	40.80	40.80	40.80	106.44	40.80	40.80	317.8	340.9	559.7
	M	563.0	552.6	-259.4	-375.4	-307.2	-310.6	-253.3	-380.4	402.7	75.71	49.3
	H	705.9	685.5	-357.8	-406.0	-439.3	-412.4	-335.7	-405.1	513.7	-162.3	-83.2
Salary, S	L	530.7	526.9	412.5	412.5	412.5	412.5	412.5	412.5	529.4	511.7	511.7
	M	725.1	714.6	708.3	727.0	708.1	708.1	708.4	731.9	723.1	773.9	773.9
	H	900.4	879.9	897.8	904.0	896.9	897.0	897.6	907.7	898.0	971.7	971.7
Hours of work, H	L	37.29	37.29	9.48	9.48	9.48	9.48	9.48	9.48	36.90	29.01	29.01
	M	48.40	48.40	46.75	49.59	46.70	46.70	46.60	49.77	48.15	57.27	57.27
	H	52.00	52.00	52.08	52.82	51.80	51.88	51.76	52.86	51.79	61.61	61.61
Fraction of men on a job, θ	L	0.500	0.434	0.062	0.062	0.062	0.062	0.062	0.062	0.500	0.062	0.062
	M	0.500	0.649	0.851	0.863	0.853	0.853	0.872	0.937	0.500	0.850	0.850
	H	0.500	0.750	0.945	0.951	0.956	0.952	0.966	0.982	0.500	0.941	0.941
Profit, $(\rho(H)-S)(l^m+l^f)$	L	3.10	4.42	6.87	6.87	6.87	6.87	6.87	6.87	3.17	6.87	6.87
	M	56.90	54.86	36.70	38.40	36.44	36.41	34.81	32.75	57.13	36.83	36.83
	H	307.2	245.7	168.0	169.7	162.7	164.7	159.171	159.169	307.4	170.8	170.9
Profit per worker, $\rho(H)-S$	L	15.83	19.58	4.29	4.29	4.29	4.29	4.29	4.29	15.88	4.29	4.29
	M	41.37	51.81	45.29	48.10	45.10	45.08	44.01	44.51	41.44	45.39	45.39
	H	102.4	122.9	105.9	107.5	103.7	104.5	102.5	104.2	102.5	107.2	107.2
Employment size for men, l^m	L	0.098	0.098	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
	M	0.688	0.687	0.689	0.689	0.689	0.689	0.689	0.689	0.689	0.689	0.689
	H	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
Employment size for women, l^f	L	0.098	0.128	1.500	1.500	1.500	1.500	1.500	1.500	0.100	1.500	1.500
	M	0.688	0.372	0.121	0.109	0.119	0.118	0.102	0.046	0.689	0.122	0.122
	H	1.500	0.500	0.087	0.078	0.068	0.076	0.052	0.027	1.500	0.094	0.094

Notes: The table displays outcomes (in the row headings) for the least productive job (labeled as L), the mid-productive job (labeled as M), and the most productive jobs (labeled as H). Refer to Table 1 for the parameter values used in the simulation.

Figure 1

Cases 1 & 2: Comparison between the case when men and women have identical job offer arrival rate and the case when the arrival rate is lower for women than men.
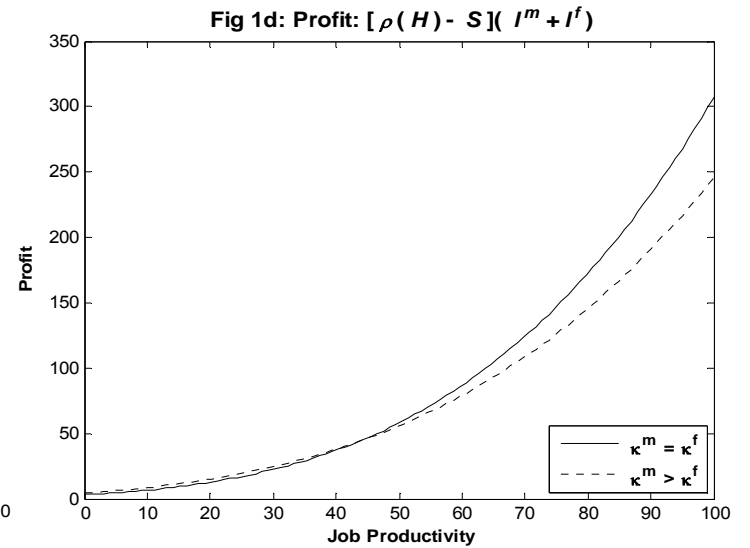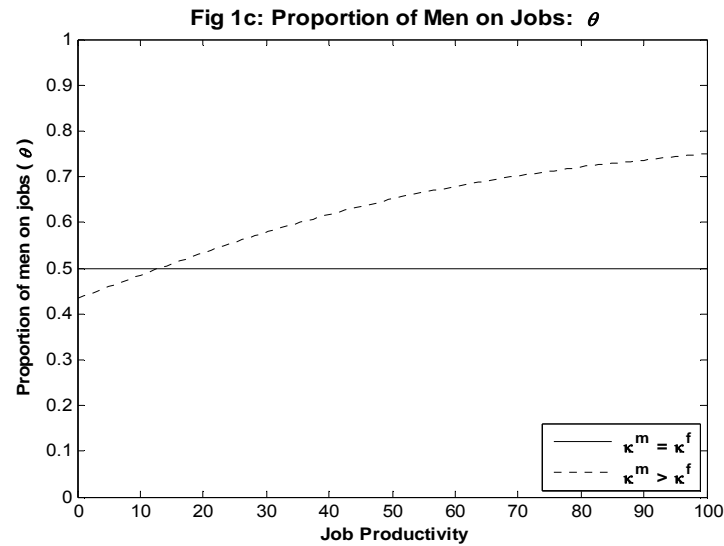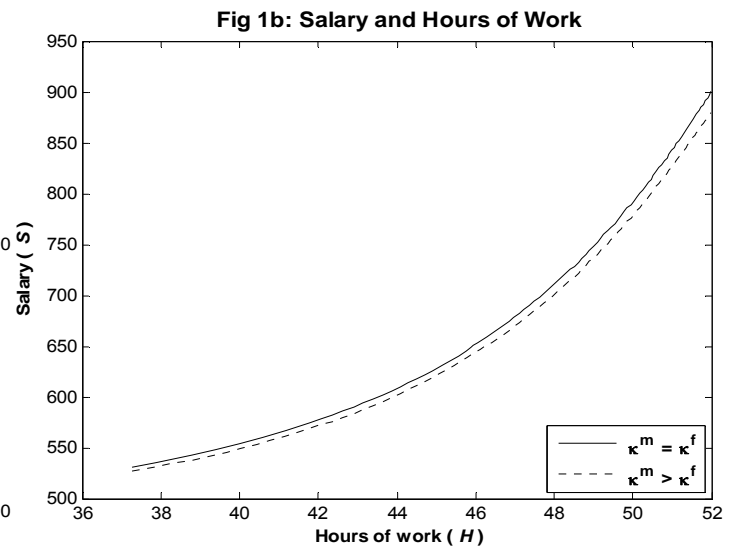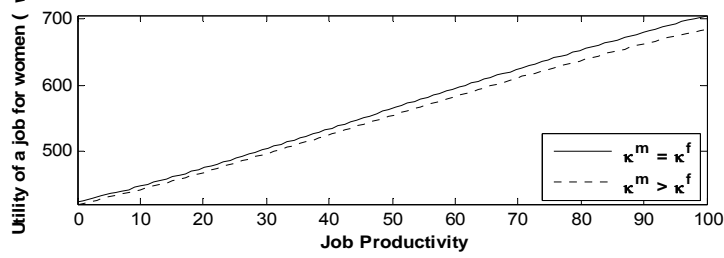

Fig 1a: Utility of a Job for Men and Women

Fig 1b: Salary and Hours of Work

Fig 1c: Proportion of Men on Jobs: θ

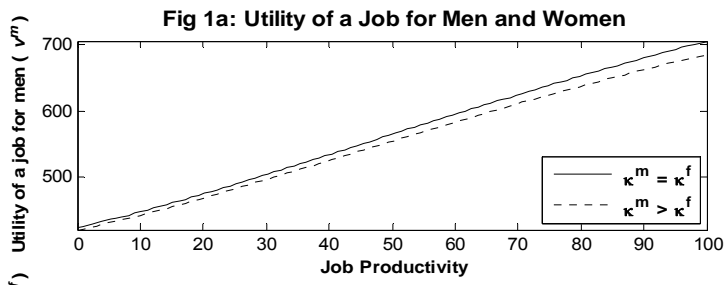Fig 1d: Profit: $[\,\rho\,(\,H\,) - S\,](\,l^m + l^f\,)$

Figure 2
Cases 3 & 3ER: Comparison between the case without discrimination and the case with discrimination.

Fig 2a: Utility of a Job for Men and Women

Fig 2b: Salary and Hours of Work

Fig 2c: Proportion of Men on Jobs: θ

Fig 2d: Profit: $[\rho(H) - S](I^m + I^f)$

Fig 2e: Profit Per Worker: $\rho(H) - S$

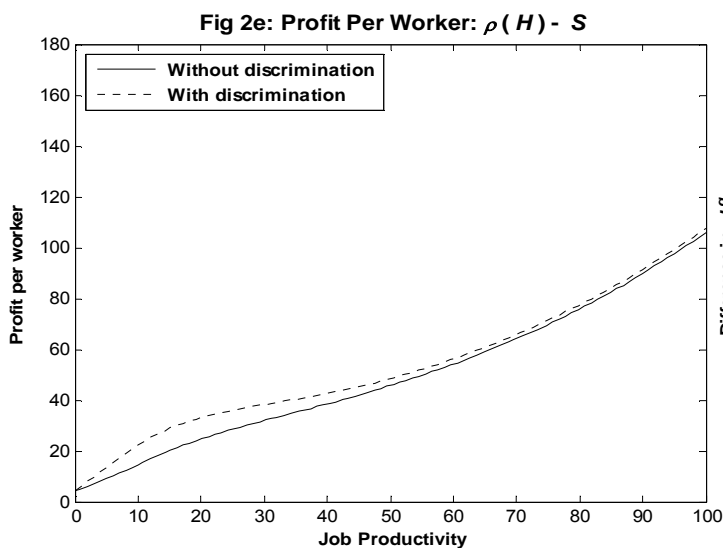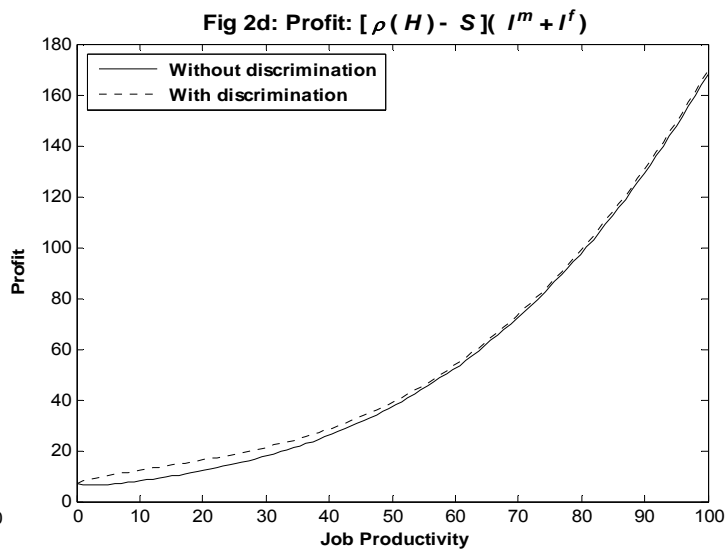Fig 2f: Difference in Employment Size with and without Discrimination
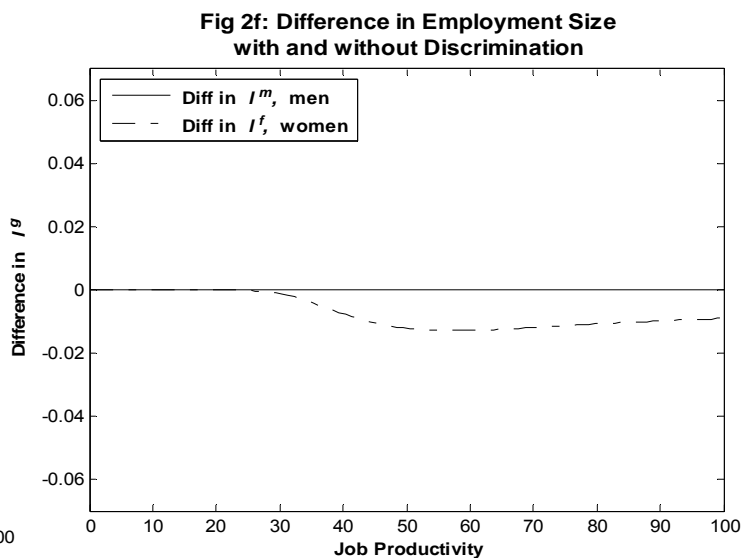
Figure 3

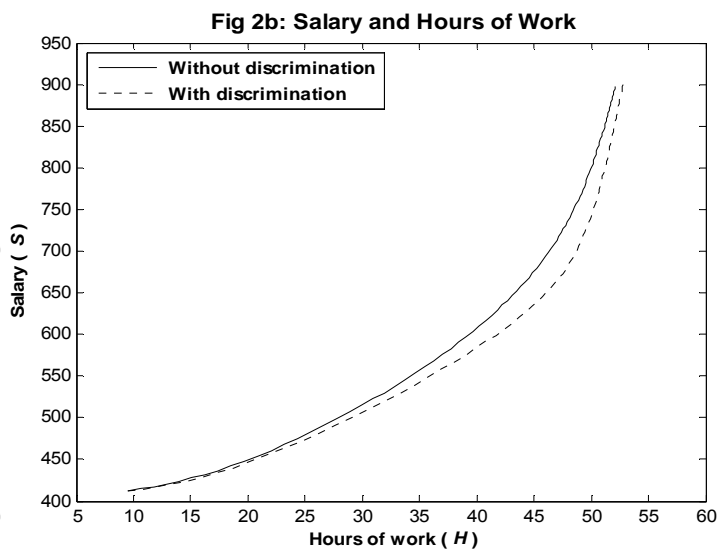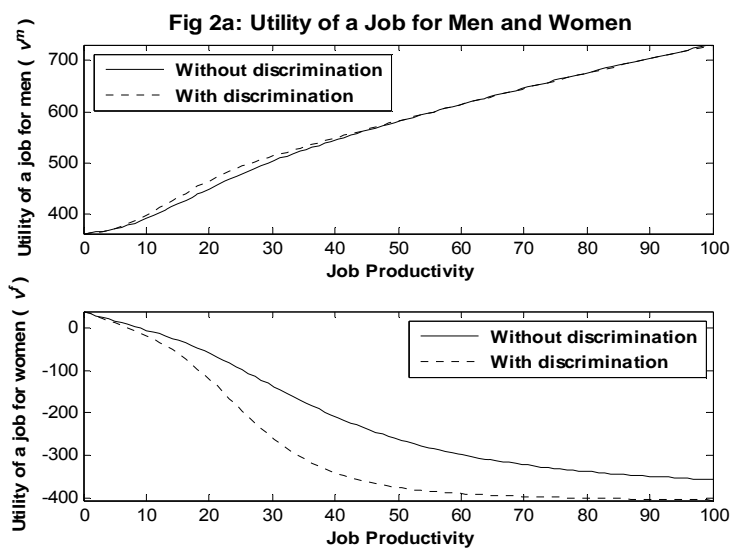**Cases 4 & 4ER: Comparison between the case without discrimination and the case with discrimination.**

Fig 3a: Utility of a Job for Men and Women

Fig 3b: Salary and Hours of Work

Fig 3c: Proportion of Men on Jobs: θ

Fig 3d: Profit: $[\,\rho\,(\,H\,)\,-\,S\,](\,I^m + I^f\,)$

Fig 3e: Profit Per Worker: $\rho\,(\,H\,)\,-\,S$

Fig 3f: Difference in Employment Size with and without Discrimination