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Joan Robinson Meets Harold Hotelling: A Dyopsonistic Explanation of the Gender Pay Gap

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Joan Robinson Meets Harold Hotelling: A Dyopsonistic Explanation of the Gender Pay Gap

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B G P E Discussion Paper Series

Joan Robinson Meets Harold Hotelling: A Dyopsonistic Explanation of the Gender Pay Gap*

Boris Hirsch[a]

Abstract: This paper presents an alternative explanation of the gender pay gap resting on a simple Hotelling-style dyopsony model of the labor market. Since there are only two employers equally productive women and men have to commute and face travel cost to do so. We assume that a fraction of the women have higher travel cost, e.g., due to more domestic responsibilities. Employers exploit that women are less inclined to commute to their competitor and offer lower wages to women. Since women's labor supply at the firm level is for this reason less wage-elastic, this model presents an explanation of wage discrimination in line with Robinson (1933).

Zusammenfassung: Das folgende Papier gibt eine alternative Erklärung geschlechtsspezifischer Lohndifferentiale im Rahmen eines einfachen Dyopsonmodells des Arbeitsmarktes im Stile von Hotelling. Da nur zwei Arbeitgeber existieren, sind gleichproduktive Frauen und Männer gezwungen, zu ihrem Arbeitgeber zu pendeln, wobei Reisekosten entstehen. Es wird angenommen, dass ein Teil der Frauen höhere Reisekosten aufweist, z.B. aufgrund häuslicher Verpflichtungen. Die Arbeitgeber machen sich zunutze, dass Frauen eine geringere Pendelneigung aufweisen und daher in geringerem Maße den Arbeitgeber wechseln, indem sie ihnen geringere Löhne anbieten. Da das Arbeitsangebot von Frauen auf Firmenebene aus diesem Grunde weniger lohnelastisch ist, stellt dies eine Erklärung von Lohndiskriminierung im Sinne von Robinson (1933) dar.

Keywords: monopsony, gender, discrimination

New JEL-Classification: J16, J42, J71

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1 Introduction

One of the stylized facts of labor markets is that on average women earn substantially less than men. For example, Altonji & Blank (1999, table 4) report for the U.S. a raw wage differential of about 28 per cent in 1995. While its extent is reduced by introducing controls for individual characteristics (such as education, occupation, and experience), a gender pay gap remains that is of remarkable size in all OECD countries (cf. OECD 2002). In addition to reflecting differences in human capital or occupational segregation, the gap also may reflect discrimination against women.

Theoretical attempts of explaining discrimination often follow Becker's (1971) concept of discrimination due to distaste. Since some employers dislike employing women, which is modeled by means of a distaste parameter in the employers' utility function, they offer lower wages to women, *ceteris paribus*. However, this kind of reasoning suffers from two severe shortcomings. On the one hand, it is difficult to interpret the gender pay gap as a long-run equilibrium outcome using Becker's concept of discrimination without assuming some sort of market power on the demand-side because under perfect competition discrimination due to distaste should be competed away in the long run. On the other hand, even if firms had some market power, the firm that engages in discrimination due to distaste would earn less profits than its non-discriminating competitors (cf., e.g., Bowlus & Eckstein 2002, Bhaskar et al. 2002). Therefore it may be promising to look at an alternative explanation of discrimination given by Robinson (1933) where firms do profit from engaging in discrimination.

In this paper we will utilize a simple Hotelling-style dyopsony model of the labor market to analyze the link between gender differences in mobility patterns, the gender pay gap, and Robinsonian wage discrimination. By doing so we aim at giving a reformulation of Robinsonian wage discrimination by means of a new monopsony model of horizontal job differentiation. The remainder of this paper is organized as follows. Section 2 introduces the concepts of Robinsonian wage discrimination, firm-level labor supply, and horizontal job differentiation in some detail, which are the key building blocks of the following analyses. Section 3 sets up the formal model: Sections 3.1 and 3.2 discuss the workers' and the firms' behavior, while section 3.3 analyzes the resulting equilibrium and investigates its properties, in particular its link to Robinsonian wage discrimination. Section 4 draws some conclusions. An appendix contains some of the proofs involved.

2 Robinsonian Wage Discrimination, Firm-Level Labor Supply, and Horizontal Job Differentiation

Robinson was the first to apply Pigou's (1932) concept of third-degree price discrimination at a commodity market to the labor market. She argued that if groups of workers can be distinguished that differ in their labor supply elasticities at the firm-level the firm will profit from paying different wages to these groups. The more elastic groups will get higher wages than the less elastic groups, *ceteris paribus*. 'Just as we have price discrimination for a monopolist, so we may have price discrimination for a monopsonist.' (Robinson 1933, p. 224) Hence, if women's labor supply at the firm-level is less elastic than men's women will earn lower wages, other things being equal.

While there is empirical evidence that women's labor supply is even more elastic at the market level (e.g., Cahuc & Zylberberg 2004, pp. 39–41), where the decision is whether to supply labor or not, this need not to hold at the firm level. From the single firm's point of view it matters only whether an individual supplies labor to this firm or another so that both unemployed and employed workers are potential suppliers of labor to this firm. Therefore firm-level labor supply and market-level labor supply are completely different concepts with the former being the relevant concept for Robinsonian wage discrimination.[1] Just recently, Ransom & Oaxaca (2005) and Hirsch et al. (2006) found that women's labor supply at the firm level is indeed substantially less elastic than men's so that Robinsonian wage discrimination is not rejected by the data and might be one explanation of the persistent empirical regularity of the gender pay gap.

While Robinsonian wage discrimination gives a simple and intuitively appealing explanation of the gender pay gap, it differs fundamentally from Becker's (1971) concept of discrimination due to distaste. The reason is that firms' only motive for engaging in Robinsonian wage discrimination is that they can increase their profits by doing so. Thus, firms actions remain profit maximizing and need not to be governed by (costly) prejudices embodied in a Beckerian distaste parameter for Robinsonian wage discrimination to work.

Nevertheless, in spite of its intuitive appeal not much tribute is paid to Robinsonian wage discrimination. For instance, Altonji & Blank's (1999) comprehen-

[1] Since Robinson's (1933) original argument was given within the standard static model of monopsony, where there is only a single employer demanding for labor, there was no room for distinguishing firm-level and market-level labor supply. Perhaps this is the main reason that the standard argument given against Robinsonian wage discrimination – that women's labor supply at the market-level is more elastic than men's – still seems so convincing.

sive summary of race and gender in the labor market does not refer to it at all. Hence, Robinsonian wage discrimination might seem as an idea whose time has passed which parallels to some extent the little interest paid to monopsony in general.[2] Since Robinson's (1933) analysis assumes monopsony power in the classic sense of a single employer one might indeed doubt its relevance. The new monopsony literature, however, whose first systematic exposition and application to nearly all traditional issues of labor economics is given by Manning (2003*a*), highlights that monopsony power may even arise if there are many firms competing for workers. Other than in a perfect competition framework where labor supply to the firm is infinitely elastic, models of new monopsony are able to generate upward-sloping firm-level labor supply curves due to search frictions, heterogeneous preferences among workers and mobility costs. While Manning (2003*a*) focusses on the impact of search frictions by utilizing equilibrium search models with wage posting in the fashion of Burdett & Mortensen (1998), the impact of heterogenous preferences among workers and mobility costs is analyzed by Bhaskar et al. (2002) and Bhaskar & To (1999, 2003) within models of horizontal job differentiation.

Analogously to models of horizontal product differentiation, models of horizontal job differentiation assume that different jobs have different non-wage characteristics and that workers differ in their preferences over these characteristics. Examples are the work schedule, the job specification, or the distance of the workplace from the worker's home.[3] Hotelling (1929) sets up a model in which otherwise identical consumers are located at different places and have to travel to buy commodities because firms (and the goods they sell) do not exist at each potential location. Hence, consumers differ only in one dimension, their geographical location. Of course, one might think of location in a less geographical context. For example, one might think of preferences over a characteristic of the commodity of interest.

Hotelling's model can be used to model horizontal job differentiation in a similar way: Otherwise identical workers are located at different places, while employers do not exist at each potential location. Workers commute and face travel cost to do so.[4] This travel cost can be both direct and indirect. Direct cost results because traveling on its own is not costless, whereas indirect cost results, for instance, from

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[2] An interesting discussion of this is given by Manning (2003*a*, pp. 6–10).

[3] Unlike vertical job differentiation, utilized by the theory of compensating wage differentials that distinguishes 'good' and 'bad' jobs, horizontal job differentiation just assumes different preferences over non-wage characteristics so that some jobs are 'good' for some workers and 'bad' for others.

[4] Again, one might think of this literally in a geographical way or, more generally, one might think of different preferences over non-wage job characteristics that demand 'traveling', i.e. abdication of some preferred job characteristics. We will, however, stick to the case that employers are horizontally differentiated due to their locations.

the fact that traveling requires time – and thus imposes opportunity costs – and that traveling might be uncomfortable to the workers. Hotelling's (1929) model and its extensions by Salop (1979) provide the basis for the models of horizontal job differentiation proposed by Bhaskar & To (1999, 2003). The quintessential idea of these models is presented by Bhaskar et al. (2002) in a Hotelling-style dyopsony model which they discuss by means of a graphical exposition.[5]

We will employ this simple dyopsony model in the following to investigate wage discrimination of equally productive men and women.[6] Jobs are horizontally differentiated because firms' locations differ. We assume that a fraction of the women differ from the men in terms of higher travel cost. We argue that this is the case because these women face higher opportunity cost of commuting as they play a more prominent role in household production than men, which is in line with empirical observation. Employers exploit that (some) women are less mobile and thus less inclined to take up a job with a competitor by offering lower wages to women.

3 The Model

3.1 Workers' Labor Supply to Firms

Assume that equally productive workers' homes are uniformly distributed along the unit interval $[0, 1]$. At each end of this line there is a firm demanding labor, firm 0 at the one end and firm 1 at the other end. Workers supply a unit of labor wage-inelastically as long as they gain a positive income from working so that they have a reservation income of zero. Moreover, a worker will choose the employer such that her or his income is maximized.

Next, suppose all workers face linear travel cost, that is travel cost are proportional to distance. Workers, however, differ in their travel cost. There are three groups of workers, each uniformly distributed on $[0, 1]$: male workers, female workers with identical travel cost as male workers, and females with higher travel cost than the other two groups. More precisely, we have a mass μ of male workers who face travel cost $\underline{t} > 0$ per unit length, and a unit mass of female workers, where a share λ, $0 < \lambda \leqslant 1$, of female workers face higher travel cost $\bar{t} > \underline{t} > 0$ than male workers, while a share $1 - \lambda$ of them face the same travel cost $\underline{t}$ as men. Therefore a man or a low-cost woman located at $0 \leqslant x \leqslant 1$ has travel cost of $\underline{t}x$ to get to firm 0 and $\underline{t}(1 - x)$ to get to firm 1, while for a high-cost woman these costs are given by

[5] To our knowledge the first presentation of this dyopsony model is due to Veendorp (1981).

[6] For an analysis of Robinsonian wage discrimination within a search model see Schlicht (1982). Madden (1977) investigates Robinsonian wage discrimination for segmented local labor markets.

$\bar{t}x$ and $\bar{t}(1-x)$, respectively. The farther firm 0, i.e. the larger x, the higher is the worker's travel cost to get to firm 0 and the lower is his travel cost to get to firm 1. Accordingly, the higher x the more she or he prefers to work for firm 1.

What might be reasons for different travel cost among women? A reason for this might be that high-cost women have higher indirect travel cost because they play a more exposed role in household production, particularly in rearing children, than the other women and men so that they attach a higher disutility to the time loss due to commuting, i.e. they face higher opportunity cost of traveling. This is also in line with empirical evidence. For instance, Hersch & Stratton (1997) show that for the U.S. married women's housework time is, on average, three times that of married men's and that women's more dominant role in housework is able to explain part of the gender pay gap in wage regressions. Furthermore, Manning (2003*a*, pp. 203/4) presents some evidence for the UK that travel-to-work times are lower for women than men, especially for those with more domestic responsibilities.

Firms are assumed to offer wages independent of workers' location separately to female and male workers. Let the corresponding offers be w_0^f and w_0^m for firm 0 and w_1^f and w_1^m for firm 1. A man located at x receives an income of $w_0^m - \underline{t}x$ when working for firm 0 and an income of $w_1^m - \underline{t}(1-x)$ when working for firm 1. Therefore he will work for firm 0 as long as $w_0^m - \underline{t}x > w_1^m - \underline{t}(1-x)$ and for firm 1 if the opposite holds as long as his income – i.e., the respective wage offer less travel cost – from doing so is nonnegative, for otherwise he would choose not to work at all. In particular, if $w_0^m + w_1^m \geqslant \underline{t}$ all male workers will decide to work and, similarly, if $w_0^f + w_1^f \geqslant \bar{t}$ all female workers will participate in the labor market which we will assume from now on. As we shall see later, this will indeed hold in equilibrium if firms are sufficiently productive. Thus, the location, at which male workers are indifferent between working for firm 0 and 1, is given by

$$x^m = \frac{w_0^m - w_1^m + \underline{t}}{2\underline{t}} \tag{1}$$

if $w_1^m - \underline{t} \leqslant w_0^m \leqslant w_1^m + \underline{t}$ where all men located at $x < x^m$ prefer working for firm 0 and all men located at $x > x^m$ prefer working for firm 1 (see figure 1). If, otherwise, $w_0^m < w_1^m - \underline{t}$ firm 0's wage compared to its competitor is such low that no male worker wants to work for firm 0 at all, whereas if $w_0^m > w_1^m + \underline{t}$ the opposite holds and every male worker wants to work for firm 0. Using the same reasoning the locations, at which high-cost and low-cost female workers are indifferent between working for firm 0 and 1, are

$$x^{\bar{f}} = \frac{w_0^f - w_1^f + \bar{t}}{2\bar{t}} \tag{2}$$

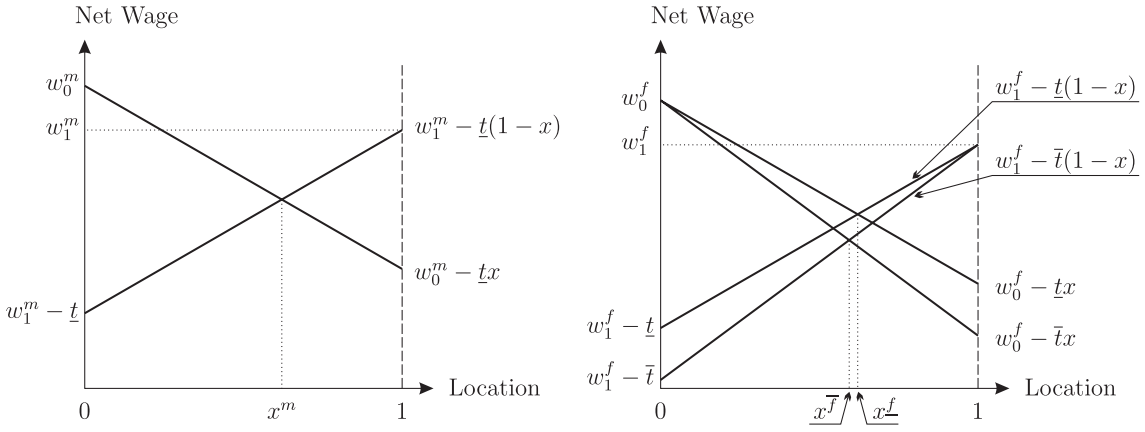

Figure 1: *The indifferent workers' locations x^m, $x^{\underline{f}}$, and $x^{\overline{f}}$.*

if $w_1^f - \overline{t} \leqslant w_0^f \leqslant w_1^f + \overline{t}$ and

$$x^{\underline{f}} = \frac{w_0^f - w_1^f + \underline{t}}{2\underline{t}} \tag{3}$$

if $w_1^f - \underline{t} \leqslant w_0^f \leqslant w_1^f + \underline{t}$, respectively, where again each high-cost and low-cost woman left to the respective indifferent female worker prefers working for firm 0 and each high-cost and low-cost woman right to her prefers working for firm 1. Now, if $w_0^f < w_1^f - \overline{t}$ no woman wants to work for firm 0, whereas if $w_1^f - \overline{t} < w_0^f < w_1^f - \underline{t}$ only some high-cost women find it profitable to work for firm 0.

Making use of the reasoning in the last paragraph we get firms' labor supply of men and women. On the one hand, the labor supply of men for firm 0 is the mass of workers left to the indifferent male worker x^m. On the other hand, the labor supply of men for firm 1 is the mass of male workers right to x^m. Thus, firm i's male labor supply is given by

$$L_i^m(w_i^m, w_j^m) = \begin{cases} 0 & \text{if } w_i^m < w_j^m - \underline{t}, \\ \dfrac{\mu(w_i^m - w_j^m + \underline{t})}{2\underline{t}} & \text{if } w_j^m - \underline{t} \leqslant w_i^m \leqslant w_j^m + \underline{t}, \\ \mu & \text{if } w_i^m > w_j^m + \underline{t}, \end{cases} \tag{4}$$

where $i = 0, 1$ and $j \neq i$. Analogously, women's labor supply to firm 0 is the mass of high-cost and low-cost women left to the respective indifferent female worker, while their labor supply to firm 1 is the mass right to her. Hence, firm i's female labor

supply is given by

$$L_i^f(w_i^f, w_j^f) = \begin{cases} 0 & \text{if } w_i^f < w_j^f - \bar{t}, \\ \dfrac{\lambda(w_i^f - w_j^f + \bar{t})}{2\bar{t}} & \text{if } w_j^f - \bar{t} \leqslant w_i^f < w_j^f - \underline{t}, \\ \dfrac{[\lambda\underline{t} + (1-\lambda)\bar{t}](w_i^f - w_j^f) + \bar{t}\underline{t}}{2\bar{t}\underline{t}} & \text{if } w_j^f - \underline{t} \leqslant w_i^f \leqslant w_j^f + \underline{t}, \\ \lambda + \dfrac{(1-\lambda)(w_i^f - w_j^f + \underline{t})}{2\underline{t}} & \text{if } w_j^f + \underline{t} < w_i^f \leqslant w_j^f + \bar{t}, \\ 1 & \text{if } w_i^f > w_j^f + \bar{t}. \end{cases} \tag{5}$$

Both male and female labor supply are increasing in firm i's own wage and decreasing in its competitor's wage (as long as $|w_0^m - w_1^m| < \underline{t}$ and $|w_0^f - w_1^f| < \bar{t}$). As a consequence, this simple dyopsony model generates upward-sloping firm-level labor supply curves for both women and men as long as the travel costs are not very small and the offered wages are not too different.

3.2 Firms' Wage-Setting Behavior

We now turn to firms' decisions. Firms are considered to behave as profit maximizers. Let Q_i denote firm i's output produced from its capital and labor inputs K_i and $L_i \equiv L_i^f + L_i^m$, respectively. Thus, women and men are assumed to be perfect substitutes in production which reflects our assumptions that men and women are equally productive and supply the same amount of labor whenever they receive a nonnegative income from doing so. We assume further that firms may differ in their productivity levels. In particular, we allow for firms employing different production technologies. Firms' production functions F_i are assumed to be twice continuously differentiable with positive, decreasing marginal products and linearly homogenous so that

$$Q_i \equiv F_i(K_i, L_i) \equiv L_i f_i(k_i), \tag{6}$$

where $k_i \equiv K_i/L_i$, $f_i(k_i) \equiv F_i(k_i, 1)$ and $F_{iK}, F_{iL}, f_i' > 0$ as well as $F_{iKK}, F_{iLL}, f_i'' < 0$ with $i = 0, 1$.

Let π_i denote firm i's profits which are i's revenue net of labor and capital costs, i.e.

$$\pi_i = L_i p_i f_i(k_i) - rK_i - w_i^m L_i^m - w_i^f L_i^f, \tag{7}$$

where p_i denotes firm i's output price and r the uniform capital rental rate. Next, we follow Bhaskar & To (2003) and define firms' net revenue product of labor $\phi_i \equiv \phi_i(r/p_i) \equiv p_i[f_i[k_i(r/p_i)] - f_i'[k_i(r/p_i)]k_i(r/p_i)]$, where $k_i(r/p_i)$ is the capital-

labor ratio optimally chosen by firm i for a given r/p_i.[7] Firm i's problem is to find optimal wage offers w_i^m and w_i^f both for male and female workers that maximize i's profits given firm j's wage offers, i.e. wage offers w_i^m and w_i^f that solve the problem

$$\max_{w_i^m, w_i^f} \pi_i = \phi_i(r/p_i)[L_i^m(w_i^m, w_j^m) + L_i^f(w_i^f, w_j^f)] - w_i^m L_i^m(w_i^m, w_j^m) - w_i^f L_i^f(w_i^f, w_j^f), \tag{8}$$

where we used firm i's previously defined net revenue product of labor.

We can now express more precisely what is meant by allowing for differences in firms' productivity levels. We consider potential differences in firms' net revenue products of labor. Therefore we allow for $\phi_0 \neq \phi_1$. There are two reasons for that. The first is that firms may have different market power in their output markets giving rise to different output prices $p_0 \neq p_1$ so that $\phi_0 = \phi(r/p_0) \neq \phi(r/p_1) = \phi_1$ because ϕ_i is strictly monotone decreasing in r/p_i and, thus, injective. Another reason may be that firms employ different production technologies so that firms production functions differ, i.e. $F_1 \neq F_0$, yielding (potentially) different net revenue products of labor even if firms face the same ratio r/p, that is $\phi_0 = \phi_0(r/p) \neq \phi_1(r/p) = \phi_1$ for some r/p. Therefore we assume from now on that $\phi_0 \neq \phi_1$ may be the case for one or even both of these reasons.

In a next step, it is possible to split up this problem of finding optimal wage offers w_i^m and w_i^f that maximize overall profits as given by (8) into two independent problems, namely of finding a wage offer w_i^m that maximizes profits from the employment of men given firm j's wage offer w_j^m and finding a wage offer w_i^f that maximizes profits from the employment of women given firm j's wage offer w_j^f. This is possible because women and men are perfect substitutes in production and firms are supposed to set wages separately for women and men and to use a constant returns to scale production technology. Thus, we get

$$\max_{w_i^m, w_i^f} \pi_i = \max_{w_i^m} \pi_i^m + \max_{w_i^f} \pi_i^f, \tag{9}$$

where

$$\pi_i^m = (\phi_i - w_i^m) L_i^m(w_i^m, w_j^m) \tag{10}$$

and

$$\pi_i^f = (\phi_i - w_i^f) L_i^f(w_i^f, w_j^f) \tag{11}$$

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[7] Obviously, ϕ_i is closely linked to firm i's marginal revenue product of labor which is given by $p_i F_{iL}(K_i, L_i) = p_i[f_i(k_i) - f_i'(k_i)k_i]$. The profit-maximizing capital-labor ratio must necessarily satisfy $\pi_{iK} = 0$ and, thus, $f_i'(k_i) = r/p_i$. Since $f_i'' < 0$ holds f_i' is invertible and we get $k_i(r/p_i) \equiv k_i = (f_i')^{-1}(r/p_i)$ so that the optimal capital-labor ratio is a strictly monotone decreasing function of r/p_i and unique due to f_i's strict concavity.

with $i = 0, 1$ and $j \neq i$. Inserting equations (4) and (5) for firm i's female and male labor supply into (10) and (11) yields

$$\pi_i^m(w_i^m, w_j^m) = \begin{cases} 0 & \text{if } w_i^m < w_j^m - \underline{t}, \\ (\phi_i - w_i^m)\dfrac{\mu(w_i^m - w_j^m + \underline{t})}{2\underline{t}} & \text{if } w_j^m - \underline{t} \leqslant w_i^m \leqslant w_j^m + \underline{t}, \\ (\phi_i - w_i^m)\mu & \text{if } w_i^m > w_j^m + \underline{t}, \end{cases} \tag{12}$$

and

$$\pi_i^f(w_i^f, w_j^f) = \begin{cases} 0 & \text{if } w_i^f < w_j^f - \bar{t}, \\ (\phi_i - w_i^f)\dfrac{\lambda(w_i^f - w_j^f + \bar{t})}{2\bar{t}} & \text{if } w_j^f - \bar{t} \leqslant w_i^f < w_j^f - \underline{t}, \\ (\phi_i - w_i^f)\dfrac{[\lambda\underline{t} + (1-\lambda)\bar{t}](w_i^f - w_j^f) + \bar{t}\underline{t}}{2\bar{t}\underline{t}} & \text{if } w_j^f - \underline{t} \leqslant w_i^f \leqslant w_j^f + \underline{t}, \\ (\phi_i - w_i^f)\left[\lambda + \dfrac{(1-\lambda)(w_i^f - w_j^f + \underline{t})}{2\underline{t}}\right] & \text{if } w_j^f + \underline{t} < w_i^f \leqslant w_j^f + \bar{t}, \\ \phi_i - w_i^f & \text{if } w_i^f > w_j^f + \bar{t}. \end{cases} \tag{13}$$

We now assume that firms simultaneously determine the wages they offer to women and men. This gives two independent static wage-setting games of complete information, where we are interested in finding Nash equilibria for both games.[8] A first conclusion that can be drawn from the payoff functions of firm i represented by (12) and (13) is that firm i will never offer a wage above its net revenue product of labor because it would incur losses otherwise so that $w_i^m, w_i^f \leqslant \phi_i$. Before we try to derive reaction functions, which give firm i's optimally chosen wage for some wage offer w_j of its competitor, we can use the principle of iterated elimination of strictly dominated strategies to show that under some non-restrictive parameter restrictions we can concentrate on those cases where $|w_0^m - w_1^m| < \underline{t}$ and $|w_0^f - w_1^f| < \underline{t}$ hold, which immensely simplifies the following analyses.

Lemma 1 (Iterated Elimination of Strictly Dominated Strategies)

(a) If $|\phi_0 - \phi_1| < \underline{t}$ elimination of strictly dominated strategies yields $|w_0^m - w_1^m| < \underline{t}$.

(b) If $|\phi_0 - \phi_1| < \bar{t}$ elimination of strictly dominated strategies yields $|w_0^f - w_1^f| < \bar{t}$.

[8] If we assumed that firms first determine wages for men and then for women, or *vice versa* this would change the solution concept (from Nash equilibrium to subgame-perfect Nash equilibrium), but not the results because the only subgame-perfect Nash equilibrium involves the same outcome as in the case where both games are played simultaneously, which follows immediately from applying backwards induction.

If even

$$|\phi_0 - \phi_1| < 2\underline{t} - \frac{\bar{t}\underline{t}}{\lambda\underline{t} + (1-\lambda)\bar{t}} \tag{14}$$

then elimination of strictly dominated strategies gives $|w_0^f - w_1^f| < \underline{t}$.

Proof. See the appendix. ■

Lemma 1 therefore requires that firms are not too different. Otherwise the more productive firm may find it profitable to offer much higher wages than its less productive competitor which could even be driven out of the market if differences become too large. If firms are symmetric, i.e. $\phi_0 = \phi_1$, $|w_0^m - w_1^m| < \underline{t}$ and $|w_0^f - w_1^f| < \bar{t}$ will even hold for all $\bar{t} > \underline{t} > 0$. In this case, $|w_0^f - w_1^f| < \underline{t}$ is guaranteed if $2\underline{t} > \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}}$.

In the following we will assume that the conditions given by lemma 1 hold so that $|w_0^m - w_1^m|, |w_0^f - w_1^f| < \underline{t}$. Hence, the profits from employing men and women are now given by

$$\pi_i^m(w_i^m, w_j^m) = (\phi_i - w_i^m)\frac{\mu(w_i^m - w_j^m + \underline{t})}{2\underline{t}} \tag{15}$$

and

$$\pi_i^f(w_i^f, w_j^f) = (\phi_i - w_i^f)\frac{[\lambda\underline{t} + (1-\lambda)\bar{t}](w_i^f - w_j^f) + \bar{t}\underline{t}}{2\bar{t}\underline{t}}, \tag{16}$$

respectively. Maximization of (15) with respect to w_i^m and (16) with respect to w_i^f as well as some rearranging of the respective first-order conditions gives firm i's reaction function, that is the optimally chosen wage for men and women given firm j's wage offer. The reaction function for male workers is

$$R_i^m(w_j^m) = \frac{1}{2}\left(\phi_i + w_j^m - \underline{t}\right), \tag{17}$$

whereas the reaction function for female workers is

$$R_i^f(w_j^f) = \frac{1}{2}\left(\phi_i + w_j^f - \frac{\bar{t}\underline{t}}{\lambda\underline{t} + (1-\lambda)\bar{t}}\right). \tag{18}$$

Since both R_i^m and R_i^f are increasing in w_j^m and w_j^f we have strategic complementarity in wage setting.

3.3 The Equilibrium and Its Properties

Mutually best responses yield unique, globally stable Nash equilibria in pure strategies with equilibrium wage offers $\hat{w}_0^m$, $\hat{w}_1^m$, $\hat{w}_0^f$, and $\hat{w}_1^f$ in which all workers

participate in the labor market if firms are sufficiently productive as is shown by the following proposition:

Proposition 1 (Equilibrium Wage Offers) *If the conditions stated in lemma 1 hold there exists a unique, globally stable Nash equilibrium in pure strategies for both female and male workers. It yields wage offers*

$$\hat{w}_i^m = \frac{2}{3}\phi_i + \frac{1}{3}\phi_j - \underline{t} \tag{19}$$

and

$$\hat{w}_i^f = \frac{2}{3}\phi_i + \frac{1}{3}\phi_j - \frac{\bar{t}\underline{t}}{\lambda\underline{t} + (1-\lambda)\bar{t}}, \tag{20}$$

respectively, where $i = 0, 1$ *and* $j \neq i$*. Furthermore, only if* $\phi_0 + \phi_1 \geqslant \frac{2\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}} + \bar{t}$ *then all workers will participate in the labor market and the equilibria derived will exist.*

Proof. Making use of the reaction functions (17) and (18), the equilibrium wage offers are implicitly given by $\hat{w}_i^m = R_i^m[R_j^m(\hat{w}_i^m)]$ and $\hat{w}_i^f = R_i^f[R_j^f(\hat{w}_i^f)]$ so that (19) and (20) follow immediately. This gives indeed unique and globally stable Nash equilibria in pure strategies due to the linearity of the reaction functions (see figure 2). Finally, if $\phi_0 + \phi_1 \geqslant \frac{2\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}} + \bar{t}$ then $\hat{w}_0^f + \hat{w}_1^f \geqslant \bar{t}$ and $\hat{w}_0^m + \hat{w}_1^m \geqslant \underline{t}$ follow directly from (19) and (20) so that every worker gains a nonnegative income from working and therefore decides to participate in the labor market. ■

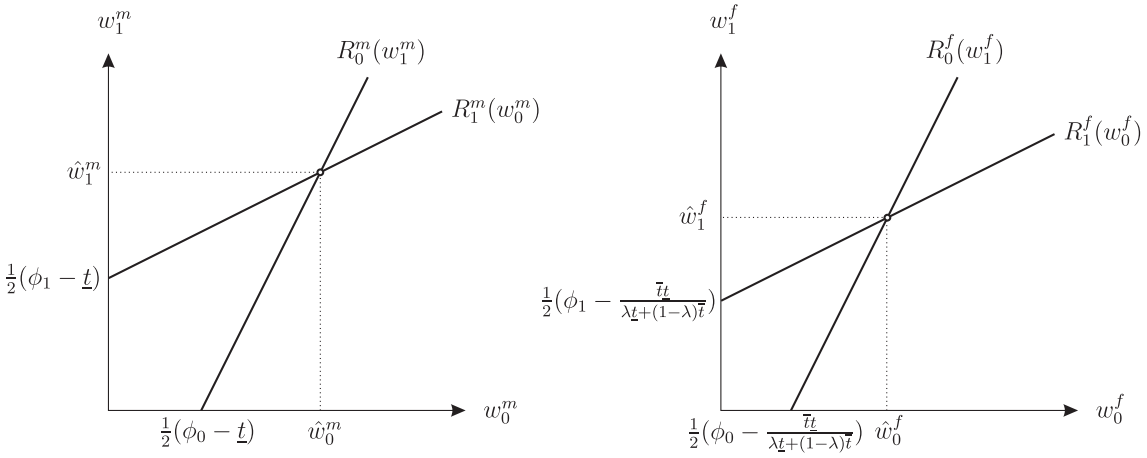

Figure 2: *The equilibrium wage offers* $\hat{w}_0^m$*,* $\hat{w}_1^m$*,* $\hat{w}_0^f$*, and* $\hat{w}_1^f$*.*

Note that if firms are sufficiently productive all workers will participate in the labor market due to $\hat{w}_0^m + \hat{w}_1^m \geqslant \underline{t}$ and $\hat{w}_0^f + \hat{w}_1^f \geqslant \bar{t}$. If this were not the case the

equilibria derived would fail to exist because we would have local monopsonists without strategic interaction for female or for both female and male workers. According to (19) and (20) both female and male workers will receive (and accept) wage offers that are below their respective marginal products. Interestingly, firm i's wage offer not only depends on i's own productivity, but also on j's, even though to a lesser extent. The latter effect reflects the impact of wage competition among employers which is, however, not complete because firm i's own characteristics partly determine the wages paid by i in equilibrium. Another interesting point to mention is the link between productivity, firm size, and wages. From (19) and (20) it follows immediately that in equilibrium the more productive firm in terms of a higher net revenue product of labor offers higher wages both to men and women. And this, in turn, implies according to (4) and (5) that the more productive firm is also the larger one in terms of employment, i.e. it employs both more men and women than the less productive firm. Therefore this model is consistent with two stylized facts of labor markets, viz. the employer size-wage effect and the positive correlation between productivity and wages (cf., e.g., Oi & Idson 1999). Eventually, note that if firms are symmetric they offer the same wages and employ both half of the men and half of the women in the market.

Next, we are interested in differences in the labor market outcomes of men and women. Therefore we consider the equilibrium wage differential $\Delta_w \equiv \hat{w}_i^m - \hat{w}_i^f$ between male and female workers.

Corollary 1 (Equilibrium Wage Differential) *The equilibrium wage differential between male and female workers is given by*

$$\Delta_w = \frac{(\bar{t} - [\lambda \underline{t} + (1-\lambda)\bar{t}])\underline{t}}{\lambda \underline{t} + (1-\lambda)\bar{t}} \tag{21}$$

It is the same in firms 0 and 1. Moreover, it is positive and strictly monotone increasing both in the travel cost of high-cost women $\bar{t}$ and the share of high-cost women among female workers λ.

Proof. Subtracting (20) from (19) yields (21) which is positive because of $\bar{t} > \lambda \underline{t} + (1-\lambda)\bar{t}$ for all $0 < \lambda \leqslant 1$. It is also independent of firms' characteristics, i.e. their net revenue products of labor. Furthermore, the wage differential is strictly monotone increasing both in the travel cost of high-cost women $\bar{t}$ and the share of high-cost women among female workers λ on account of

$$\frac{\partial \Delta_w}{\partial \bar{t}} = \frac{\lambda \underline{t}^2}{[\lambda \underline{t} + (1-\lambda)\bar{t}]^2} > 0 \tag{22}$$

and

$$\frac{\partial \Delta_w}{\partial \lambda} = \frac{\bar{t}\underline{t}(\bar{t} - \underline{t})}{[\lambda \underline{t} + (1 - \lambda)\bar{t}]^2} > 0, \tag{23}$$

which completes the proof of corollary 1. ■

The consequence of corollary 1 is that women earn less than men in equilibrium even though men and women are equally productive and perfect substitutes in production just because a share of women face higher travel cost. The reasoning is as follows: Since firms cannot distinguish low- and high-cost women *ex ante* all women receive lower wage offers in equilibrium as firms know that women face higher travel cost than men on average. Therefore the average woman is less inclined to change employers for wage-related reasons because she avoids commuting to a greater extent than a man which in turn reduces competition among employers for female workers. Hence, even low-cost women who do not differ from men in terms of productivity and travel cost are affected as they receive and accept lower wage offers than men due to statistical discrimination by the firms. Furthermore, the extent of wage discrimination erodes as the share of high-cost women declines and as the travel cost of high-cost women reduces, which affirms intuition.[9]

Next, we consider the equilibrium wage elasticity of firm's female and male labor supply. As Robinsonian wage discrimination arises if and only if women's labor supply to firms is less elastic than men's it is of particular interest to investigate whether gender-specific labor supply elasticities differ and whether the difference goes in the same direction as it would if Robinsonian wage discrimination occurred. If this were the case another point of interest would be the link between differences in elasticities and the wage differential. The following corollary 2 shows that not only women's labor supply at the firm level is less elastic than men's, but also that a direct link between the elasticity and the wage differential arises.

[9] One might ask whether this sort of wage discrimination is a long-run equilibrium outcome. If firms choose wages once-for-all, an assumption typically made in search-theoretic models used to analyze oligopsonistic labor markets, such as the model by Burdett & Mortensen (1998), then the gender pay gap from corollary 1 will obviously be a long-run equilibrium outcome. Furthermore, the assumption that employers choose wages once-for-all seems quite reasonable in a steady-state environment, which is assumed by those models (cf., e.g., Coles 2001). Things get more complicated if we allow for infinitely repeated interaction between employers. Analogously to the large tacit collusion literature (e.g., Ivaldi et al. 2007), there might be feasible collusive wage offers in this case, where women whose reservation incomes are higher than men's (in terms of wage offered plus travel cost for high-cost women) get a higher wage than men in order to guarantee their participation in the market. We do not want to go into details, but note the following: If tacit collusion does not work in the sense that both firms play non-cooperatively such that every period's outcome is the Nash equilibrium from proposition 1 then the gender pay gap from corollary 1 appears every period and is, thus, again a long-run equilibrium outcome – even if we allow for repeated interaction.

Corollary 2 (Equilibrium Firm-Level Labor Supply Elasticities)

(a) In equilibrium the elasticity of male labor supply to firm i is given by

$$\hat{\varepsilon}_i^m = \frac{\frac{2}{3}\phi_i + \frac{1}{3}\phi_j - \underline{t}}{\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \underline{t}}, \tag{24}$$

where $i = 0, 1$ and $j \neq i$.

(b) The equilibrium elasticity of female labor supply to firm i is given by

$$\hat{\varepsilon}_i^f = \frac{\frac{2}{3}\phi_i + \frac{1}{3}\phi_j - \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}}}{\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}}}, \tag{25}$$

where $i = 0, 1$ and $j \neq i$.

(c) The equilibrium differential in male and female labor supply elasticities to firm i $\Delta_{\varepsilon,i} \equiv \varepsilon_i^m - \varepsilon_i^f$ differs among firms if and only if $\phi_0 \neq \phi_1$ and is given by

$$\Delta_{\varepsilon,i} = \frac{\phi_i}{\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \underline{t}\right)\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}}\right)}\Delta_w, \tag{26}$$

where $i = 0, 1$ and $j \neq i$. It is positive and proportional to the wage differential. Furthermore, it is also strictly monotone increasing both in the travel cost of high-cost women $\bar{t}$ and the share of high-cost women among female workers λ.

Proof. See the appendix. ■

First of all, it is interesting to note that women's labor supply to the firm is less elastic than men's even though both women and men supply labor totally inelastically at the market level. This affirms theoretically the importance of distinguishing market-level and firm-level labor supply when investigating firms' potential to engage in wage discrimination due to monopsonistic wage-setting power. There is some empirical evidence (e.g., Ransom & Oaxaca (2005) and Hirsch et al. (2006)) that women's labor supply at the firm-level is indeed less elastic, even though women's labor supply at the market-level might be not. Furthermore, the proportionality of the wage and the elasticity differential has an important consequence: Differences in elasticities necessarily imply differences in outcomes, and *vice versa*. Therefore the results from corollary 2 make clear that the wage differential and the elasticity differential are two sides of the same coin which gives another interesting result in line with Robinsonian wage discrimination. For this reasons we get an explanation why elasticities of men and women might differ,

namely due to differences in mobility arising from differences in travel costs, which are the underlying force of both wage and elasticity differences.

Eventually, one might also ask which firm employs more women relative to men. Let γ_i denote the share of women among firm i's workers in equilibrium with $i = 0, 1$. That is, $\gamma_i \equiv L_i^f(\hat{w}_i^f, \hat{w}_j^f)/L_i^m(\hat{w}_i^m, \hat{w}_j^m)$. The following corollary answers this question.

Corollary 3 (Equilibrium Job Location of Female Workers) *The higher is firm i's net revenue product of labor ϕ_i the lower is its share of women among workers γ_i where $i = 0, 1$. In particular, this means that the more productive firm will employ less women relatively to men in equilibrium than its less productive competitor.*

Proof. Inserting (19) and (20) into (4) and (5), respectively, and bearing in mind that $|\hat{w}_0^s - \hat{w}_1^s| < \underline{t}$ with $s = f, m$ must hold we have

$$\gamma_i = \frac{\frac{\lambda\underline{t}+(1-\lambda)\bar{t}}{2\bar{t}\underline{t}}\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}}\right)}{\frac{\mu}{2\underline{t}}\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \underline{t}\right)}, \tag{27}$$

where $i = 0, 1$ and $j \neq i$. The partial derivative of γ_i with respect to ϕ_i is given by

$$\frac{\partial\gamma_i}{\partial\phi_i} = \frac{\frac{1}{3}\frac{\lambda\underline{t}+(1-\lambda)\bar{t}}{2\bar{t}\underline{t}}\frac{\mu}{2\underline{t}}\left(\underline{t} - \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}}\right)}{\left[\frac{\mu}{2\underline{t}}\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \underline{t}\right)\right]^2} = -\frac{\frac{1}{3}\frac{\lambda\underline{t}+(1-\lambda)\bar{t}}{2\bar{t}\underline{t}}\frac{\mu}{2\underline{t}}\Delta_w}{\left[\frac{\mu}{2\underline{t}}\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \underline{t}\right)\right]^2} < 0 \tag{28}$$

so that γ_i decreases as ϕ_i increases. Since $\gamma_0 = \gamma_1$ holds if $\phi_0 = \phi_1$ this implies that the more productive firm employs less women relatively to men in equilibrium, i.e. $\gamma_i < \gamma_j$ if and only if $\phi_i > \phi_j$. ■

The intuition behind this result is rather straightforward. From proposition 1 we know that the more productive firm pays higher wages to both men and women and therefore employs more workers from both groups, which reflects the aforementioned employer size-wage effect. Moreover, we know from corollary 2 that women (on average) react less elastically to wage changes than men. Hence, the higher wages offered by the more productive firm increase the number of male workers to a greater extent than the number of female workers. And this, in turn, translates into a lower share of women among the more productive firm's workers. The results from corollary 3 add another hypothesis that can be tested empirically: We would expect that more productive firms have a lower share of women in their workforce.

4 Conclusions

In this paper we have presented a Robinsonian explanation of the gender pay gap based on a Hotelling-style dyopsony model of the labor market in the fashion of Bhaskar et al.'s (2002) horizontal job differentiation model. Equally productive women and men are located at different places and supply labor totally inelastically at the market, while employers with potentially different productivity levels exist only at two locations. Thus, female and male workers commute and face travel cost to do so, where we assume that a share of the female workers face higher travel cost than men. Employers who offer wages separately to men and women exploit the fact that women are less inclined to commute than men (that is that the wage competition among employers for female workers is less fierce) and pay lower wages to women than to men in equilibrium. Since employers cannot distinguish low- and high-cost women even low-cost women who do not differ from men in their behavior are affected and earn lower wages due to statistical discrimination by the employers. Furthermore, both men and women earn less than their marginal products because firms' different locations give rise to some monopsony power, for labor markets are to some extent 'thin' in the geographical sense (cf. Manning 2003*b*).

That women are less inclined to commute than men is reflected in their lower firm-level labor supply elasticity. Therefore gender differences in wages and in firm-level labor supply elasticities are two sides of the same coin, viz. women's higher average travel cost. This, in turn, means that the difference in travel cost and, thus, in mobility represents the driving force of Robinsonian wage discrimination in this model. This Robinsonian approach to the gender pay gap has the virtue of explaining it in lines of firms' profit maximization. Hence, this reasoning does not suffer from the need to relax the assumption of firms' profit-maximizing behavior because there are no assumptions like a Beckerian distaste parameter involved. As firms do profit from paying lower wages to women, they behave like perfectly rational profit maximizers when discriminating against women.

Additionally, the model generates several hypotheses that can be tested empirically: First, the more productive firm will pay higher wages to both men and women and will therefore employ more workers from both groups. The model is thus consistent with the empirical regularity of an employer size-wage effect as well as a positive correlation between firm's productivity and wages in equilibrium (cf., e.g., Oi & Idson 1999). Second, the model predicts that wage differentials must be accompanied by differences in firm-level labor supply elasticities (not in market-level labor supply elasticities), where women get paid less if and only if they are the less

elastic group. These differences are indeed found by two recent studies, viz. Ransom & Oaxaca (2005) and Hirsch et al. (2006). Third, the model predicts that the share of women in the workforce is lower for more productive firms, which can be tested empirically, too.

As we noted earlier the driving force of the gender pay gap in this model is given by the difference in travel cost between high-cost women and men and the resulting lower mobility of women on average. And we argued that one of the most convincing reasons for this difference is women's dominant role in housework, especially in rearing children. In the model there are two variables that directly affect the magnitude of the gender pay gap: the share of high-cost women among female workers λ and the travel cost of high-cost women $\bar{t}$. Reducing one of these variables reduces as well the wage differential between men and women as the elasticity differential. Therefore governments may wish to reduce λ and/or $\bar{t}$, for example, by subsidizing or providing additional child care facilities. Hence, this model highlights the role of gender-specific differences in mobility patterns as one explanation for the gender pay gap and gives an argument why augmenting women's mobility is likely to reduce this gap.[10]

Though we feel confident that this paper is able to give a reformulation of Robinsonian wage discrimination in line with the growing new monopsony literature that is more convincing than its original formulation within the simple monopsony model with only one employer, the model presented is still highly stylized. For instance, workers' labor supply behavior at the market level is modeled in a very rudimentary way just as a participation decision, whereas the amount of labor supplied by the individual worker is fixed. Similarly, we dealt with an environment with only two employers. Future research should relax these (and other) assumptions to evaluate the robustness of the predictions given by our simple dyopsony model. Besides, the model generates several testable hypotheses that future research should investigate empirically. If the model presented gives an explanation of the gender pay gap that is in line with actual data, much more tribute should be paid to Robinsonian wage discrimination as an alternative monopsonistic explanation of the gender pay gap.

[10] The model is also able to explain the persistence of a gender pay gap that originally might have been caused by traditional norms. Household optimization would lead to more housework by women because women earning less than men may have lower opportunity cost when engaging in household production. If women's lower wages were the reason for high-cost women's more pronounced affiliation to housework and, thus, for their higher travel cost, which in turn – as we have seen – results in a gender pay gap for all women due to Robinsonian wage discrimination, this could explain the persistence of women's more prominent role in household production even if traditional norms' influence may have vanished. While traditional norms might have been the reason for this in the past, today household optimization would have the same consequence. Hence, this would constitute some kind of a self-fulfilling feedback mechanism.

Appendix

Proof of Lemma 1

(a) Assume that firm i offers a wage $w_i^m = w_j^m - \underline{t} + \varepsilon$ for some $0 < \varepsilon < 2\underline{t}$, where $i = 0, 1$ and $j \neq i$. Then i's profits from doing so are given by

$$[\phi_i - (w_j^m - \underline{t} + \varepsilon)]\frac{\mu\varepsilon}{2\underline{t}} \tag{A.1}$$

which follows from (12). This term is positive if and only if $\phi_i - w_j^m + \underline{t} > 0$. Since j's offer must be no more than its net revenue product of labor (otherwise its profits would be negative), i.e. $w_j^m \leqslant \phi_j$, (A.1) is always positive if $\phi_j - \phi_i < \underline{t}$. Therefore i will not offer a wage below $w_j^f - \underline{t}$ which would mean lower, i.e. zero, profits. Since the same reasoning holds both for firms 0 and 1 we must have $|w_0^m - w_1^m| < \underline{t}$ if $|\phi_0 - \phi_1| < \underline{t}$.

(b) For the proof that $|w_0^f - w_1^f| < \bar{t}$ if $|\phi_0 - \phi_1| < \bar{t}$ see the proof of (a), *mutatis mutandis*. To show that $|\phi_0 - \phi_1| < 2\underline{t} - \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}}$ implies $|w_0^f - w_1^f| < \underline{t}$ first note that $|\phi_0 - \phi_1| < 2\underline{t} - \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}}$ implies $|\phi_0 - \phi_1| < \bar{t}$ so that $|w_0^f - w_1^f| < \bar{t}$ must hold. Moreover, note that π_i^f is continuous in w_i^f and continuously differentiable in w_i^f for $w_i^f \in \mathbb{R}^+ \backslash \{w_j^f - \bar{t}, w_j^f - \underline{t}, w_j^f + \underline{t}, w_j^f + \bar{t}\}$. If $w_j^f - \bar{t} < w_i^f < w_j^f - \underline{t}$ the partial derivative of π_i^f with respect to w_i^f is given by

$$\left.\frac{\partial \pi_i^f(w_i^f, w_j^f)}{\partial w_i^f}\right|_{w_j^f - \bar{t} < w_i^f < w_j^f - \underline{t}} = \frac{\lambda}{2\bar{t}}(\phi_i - 2w_i^f + w_j^f - \bar{t}). \tag{A.2}$$

This term is positive if and only if $\phi_i - 2w_i^f + w_j^f - \bar{t} > 0$. Since $w_i^f > w_j^f - \bar{t}$ and $w_j^f \leqslant \phi_j$ must hold (A.2) is positive for all $w_j^f - \bar{t} < w_i^f < w_j^f - \underline{t}$ if $\phi_j - \phi_i < \bar{t}$. Next, we consider the partial derivative of π_i^f with respect to w_i^f for $w_j^f - \underline{t} < w_i^f < w_j^f + \underline{t}$ which is given by

$$\left.\frac{\partial \pi_i^f(w_i^f, w_j^f)}{\partial w_i^f}\right|_{w_j^f - \underline{t} < w_i^f < w_j^f + \underline{t}} = \frac{[\lambda\underline{t} + (1-\lambda)\bar{t}](\phi_i - 2w_i^f + w_j^f) - \bar{t}\underline{t}}{2\bar{t}\underline{t}}. \tag{A.3}$$

Let $w_i^f = w_j^f - \underline{t} + \varepsilon$ for some $0 < \varepsilon < 2\underline{t}$. Then (A.3) becomes

$$\left.\frac{\partial \pi_i^f(w_j^f - \underline{t} + \varepsilon, w_j^f)}{\partial w_i^f}\right|_{w_j^f - \underline{t} < w_i^f < w_j^f + \underline{t}} = \frac{\lambda\underline{t} + (1-\lambda)\bar{t}}{2\bar{t}\underline{t}}(\phi_i - w_j^f + 2\underline{t} - 2\varepsilon) - \frac{1}{2}. \tag{A.4}$$

There exists some $\varepsilon > 0$ such that (A.4) is positive if and only if $\phi_i - w_j^f + 2\underline{t} - \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}} > 0$. Since $w_j^f \leqslant \phi_j$ must hold (A.4) is always positive if $\phi_j - \phi_i < 2\underline{t} - \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}}$ is satisfied. Bearing in mind that π_i^f is continuous in w_i^f, π_i^f is under

this condition increasing in w_i^f on $[w_j^f - \bar{t}, w_j^f - \underline{t} + \varepsilon]$, and therefore firm i will not choose some wage $w_i^f \leqslant w_j^f - \underline{t}$. Since the same reasoning holds both for firms 0 and 1 we must have $|w_0^f - w_1^f| < \underline{t}$ if $|\phi_0 - \phi_1| < 2\underline{t} - \frac{\bar{t}\underline{t}}{\lambda\underline{t}+(1-\lambda)\bar{t}}$.

Proof of Corollary 2

(a) The equilibrium labor supply elasticity of men to firm i is given by

$$\hat{\varepsilon}_i^m = \frac{\partial L_i^m(\hat{w}_i^m, \hat{w}_j^m)}{\partial w_i^m} \frac{\hat{w}_i^m}{L_i^m(\hat{w}_i^m, \hat{w}_j^m)}, \tag{A.5}$$

where $i = 0, 1$ and $j \neq i$. According to (13) we have

$$\hat{w}_i^m = \frac{2}{3}\phi_i + \frac{1}{3}\phi_j - \underline{t}. \tag{A.6}$$

Inserting (A.6) into (4) and bearing in mind that $|\hat{w}_0^m - \hat{w}_1^m| < \underline{t}$ must hold under the conditions stated in lemma 1 we get

$$L_i^m(\hat{w}_i^m, \hat{w}_j^m) = \frac{\mu}{2\underline{t}} \left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \underline{t} \right). \tag{A.7}$$

Furthermore, we have according to (4)

$$\frac{\partial L_i^m(\hat{w}_i^m, \hat{w}_j^m)}{\partial w_i^m} = \frac{\mu}{2\underline{t}}. \tag{A.8}$$

Combining (A.6)–(A.8) yields

$$\hat{\varepsilon}_i^m = \frac{\frac{2}{3}\phi_i + \frac{1}{3}\phi_j - \underline{t}}{\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \underline{t}}. \tag{A.9}$$

(b) Analogously, women's labor supply elasticity to firm i is given by

$$\hat{\varepsilon}_i^f = \frac{\partial L_i^f(\hat{w}_i^f, \hat{w}_j^f)}{\partial w_i^f} \frac{\hat{w}_i^f}{L_i^f(\hat{w}_i^f, \hat{w}_j^f)} \tag{A.10}$$

with $i = 0, 1$ and $j \neq i$. According to (14) we have

$$\hat{w}_i^f = \frac{2}{3}\phi_i + \frac{1}{3}\phi_j - \frac{\bar{t}\underline{t}}{\lambda\underline{t} + (1-\lambda)\bar{t}}. \tag{A.11}$$

Inserting (A.11) into (5) and bearing in mind that $|\hat{w}_0^f - \hat{w}_1^f| < \underline{t}$ must hold under the conditions stated in lemma 1 gives

$$L_i^f(\hat{w}_i^f, \hat{w}_j^f) = \frac{\lambda\underline{t} + (1-\lambda)\bar{t}}{2\bar{t}\underline{t}} \left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \frac{\bar{t}\underline{t}}{\lambda\underline{t} + (1-\lambda)\bar{t}} \right). \tag{A.12}$$

Moreover, according to (5) we have

$$\frac{\partial L_i^f(\hat{w}_i^f, \hat{w}_j^f)}{\partial w_i^f} = \frac{\lambda \underline{t} + (1-\lambda)\bar{t}}{2\bar{t}\underline{t}}. \tag{A.13}$$

Combining (A.11)–(A.13) gives

$$\hat{\varepsilon}_i^f = \frac{\frac{2}{3}\phi_i + \frac{1}{3}\phi_j - \frac{\bar{t}\underline{t}}{\lambda \underline{t}+(1-\lambda)\bar{t}}}{\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \frac{\bar{t}\underline{t}}{\lambda \underline{t}+(1-\lambda)\bar{t}}}. \tag{A.14}$$

(c) Subtracting (A.14) from (A.9) yields

$$\begin{aligned} \Delta_{\varepsilon,i} &= \frac{\phi_i}{\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \underline{t}\right)\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \frac{\bar{t}\underline{t}}{\lambda \underline{t}+(1-\lambda)\bar{t}}\right)}\left(\frac{\bar{t}\underline{t}}{\lambda \underline{t} + (1-\lambda)\bar{t}} - \underline{t}\right) \\ &= \frac{\phi_i}{\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \underline{t}\right)\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \frac{\bar{t}\underline{t}}{\lambda \underline{t}+(1-\lambda)\bar{t}}\right)}\Delta_w \end{aligned} \tag{A.15}$$

Since the ratio in (A.15) is positive $\Delta_{\varepsilon,i} \propto \Delta_w$ holds. Next, consider the partial derivatives of $\Delta_{\varepsilon,i}$ with respect to $\bar{t}$ and λ. Firstly, note that $\frac{\partial}{\partial \bar{t}}\frac{\bar{t}\underline{t}}{\lambda \underline{t}+(1-\lambda)\bar{t}} = \frac{\partial \Delta_w}{\partial \bar{t}}$ and $\frac{\partial}{\partial \lambda}\frac{\bar{t}\underline{t}}{\lambda \underline{t}+(1-\lambda)\bar{t}} = \frac{\partial \Delta_w}{\partial \lambda}$. Secondly, define $\psi \equiv \frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \underline{t}$ and $\chi \equiv \frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \frac{\bar{t}\underline{t}}{\lambda \underline{t}+(1-\lambda)\bar{t}}$. Thirdly, note that $\psi = \chi - \Delta_w$. Hence, we have

$$\begin{aligned} \frac{\partial \Delta_{\varepsilon,i}}{\partial \bar{t}} &= \frac{\phi_i \frac{\partial \Delta_w}{\partial \bar{t}}\psi\chi - \phi_i \Delta_w \psi \frac{\partial \Delta_w}{\partial \bar{t}}}{(\psi\chi)^2} \\ &= \frac{\phi_i \psi(\chi - \Delta_w)}{(\psi\chi)^2}\frac{\partial \Delta_w}{\partial \bar{t}} \\ &= \frac{\phi_i}{\chi^2}\frac{\partial \Delta_w}{\partial \bar{t}} \\ &= \frac{\phi_i}{\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \frac{\bar{t}\underline{t}}{\lambda \underline{t}+(1-\lambda)\bar{t}}\right)^2}\frac{\partial \Delta_w}{\partial \bar{t}} > 0 \end{aligned} \tag{A.16}$$

Mutatis mutandis, we get

$$\frac{\partial \Delta_{\varepsilon,i}}{\partial \lambda} = \frac{\phi_i}{\left(\frac{1}{3}\phi_i - \frac{1}{3}\phi_j + \frac{\bar{t}\underline{t}}{\lambda \underline{t}+(1-\lambda)\bar{t}}\right)^2}\frac{\partial \Delta_w}{\partial \lambda} > 0. \tag{A.17}$$

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