Segregation, Wage Structure and the Gender Gap [1]

Ori Zax[2]

August 29, 2007

[1]This paper is based on a chapter of my doctoral dissertation at Tel Aviv University. I wish to thank my advisor, Yoram Weiss, as well as Stefania Albanesi, Pierre-Andre Chiappori, Graciela Chichilnisky, Gabrielle Gayer, Oded Hochman, Bentley MacLeod, Ady Pauzner, Bernard Salanie, Yaron Yehezkel and David Wettstein for many helpful suggestions. I also wish to thank the participants in seminar conducted at Ben Gurion University, Columbia University, New York University, Tel Aviv University, and in meeting of the International Atlantic Economic Society for their comments.

[2]The Eitan Berglas School of Economics, Tel Aviv University, Ramat Aviv, Tel Aviv, 69978, Israel. Email: orizax@post.tau.ac.il

Abstract

This paper proposes theoretical explanations to several observed features of the gender differences found in the labor market. Empirical evidence indicates that females acquire more schooling than males do but earn lower wages; they also gain less from experience but more from tenure. To explain these phenomena, the paper analyzes an economy in which females use a rising wage-tenure profile or a larger amount of schooling to signal employers regarding their expected absence. We show that females are indifferent to over-investing in schooling and obtaining a better job or absence from work.

JFL Classification: J22, J24, J31

Keywords: Time allocation, human capital, wage differentials

1 Introduction

A great deal of empirical evidence supports the assertion that male wages are higher than female wages. Additional evidence, documented in various studies, show that in the recent years, females acquire more schooling than do males; that the labor force is segregated, with some occupations dominated by males and others by females; that females receive larger tenure and schooling premiums whereas males receive larger experience premiums; and that females in recent decades have chosen to increase their schooling[1].

Previous models that analyze the gender gap in the labor market have focused on the supply side (the supply of female labor), which differs from the supply of male labor in one fundamental aspect: Giving birth induces interruptions in working life or periods in which higher production at home reduces the amount of effort that can be invested at work. The model presented here proposes an alternative approach, focusing on the demand side. Thus, future interruptions lessen the willingness of employers to hire females and, therefore, generate the need for a mechanism to enable females to become more committed to the labor force. This paper proposes two mechanisms. The first is a sufficiently steep wage-tenure profile that, by deferring wages, increases the incentives for females' to stay in the labor force. The second mechanism is the larger amount of schooling obtained by females when compared to males. This amount of schooling raises females' wages and decreases females' incentives to absent themselves from work. The mechanisms differ in a profound way: The first is efficient if one assumes a perfect capital market but is not enforceable ex post; the second is enforceable ex post but inefficient due to over-investment in schooling.

Goldin, Katz, and Kuziemko (2006) find that the share of females at colleges in the United States has been rising since the 1950s. In 2002, among seventeen OECD countries with consistent tertiary enrollment, only two (Turkey and Switzerland) had a higher ratio of male to female undergraduates.

Another prediction made in this paper is that males receive a higher experience premium than do females (Blau and Kahn (1997); Connolly and Gottschalk (2006);

[1] We should note here that tenure measures the period of employment with the current employer and experience measures all past employment.

Gottschalk and Denziger (2003)) whereas females receive a higher tenure premium (Hersch and Reagan (1990) (1994)) as well as a higher schooling premium (Dougherty, 2005; Gronau, 1988). Gottschalk and Danziger (2005) find that between 1979 and 1989, the mean wage rates of college graduates relative to high school graduates increased from 21 to 35 percent for males and from 29 to 45 percent for females.

Bayard, Hellerdtein, Neumark, and Troske (2003) find that although much of the sex gap in wages can be traced to the segregation of females in lower-paying occupations, industries, firms and occupations within firms, a substantial part of the gap can be directly attributable to the individual's gender. Overall, their estimates indicate that approximately half of the sex gap in wages takes the form of wage differences between males and females within narrowly defined occupations within firms.

Bronars and Famularu (1997) find that inclusion of employer fixed effects changes only female returns to education and tenure whereas male returns to education and tenure remain identical across specifications. They also find that a sizable proportion of the male-female wage differential for less educated and experienced workers was due to the concentration of female workers with low wage employers. They conclude that obtaining a job with a high-wage employer is an important aspect of human capital investment for females.

In the first paper to model explanations for the gender wage gap and its effect on the division of labor, Mincer and Polachek (1974) show that investments in the human capital of each family member requires attention not only to the labor he supplies but also to the labor supplied by other members of the family. Hence, one feature differentiating males from females is the interruptions (or expected interruptions) in their careers. Mincer and Polachek (1974) find that married females supply less labor and enjoy lower returns to experience than do both males and single females. Based on the preceding study and on Ben-Porath's (1967) original study of investment in human capital, Weiss and Gronau (1981) analyze the implications of the interaction between labor market participation and wages for the interpretation of observed sex-related differences in earnings.

Another explanation of the gender differences in occupational status centers on presumed differences between the sexes in taste for non-pecuniary job attributes (Filler, 1983). For instance, females who take care for children prefer jobs that allow for more

flexible hours.

Turning to the demand side, Hashimoto (1979, 1981) shows that due to the existence of transaction costs, the firm and the worker both share the costs and benefits of the investment in specific investment, in order to reduce the terminating of the relationship according to the variance of their alternative options. One implication of this model is the following: If females have a higher variance (due to their home production), they enjoy a steeper wage-tenure profile.

Lazear (1979) shows that it is optimal for firms and workers to have a payment scheme that pays workers less than their marginal product when they are young and more than their marginal product when they are old. If the expected tenure within a firm is shorter for females, their wage–tenure profile will be steeper (Hersch and Reagan, 1997).

Traditionally, females have had the main responsibility for the bringing up of children. If employers expect this to continue to be the case in the future, they will place females in jobs that can be combined with child care responsibilities. Given these expectations, the rational choice from a family's perspective is that the male will spend a greater effort in the labor market while the female will exert greater effort in home, caring for the children. Employers' expectations then become self-confirming (Lommerud and Vagstad, 2000, Albanesi and Olivetti, 2006).

The above equilibrium was further discussed as a contract theory problem in Chichilnisky (2006). She analyzes an economy with two distinct institutions: the market and the family and two types of individuals, males and females who are ex ante identical. She shows that if families and firms cannot sign a contract assigning the amount of effort each individual is to exert at home, the economy will reach an inferior solution in which females exert greater effort at home than at the market.

The present model is based on three main assumptions. First, frequent absences reduce the amount of human capital that an individual has acquired. Second, the rate of absenteeism is private information known only to an employee and his employer. The result of these two assumptions is that females' outside employers do not observe the total amount of human capital that individuals have acquired. The third assumption is that employers cannot observe an individual's product (which is a function of his human capital). The asymmetric information regarding this variable result in a moral hazard

problem: It enables employers to pay females a wage that is below their marginal product in later life.

In this paper, we show that due to the private information regarding their human capital, employers offer females steeper wage tenure profiles than they offer males. An increasing wage tenure profile allows the firm to screen potential female employees and hire only those females whose expected rate of absenteeism is low. When employers cannot commit to a rising wage-tenure profile, females choose a positive rate of absenteeism. Females are consequently forced to choose employers who can commit to an increasing wage-tenure profile or accept lower-paying jobs, which results in a segregated labor force.

To obtain a higher-paying job, any female who internalizes the equilibrium described above may acquire schooling above the optimal level (the level chosen by males). Females use this strategy to signal their intention of having a lower rate of absenteeism after giving birth. Employers of females with a higher amount of schooling are willing to bear the fixed cost and hire them. In equilibrium, females are indifferent toward over-investing in schooling and obtain higher-paying jobs or choose a positive rate of absenteeism.

If we relax the assumption of asymmetric information, our model becomes a classic model for the analysis of investment in human capital. We show that if females' market product is higher than their home product, they behave as males. However, we also show that if females' market product is lower than their home product, they withdraw from the market or choose to work part-time. Females who choose to work part time acquire a lower amount of human capital and receive lower wages than males.

The paper's main findings are that, in contrast to previous studies, females acquire a higher amount of schooling than do males or exhibit steeper wage-tenure profiles. Both conclusions stem from the need to signal potential employers that the female agent will have a low rate of absenteeism. Another prediction made by the paper refers to segregation in the labor force. This segregation occurs in two cases: (1) if there are employers who can commit to an increasing wage-tenure profile (even if the profiles are inefficient ex post), females accept jobs with them (government is an example of this kind of employer); (2) females acquire more schooling and become indifferent between the two industries. This means that if the number of employers who can commit to an increasing wage-tenure profile is limited, females are indifferent between over-investment in schooling and joining

the higher-paying industries or joining the lower-paying industries and withdrawing from the labor force after giving birth.

The remainder of the paper is organized as follows: Section 2 describes the model and presents its main results; Section 3 discusses an economy without information asymmetry (in which it is inefficient to invest in the fixed cost associated with hiring a female). Section 4 then discusses the main results and proposes a policy recommendation. Section 5 concludes and suggests further areas of research.

2 The Model

We analyze an economy with two types of agents: males and females. These two types differ in one profound way: Females have a positive home product in the period following giving birth while males do not. The main assumptions of the model are that the acquisition of human capital is decreasing in home hours and that employers cannot observe the product of each individual. The result of these assumptions is that while females' current employers observe their product via their acquisition of human capital, the alternative wage of each female is a function of her expected human capital rather than her own. We investigate the optimal investment in human capital within this economy and show the different incentives to do so facing males versus females.

2.1 The Basic Ingredients

The model presented here analyzes the demand side of an economy that consists of two industries, A and B. Two factors differentiate between the two industries. First, individuals employed in industry A acquire human capital via on-the-job training; hence, they generate higher lifetime product than do individuals employed in industry B having the same amount of schooling. The second difference is a fixed cost, denoted C, associated with hiring a worker in industry A only.

The fixed cost may be conceived as the employer's cost of searching for or training a new employee. We show below that the fixed cost is needed only for the segregation result even though it may be negligible and has no perceived effect on this result.

Time is continuous. We denote the length of each individual's lifetime by T. We assume that home productivity takes the value of 0 prior to t_1, a value of Q between t_1 and t_2, and a value of 0 between t_2 and T. To simplify matters, we assume that for males, $Q = 0$. Furthermore, every individual can choose his or her rate of absenteeism. An individual can choose a positive rate of absenteeism and exert effort both at home and in the market, which implies producing less in the market; or a zero rate of absenteeism and exert effort only in the market. Note that an individual employed in industry A who chooses a zero rate of absenteeism acquires additional human capital. In Subsection (2.4.2) we endogenize t_1, the date of giving birth.

The model's timing is as follows: Each individual can go to school; the duration of schooling is denoted by s. After finishing school, he or she enters either industry B or industry A.

Due to the assumption that males do not have a home product and that individuals who absent themselves from work produce less in the market, all males choose a zero rate of absenteeism.

The assumption regarding a constant Q and a fixed t_2 is made in order to simplify the algebra. Allow us to characterize the value of female's home product and the period in which it is optimal for her to stay at home. Weiss and Gronau (1981) assume that Q decreases with time and, therefore, that females' return to the labor force is determined endogenously. We can modify the model by analyzing a case in which t_2, the date after which the value of the home product equals 0, differs between industry A and B.

We make three main assumptions:

1. Frequent absences reduce the amount of human capital that an individual has acquired.

2. The rate of absenteeism is private information known only to each employee and his current employer.

That is, even if employers can observe whether an individual works part or full time; they cannot observe the rate of absenteeism chosen by each individual. Outside employers cannot observe how many hours each individual works per day and how many times each individual has left early to take care of his children.

3. Following Waldman (1984), we assume that employers cannot observe the product

of each employee. Hence, the alternative wage of each employee equals his expected product.

Alternatively, we can assume that an individual's product is observable after some period. Since we analyze an economy with a finite horizon; we therefore obtain that the alternative wage of each individual equals his expected product at every given period.

As a result of these assumptions, outside employers do not observe the amount of human capital acquired by each individual. We obtain that a male's alternative wage equals his product, whereas the alternative wage of a female who has accumulated additional human capital is below her product. This alternative wage allows a female's current employer to lower her wage, which in turn reduces her incentive to choose a zero rate of absenteeism. This assumption will be relaxed later.

We also make the following additional assumptions:

4. There are no search costs or elements of friction. As a result, the alternative wage of each employee coincides with the highest wage offer he could possibly receive.

5. Individuals maximize the present value of their wage stream over their lifetimes. They plan a lifetime earning and participation path under conditions of certainty, a competitive labor market and a perfect capital market.

6. Courts cannot observe the rate of absenteeism chosen by individuals in previous periods or the amount of human capital acquired by them. Agents consequently cannot commit toward their future actions: Employees cannot commit to their future rate of absenteeism and firms cannot commit to wage levels as a function of the amount of absenteeism chosen by each employee. We later discuss the equilibrium obtained in an economy in which some employers can commit to future wages while other employers cannot (the government serves as an example of the first kind of employer).

7. The maximum lifetime product of an individual employed in industry A is higher than the maximum lifetime product – including home product – of an individual employed in industry B, despite the fixed cost associated with hiring an employee in industry A.

8. There is no depreciation of human capital.

9. There is free entry of firms into the economy; hence, each firm earns zero profits.

Individuals employed full time in industry A (i.e., do not choose a positive rate of absenteeism) acquire additional human capital and produce $\delta_2 e^{gs}$ ($\delta_2 > 1$) following time

t_3. Individuals choosing a positive rate of absenteeism produce less during their periods of absence; they therefore produce $\delta_1 e^{gs}$ ($\delta_1 < 1$) during the period of absenteeism and e^{gs} afterward, where g denotes the marginal product of schooling. The assumption that human capital increases in time t_3 and is constant prior to as well as following that time is a simplifying assumption; we can also solve the model and obtain all its qualitative results without this assumption.

The lifetime output of individuals employed in industry A who work continuously is given by:

$$TP_A(s) = \mathrm{R}e^{sg}\left(\int_s^{t_3} e^{-rt}dt + \delta_2 \int_{t_3}^{T} e^{-rt}dt\right) - C \tag{1}$$

where s denotes the amount of schooling, R denotes the rental rate of a unit of human capital, r denotes the interest rate and g the marginal product of schooling ($g > r$).

The life time output of individuals employed in industry B who do not choose a positive rate of absenteeism is given by:

$$TP_B(s) = \mathrm{R}e^{sg}\int_s^{T} e^{-rt}dt \tag{2}$$

The life time output of individuals employed in industry A who choose a positive rate of absenteeism is given by

$$\mathrm{R}e^{sg}\int_s^{t_1} e^{-rt}dt + (Q + \delta_1 \mathrm{R}e^{sg})\int_{t_1}^{t_2} e^{-rt}dt + \mathrm{R}e^{sg}\int_{t_2}^{T} e^{-rt}dt - C \tag{3}$$

The life time output of individuals employed in industry B who choose a positive rate of absenteeism is given by

$$\mathrm{R}e^{sg_i}\int_s^{t_1} e^{-rt}dt + (Q + \delta_1 \mathrm{R}e^{sg})\int_{t_1}^{t_2} e^{-rt}dt + \mathrm{R}e^{sg}\int_{t_2}^{T} e^{-rt}dt \tag{4}$$

2.2 Equilibrium

We now turn to the characterization of the equilibrium. We start the discussion by analyzing males' wages in both industries and the wages of females employed in industry B. We then discuss the wages of females employed in industry A.

Both males and females enjoy a wage of Re^{sg} in industry B, this being their spot-market wage and their marginal product since there is no information a-symmetry in that industry. In industry A, males enjoy wages of $\frac{e^{sg}\int_s^{t_3} e^{-rt}dt - C}{\int_s^{t_3} e^{-rt}dt}$ prior to t_3, the time in which their product rises due to their increased human capital. Males' wages following t_3 equal $R\delta_2 e^{sg}$, this being both their expected and actual product. As a result, males' lifetime product equals their lifetime wages.

The assumption regarding a competitive labor market is needed in order to generate the incentives which are necessary to produce efficient investments in schooling. Based on this assumption, each worker receives his net productivity despite the fixed cost. In addition, note that any contract that smoothes wages in the training period is both ex post and ex ante efficient, the fixed cost is carried out only once, after which every worker obtains a higher wage than his alternative wage and every firm receives a positive profit; therefore, the contract is self-enforced.

We denote by s_j the amount of schooling chosen by individuals who plan a full working life and receive wages equal to their marginal product. By differentiating equation (1) and (2) with respect to s, we can show that the optimal schooling is given by

$$s_A = T + t_3 + \frac{ln\left(\frac{r-g}{e^{rT}g(\delta_2-1)-e^{rt_3}g\delta_2}\right)}{r} \tag{5}$$

$$s_B = T + \frac{\ln\left(\frac{g-r}{g}\right)}{r} \tag{6}$$

We add the following assumption

$$\delta_2 R e^{s_A g} + Q > R e^{s_A g} \tag{7}$$

As a result of this assumption, the home product of females who acquire the optimal amount of schooling is higher than their market product in the period following giving birth.

We next turn to analyzing wages of females employed in industry A. Note that we assume asymmetric information in every period following t_2. No information asymmetries are observed between t_1, the time of giving birth, and t_2, the period following a female's absence. The new employer of a female who changed employers between t_1 and t_2 can

observe whether she chooses a positive or zero rate of absenteeism during the current period. As a result, such a female's alternative wage during that period (i.e., between t_1 and t_2) equals her product.

Females employed in industry B receive wage Re^{sg}, this being both their spot-market wage and their marginal product. As a result, every female employed in industry B enjoys a lifetime wage which equals to her lifetime product. Due to the private-information assumption–a female's decision to choose a zero or a positive rate of absenteeism is not publicly known–females have the same alternative wage in the period following t_2 whether they acquired additional human capital or not. We denote females' alternative wage in the period following t_2 by $W(s)$.

Using the assumption captured in equation (7) , we obtain that

$$(Q + \delta_1 \mathrm{Re}^{s_A g}) \int_{t_1}^{t_2} e^{-rt} dt + W(s) \int_{t_2}^{T} e^{-rt} dt > \mathrm{Re}^{s_A g} \int_{t_1}^{t_2} e^{-rt} dt + W(s) \int_{t_2}^{T} e^{-rt} dt \quad (8)$$

The LHS of equation (8) represents the lifetime wage stream of a female who chooses a positive rate of absenteeism starting period t_1. The RHS represents the lifetime wage stream of a female who chooses a zero rate of absenteeism.

Therefore, even though females generate a larger total product during the rest of their working life outside the home than the product they would have produced at home, it is not sufficiently high for females not to choose a positive rate of absenteeism after she gives birth due to the assumed private information regarding their acquisition of additional human capital. Given this assumption, there is no efficient ex post contract and, for this reason, no self enforcing contract that can generate the incentives necessary to induce females to invest in s_A, the optimal amount of human capital. Note that when the inequality (8) is reversed, the economy can generate the sufficient incentives to induce both types of agents (males and females) to choose industry A.

It follows that females who acquire s_A and employed in industry A will have a higher lifetime wage if they choose a positive rate of absenteeism than if they choose a zero rate of absenteeism. This result stems from their anticipated future wage. Females have the same alternative wage following t_2 irrespective of whether they choose a positive or a zero rate of absenteeism. Hence, all females will choose a positive rate of absenteeism and their alternative wage in the period following t_2 $W(s)$ will be Re^{sg}.

Females who plan to join either industry A or B and choose a positive rate of absenteeism maximize

$$\mathrm{Re}^{sg}\int_{s}^{t_1} e^{-rt}dt + (Q+\delta_1\,\mathrm{Re}^{sg})\int_{t_1}^{t_2} e^{-rt}dt + \mathrm{Re}^{sg}\int_{t_2}^{T} e^{-rt}dt \tag{9}$$

We denote by s_w the solution to equation (9). Differentiating equation (9) with respect to s, one can show that

$$s_w = T + t_1 - t_2 + \frac{Ln\left(\frac{g-r}{g\left(e^{r(t_1+t_2)}+\left(e^{r(T+t_1)}-e^{r(T+t_2)}\right)(\delta_1-1)\right)}\right)}{r} \tag{10}$$

One can show that

$$TP_A\left(s_w\right) < TP_B\left(s_B\right) < TP_B\left(s_w\right) < TP_A\left(s_A\right) \tag{11}$$

The last inequalities are obtained from assumption (7), whereas the first inequality stems from the fixed cost of hiring an employee in industry A.

Intuitively, the highest lifetime product is produced by an employee who works continuously in industry A. The lowest lifetime product is produce by an individual who is employed in industry A and chooses a positive rate of absenteeism does not acquire additional human capital and has a product lower than an individual employed in industry B due to the fixed cost.

Due to the inequality captured in Equation (11), if a female cannot receive a wage equal to her product in industry A, she enters industry B at the beginning of her working life.

Note that in the absence of asymmetric information, we obtain an efficient solution. Under the assumption that females' lifetime product is higher when they choose a zero rate of absenteeism, all females will choose the optimal amount of schooling, a zero rate of absenteeism and join industry A.

We can conclude:

Conclusion 1: Males enjoy a rising wage-experience profile while females have a constant wage-experience profile.

Conclusion 2: When the firm can commit to the entire wage contract, it chooses a rising wage-tenure profile for females in order to recruit them.

Note that tenure measures the period of employment in the current firm while experience measure all previous employment.

Conclusion 3: When the firm cannot commit to the entire wage contract, the labor market is segregated; this is, females choose industry B and males choose industry A.

The intuition behind the first and second conclusion is the following: All males choose a zero rate of absenteeism; hence, because there is no private information regarding the amount of human capital acquired by each male, males enjoy an increasing wage experience profile. Due to their positive home product, females cannot signal whether they acquired additional human capital after giving birth to external employers. This inability encourages females not to acquire additional human capital. The equilibrium is characterized by males employed in industry A and females employed in either industry B or in industry A with employers who can commit to a rising wage-tenure profile. In Section (2.3) we discuss the assignment of females to different firms and industries.

We obtain that a female employed in a firm that can commit to the entire wage tenure profile receives a wage equals to her lifetime product. However, the lifetime wage of a female who chose industry A and a zero rate of absenteeism in a firm that cannot commit to the entire wage tenure profile falls below her lifetime product.

Note that the force that generates these results is the assumption captured in equation (8), an assumption that can be maintained regardless of the fixed cost. Due to this assumption, firms must offer increasing wage-tenure profiles.

For example, let us assume that $C = 0$; in this case, all females choose to be absent; as a result, they join industry B. Males enjoy an increasing wage-experience profile while females, employed in firms that can commit to future wages, enjoy an increasing wage-tenure profile. This result is obtained even when the firm can choose C without treating it as exogenous. The only result requiring a positive fixed cost is that of a segregated labor force.

In equilibrium, it cannot be that firms pay females a wage of $Q+\delta_1 \mathrm{Re}^{sg}$ following birth and females choose a zero rate of absenteeism. Females who receive a wage sufficiently high in that period have lower incentives to choose a zero rate of absenteeism. If firms and females choose these strategies, females work full time and acquire additional human capital. Females' alternative wage in the period following t_2 is lower than their product;

their current employer can thus decrease their wage during that period and, by doing so, receive all the rent. However, these strategies cannot be an equilibrium. Firms cannot commit to paying females a large wage at period t_2 whereas females can demand a higher wage in the period immediately prior to t_2 in order to support their choice of a zero rate of absenteeism during that period.

2.3 Schooling as a signaling device

In this section, we assume that firms can only commit to a contract that can be enforced ex post. Therefore, in the setup described above, employers lack a mechanism enabling commitment to a wage profile that induces females not to choose a positive rate of absenteeism in the period after they give birth. Firms and females internalize this outcome and the economy forces females into industry B. To overcome this inefficient scenario, females need to increase their future productivity in order to raise the cost of their absenteeism.

The model suggests another way of increasing future wages. By choosing to increase their schooling, females increase their future productivity and, in turn, their future wages. As a result, their cost of absenteeism rises. Their higher future productivity allows employers to design a contract that is efficient ex post and hence self-enforced, thus allowing them to hire females for industry A. Females who over-invest in schooling generate a higher lifetime product in industry A than in industry B and, as a result, enjoy a higher lifetime wage.

To generate a contract that is enforceable, Females need to acquire the amount of schooling that makes them indifferent toward absence or working continuously in the period following giving birth. Note that this amount of schooling is larger than the optimal amount of schooling, as chosen by males. Therefore, females choose s^{com} such that

$$Q + \delta_1 \operatorname{Re}^{s_{com}g} = \operatorname{Re}^{s_{com}g} \tag{12}$$

Using equation (12) One can show that

$$e^{s^{com}g} = \frac{Q}{R\left(1-\delta_1\right)} \tag{13}$$

This amount of schooling (the amount needed by females to increase their future productivity) provides females with an incentive to work continuously after giving birth.

As a result, employers are willing to recruit females into industry A and to bear the fixed cost.

We denote

$$TP_A\left(s^{com}\right) - TP_B\left(s_B\right) \equiv \pi \tag{14}$$

where π represents the difference in lifetime productivity between the two industries. Note that because $s^{com} > s_A$, π is not necessarily positive.

Comclusion 4: When $\pi > 0$ ($\pi < 0$) females choose an amount of schooling of s^{com} (s_B) and join industry A (B)

Proof. Using equations (14) and (12). ■

When $\pi > 0$, this amount of schooling generates a surplus that allows females to commit to not choosing a positive rate of absenteeism and exert effort only in the market after giving birth.

conclusion 5: Males' lifetime product is higher then females' lifetime product.

Proof. Using equation (12) ■

Intuitively, females maximize their productivity under restrictions while males do so absent any restrictions.

There is an obvious inefficiency stemming from Conclusion (5): Females choose larger amount of schooling, thereby decreasing their lifetime productivity in order to generate higher productivity later in life. This inefficiency reduces females' lifetime wage.

What mechanisms assign females to different industries? Two such mechanisms exist. The first is random: If the number of firms that can commit to a rising wage-tenure profile is limited, reducing the rental rate of a unit of human capital (R) cannot alter this amount. The ability of a firm to commit toward a future wage is not a fuction of the current wage. Even though changing wages cannot generate more jobs to which firms can commit, the firm can reduce wages in these kinds of jobs, making them less appealing to males. Bullow and Summers (1986) apply such a mechanism.

Orazem and Mattila (1998) find a higher percentage of females employed in government jobs. Conclusion (2) predicts that females who do invest in schooling would rather be employed by firms that can commit to the entire wage contract. Assuming that it is easier for government than for competitive firms to commit, females would rather take

a government job. Previous papers have explained why females tend to be employed in government jobs by analyzing the different job characteristics generally associated with those jobs, such as more flexible hours (Filler, 1983), cannot explain females' behavior in government jobs in fields such as nursing.

Becker and Lindsay (1994) as well as Bronars and Famularu (1997) find that females' return to tenure differs across private employers as well; they show that only some private employers pay females a higher tenure premium than males.

The above mechanism entails a limit to the number of females that acquire schooling. This limit can be reached by adjusting for the fixed number of females who attend school (for example, the government may hire a fixed number of teachers each period, with this number equal to the number of females who acquire schooling). Otherwise, only females who obtain a job with an employer who can commit will acquire the optimal amount of schooling.

The second mechanism that assigns females into different industries is heterogeneity among females. One way to extend our model is by introducing heterogeneity into ability and concluding that different ability thresholds are needed for members of each gender employed in industry A ; this kind of mechanism appears in Lazear and Rosen (1990).

In the absence of heterogeneity, we obtain:

Conclusion 6: The model has three equilibria

Equilibrium 1: – Females are indifferent toward over-investment in schooling and employment in industry A or being employed in industry B.

Equilibrium 2: – Males employed in industry A and females employed in industry B.

Equilibrium 3: – Males and females are employed in industry A

In the first equilibrium, Females are indifferent between over-investment in schooling and joining the higher-paying industries or joining the lower-paying industries. In this equilibrium, R is determined in such a way that females are indifferent between the two industries. The parameters that make females indifferent between the two industries satisfy the following:

$$R = \frac{Q\int_{t_1}^{t_2} e^{-rt} + C}{e^{s^{com}g}\int_{s^{com}}^{s^{com}+t_3} e^{-rt} + \delta_2 e^{s^{com}g}\int_{s^{com}+t_3}^{T} e^{-rt} - e^{s_B g}\int_{s_B}^{T} e^{-rt}} \tag{15}$$

where s_B is given by the equation (10)

The price of human capital in this equilibrium is R; the amount of schooling chosen by females who join industry A is s^{com}, which is jointly determined by equations (13) and (15). The last two equilibria are characterized by males employed in industry A and females employed in either industry A or B. In these equilibria, R is exogenous and provided by a general equilibrium framework.

Comclusion 7: An increase in T (an agent's lifetime) or in g (the marginal product of schooling) while keeping t_1 and t_2 constants, decreases both R and s^{com} while increases s_A. An increase in Q causes s^{com} to increase.

Proof. Differencing equation (15) with respect to T, g and Q and using equation (13). ■

Intuitively, s_A is the result of the maximization of an individual's lifetime product; hence, an increase in T or g results in an increase in s_A. However, as long as $s^{com} > s_A$, s^{com}, is the minimum amount of schooling that allows females to commit to a zero rate of absenteeism. We obtain that, an increase in g or T or raises the cost of choosing a positive rate of absenteeism. Therefore, it allows females to commit to a zero rate of absenteeism after acquiring less schooling.

2.4 Extensions

We turn to an extension of the model by analyzing adverse selection among females; we assume that females differ in their home product and that their home product is not publicly known. We also endogenize t_1, the time of giving birth.

2.4.1 Adverse Selection Among Females

This setup allows us to analyze the adverse selection problem, that is, the case where females have private information regarding their home productivity in addition to the chosen rate of absenteeism.

We assume that

$$Q \in (Q_L, Q_H) \tag{16}$$

This economy consists of two cases, which we analyze separately.

The first case is the following:

$$\begin{aligned} & Re^{s_A g}\left(\int_s^{t_3} e^{-rt}dt + \delta_2 \int_{t_3}^{T} e^{-rt}dt\right) \\ > \;& \mathrm{Re}^{s_A g}\int_s^{t_1} e^{-rt}dt + (Q_L + \delta_1)\int_{t_1}^{t_2} e^{-rt}dt + \delta_2 \,\mathrm{Re}^{s_A g}\int_{t_3}^{t_1} e^{-rt}dt \end{aligned} \tag{17}$$

$$\begin{aligned} & Re^{s_A g}\left(\int_s^{t_3} e^{-rt}dt + \delta_2 e^{s^{sig} g}\int_{t_3}^{T} e^{-rt}dt\right) \\ < \;& \mathrm{Re}^{s_A g}\int_s^{t_1} e^{-rt}dt + (Q_H + \delta_1 \,\mathrm{Re}^{s_A g})\int_{t_1}^{t_2} e^{-rt}dt + \delta_2 \,\mathrm{Re}^{s_A g}\int_{t_3}^{t_1} e^{-rt}dt \end{aligned} \tag{18}$$

Conclusion 8: If equations (17) and (18) hold, then a female with productivity at home equal to Q_L invests s_A in schooling and joins industry A; a female with productivity at home equal to Q_H invests s_B in schooling and joins industry B.

Proof. Using equations (17) and (18) ■

Alternatively, if equations (17) and (18) do not hold and s^{sig} is such that $e^{s^{sig} g} = \frac{C_H}{R(1-\delta_1)}$ the following inequality holds:

$$\begin{aligned} & Re^{s^{sig} g}\left(\int_s^{t_3} e^{-rt}dt + \delta_2 e^{s^{sig} g}\int_{t_3}^{T} e^{-rt}dt\right) \\ > \;& \mathrm{Re}^{s^{sig} g}\int_s^{t_1} e^{-rt}dt + \left(C_L + \delta_1 \,\mathrm{Re}^{s^{sig} g}\right)\int_{t_1}^{t_2} e^{-rt}dt + \delta_2 \,\mathrm{Re}^{s^{sig} g}\int_{t_3}^{t_1} e^{-rt}dt \end{aligned} \tag{19}$$

We then obtain the following:

Conclusion 9: Females with $Q = Q_L$ invest s^{sig} and join occupation A, while females with $C = C_H$ invest s_B and join occupation B.

Proof. Using equation (19) . ■

In this setup there is no need for signaling. Females with $Q = Q_H$ invest s_B and withdraw from the labor force in the period following t_1.

2.4.2 Endogenous the Time of Giving Birth

One of the basic premises of the model is that the date of giving birth is exogenous. The present model allows us to treat the time of giving birth as endogenous. We assume that females can postpone the time of giving birth (by controlling the time of conception) and by doing so signal their intention of working full time at the beginning of their working lives. We assume that both kinds of employers (current and external) can observe the time when females give birth.

We use O to denote the disutility of postponing the date of giving birth from t_1 to $s+t_3$; hence, O represents the monetary equivalent to the utility lost from postponement of giving birth.

Conclusion 10: Females postpone their date of giving birth to $s+t_3$ and behave like males (they do not postpone the date of giving birth to $s+t_3$) when $O < TP_A(s_A) - TP_B(s_B)$ $(O > TP_A(s_A) - TP_B(s_B))$.

Intuitively, if females give birth at the end of their occupational training period, there is no private information; females have acquired the additional human capital and there is no need to signal this fact to external employers. Recall that the a-symmetric information assumption holds only regarding the acquisition of human capital. Hence, following t_3, the time of the acquisition of additional human capital, no a-symmetry remains. Neither females nor employers have an incentive problem in this scenario. As a result, females can commit to the date of giving birth.

3 Choice of effort

In this section we analyze an economy in which the cost to females of exerting an effort at the start of their working life is higher than the cost to males. The main result of this section is that employers who internalize the said would prefer to hire males as their interns. This decision increases males' human capital via improved training. As a result, males generate a greater lifetime product and, in turn, receive higher wages.

In the standard analysis of human capital acquisition, investments are made at decreasing rates. Thus, in models containing different jobs that provide different quantities

or qualities of training, the training that individuals receive early in their working lives is crucial for obtaining a higher lifetime wage. Individuals who cannot be employed at a job that provides training have fewer incentives to acquire human capital earlier. Employers of individuals who can withdraw from the labor force later internalize employees' lower incentives for acquiring human capital and, as a result, are unwilling to train and invest in them.

In this section we assume that every individual who is employed in industry A can join a training program (or take an internship) for a fixed duration t_3. During the training, an individual who exerts an effort of 1(0) produces $p\,\mathrm{Re}^{sg}$ ($q\,\mathrm{Re}^{sg}$) ($1 > p > q$). After the program's completion, an individual who exerted an effort of 1 (0) produces pwe^{sg} (qwe^{sg}) ($w > \delta_2$) for the rest of his or her working life.

Hence, an individual who plans to join the training program and exert an effort of 1(0) produces

$$p\left(e^{gs}\int_{s}^{s+t_3} e^{-rt}dt + we^{gs}\int_{s+t_3}^{T} e^{-rt}dt\right) - C \tag{20}$$

$$q\left(e^{gs}\int_{s}^{s+t_3} e^{-rt}dt + we^{gs}\int_{s+t_3}^{T} e^{-rt}dt\right) - C \tag{21}$$

where s denotes the amount of schooling.

By differencing equation (20) with respect to s, one can show that the optimal s, denoted by $s_{tr}(e)$, is obtained by

$$\begin{aligned} 0 = &-(1-p)\,e^{s_{tr}g+r(s+t_3)} + \frac{e^{gs-r(s+T+t_3)}\left(e^{rT}-e^{r(s+t_3)}\right)(1-p)(g-r)}{r} + \\ &p\left(\frac{e^{gs-r(s+t_3)}\left(e^{rt_3}-1\right)(g-r)}{r} - we^{gs+r(s+t_3)-r(s+T+t_3)} + \frac{we^{gs_{tr}-r(s+T+t_3)}\left(e^{rT}-e^{r(s+t_3)}(g-r)\right)}{r}\right) \end{aligned} \tag{22}$$

We use $TP_{tr}(s_{tr}, e)$ to denote the lifetime product of an individual who join the training program. $e \in (0,1)$ denotes whether the individual will exert an effort (1) or, alternatively, will not exert an effort (0). We denote the disutility of males' efforts by by $V_m(k)$ and females' efforts by $V_f(k)$, $k \in (0,1)$.

We add the following assumptions:

$$V_m(0) = V_f(0) < V_m(1) < V_f(1) \tag{23}$$

$$TP_{tr}(s_{tr},1)-V_f(1)<TP_A(s_A)<TP_{tr}(s_{tr},1)-V_m(1) \tag{24}$$

The first equation captures the assumption that females incur higher costs for exerting effort due to their childcare cost. The second equation captures two main assumptions, i.e., it is inefficient for the economy to generate incentives to encourage females to exert effort in training programs and males generate a larger product if they participate in training programs than if they do not. The result of these assumptions is that males always participate in training programs.

We denote

$$V_m(0)=V_f(0)=V(0)$$

Conclusion 11: When $TP_{tr}(s_{tr},0)-V(0)<TP_A(s_A)$, males participate in training program, exert an effort of 1 as well as receive a wage of $\frac{pe^{gs}\int_0^{t3}e^{-rt}dt-C_{tr}}{\int_0^{t3}e^{-rt}dt}$ during the training period and a wage of pwe^{gs}, following the training period. Due to their lower product while participating in the training program, females do not enroll in such programs.

Conclusion 12: When $TP_{tr}(s_{tr},0)-V(0)>TP_{tr}(s_{tr},1)-V_m(1)$, males and females participate in training programs, do not exert an effort as well as receive a wage of $\frac{qe^{gs}\int_0^{t3}e^{-rt}dt-C_{tr}}{\int_0^{t3}e^{-rt}dt}$ during the training period and a wage of qwe^{gs}, following the training period.

Conclusion 13: When $TP_{tr}(s_{tr},1)-V(1)>TP_{tr}(s_{tr},0)-V(0)>TP_A(s_A)$, males and females participate in training programs. Males exert an effort of 1; females do not exert an effort. Males thus receive a wage of $\frac{pe^{gs}\int_0^{t3}e^{-rt}dt-C_{tr}}{\int_0^{t3}e^{-rt}dt}$ whereas females receive $\frac{qe^{gs}\int_0^{t3}e^{-rt}dt-C_{tr}}{\int_0^{t3}e^{-rt}dt}$ during the training period. After the training period, males receive a wage of pwe^{gs} and females receive a wage of qwe^{gs}.

Proof. Straightforward, using equations (23) and (24). ■

In the economy analyzed here, we assume that there are parameter limits within which it is inefficient for employers to incur the fixed cost associated with hiring females. Based on this assumption, females have lower incentives to invest in human capital. This section also offered an intuition for an economy in which employees do not choose whether to exhibit a positive rate of absenteeism but do choose the rate of absenteeism. Under

this setup, one may view 0 as the optimal effort for females and a rate 1 as the optimal rate for males.

4 Discussion

The model presented here proposes a new approach to analyzing the gender wage gap. It shows that when firms cannot commit to the entire wage-tenure profile, they cannot produce a contract capable of retain females working full time after they give birth. Notably, under the assumption of a perfect capital market in which firms can commit to the entire wage contract, the outcome is Pareto optimal and females acquire the optimal amount of human capital.

In economies in which firms cannot commit to the entire wage-tenure profile, the outcome is no longer efficient. Females over-invest in schooling in order to convince potential employers to hire them, that is, high investments in schooling signal their commitment to low rate of absenteeism after giving birth. In other words, if firms lack a commitment mechanism, the economy cannot opt for the first-best solution and must shift to the second-best one. This solution is characterized by over-investment in human capital by females and thus facilitates inefficient commitment mechanisms.

Note that in the absence of asymmetric information, we obtain the following: If for the optimal amount of schooling females' home product subsequent to giving birth is above their market product, there is no need for signaling. All females will then choose the optimal amount of schooling, a zero rate of absenteeism and enter industry A.

Another result of this paper is that as long as the parameters are such that females' market product after giving birth is lower than their home product, females will exhibit a steeper wage-tenure profile than will males. Furthermore, as long as firms cannot commit to the entire wage contract, females will choose to acquire more schooling than will males. This results in inefficiency and lower females' lifetime product and wage. Females invest in acquiring human capital and enjoy a tenure (or experience) wage profile similar to males when the value of their home product (Q) is lower than their market product at t_1. Note that Q may be a function of g as well (via the spouse's wage).

The main policy device that may enhance females' attachment to the labor force and

encourage them to acquire the optimal amount of schooling is one that permits firms or workers to commit to long-term employment contracts. Even if this mechanism is inefficient ex post, one way to introduce such a mechanism is to encourage unions in female-dominated sectors; another way is to lower mother's income tax rate. Still another mechanism involves subsidies to daycare, especially daycare provided by the mothers' firms, a method that lowers Q while increasing females' attachment to their employers. A third way is to raise females' retirement age. Subsidization of schooling acquired by females is another device to increase females' commitment to choose a zero rate of absenteeism. By decreasing the cost of schooling females can increase their future wage and hence the cost of choosing a positive rate of absenteeism. These mechanisms generate a Pareto improvement that enhances females' utility as well as firms' profits.

5 Conclusion

This paper conveyed the main points of a different approach to the analysis of the gender gap. The model presented compares employers' incentives for hiring females with their incentives for hiring males. This approach elicits new insights into females' incentives for choosing occupations and levels of schooling. We show that when employers cannot commit to a wage structure that is not efficient ex post, employers face a moral hazard problem that results in segregated labor markets. To counter segregation, females overinvest in schooling and thereby signal their intention of low rates of absenteeism.

From a theoretical point of view, this setup yields a principal-agent problem under conditions of asymmetric information, a situation where agents can increase their investments in an observable variable in order to signal their intentions to invest in an unobservable variable. Another example of this kind of investment is a retailer who makes a large investment in a new store in order to signal to her supplier her intentions of investing in unobserved variables such as better employees in the future.

The difference between males' and females' wages is a well-documented empirical observation, valid across countries and periods of time. Other evidence shows that females have a steeper wage-tenure profile than do males and enjoy higher schooling premiums. This paper argues that this steeper wage profile may also serve as a signaling device to

potential employers regarding female employees' expected rate of absenteeism.

The main empirical prediction of our model, and subject for future research, is that the more schooling a female acquires, the higher her return to experience. Other promising directions for further research is the augmentation of the model with additional abilities and the identification of the different amounts of acquired by individuals as a function of both their abilities and their gender.

6 References

Bayard Kimberly. Hellerstein Judith. Neumark David. and Troske Kenneth. (2003) "New Evidence on Sex Segregation and Sex Differences in Wages from Matched Employee-Employer Data" Journal of Labor Economics, 21, 887-922.

Becker Elizabeth. and Lindsay Cotton M. (1994) "Sex Differences in Tenure Profiles: Effects of Shared Firm Specific Investment" Journal of Labor Economics, 12, 98-118.

Ben-Porath, Yoram. (1967) "The Production of Human Capital and the Life Cycle of Earnings" Journal of Political Economy, 75, 352-378

Blau Francine.D. and Lawrence Kahn, M. (1997) "Swimming upstream: Trends in the Gender Wage Differential in the 1980s" Journal of Labor Economics 15, 1-42

Bronars, Stephen G. and Famulari Melissa (1997). "Wage Tenure and Wage Growth Variation Within and across Establishments" Journal of Labor Economics, 15, 285-317

Bulow, Jeremy I. and Summers Lawrence H. (1986) "A Theory of Dual Markets with Application to Industrial Policy, Discrimination, and Keynesian Unemployment", Journal of Labor Economics, 4, 376-414.

Connolly Helen and Gottschalk Peter (2006) Differences in Wage Growth by Education level Do Less Educated Workers Gain Less from Work Experience?" Working paper Boston College.

Chichilinisky, Graciela. (2006). "The Gender Gap", Columbia University.

Dougherty, Christopher. (2005) "Why is the return to schooling Higher for Women than for Men?" Journal of Human Resources, 40, 969-988.

Filer, Randall. (1983) "Sexual Differnces in Earnings: The Role of individual Personalities and Testes" Journal of human Resources, 18, 87-99.

Goldin Claudia, Lawrence F. Katz and Kuziemko, Ikyana. (2006) "The Homecoming of American College Women: The Reserval of the College Gender Gap" Journal of Economic Perspectives, 20, 133-156.

Gottschalk, Peter. and Danziger, Sheldon. (2003) "Wage Inequality, Earnings Inequality snd Poverty in the U.S. Over the Last Quarter of the Twentieth Century." Boston College Working Papers in economics No. 560.

Gottschalk, Peter. and Danziger, Sheldon. (2005) "Inequality of wages, Earnings, and Family income: 1975-2002" Review of income and Wealth,51, 231-254.

Gronau, Reuben. (1988) "Sex-related wage differentials and females's Interrupted Labor Careers-the Chicken or the Egg" Journal of Labor Economics, 6, 277-301.

Hashimoto, Masanori (1979) "Bonus Payment, On-The-Job Training, and Life-time Employment in Japan" The Journal of Political Economy, 87, 1086-1104.

Hashimoto, Masanori (1981) "Firm-Specific Human Capital as a Shared Investment" American Economic Review, 71, 475-482.

Hersch Joni. and Reagan Patricia B. (1997) "Worker Effort Decisions and Efficient Gender-Specific Wage Tenure Profiles", Economic Equiry, 35, 193-207.

Lazear Edward.P (1979) "Why is There Mandatory Retirement?" Journal of Political Economy, 87, 1261-1284.

Lazear Edward.P. and Rosen Sherwin. (1990) "Male-Female Wage Differentials in Job Ladders" Journal of Labor Economics, 8, 106-123.

Lommerud Kjell Erik. and Vagstad Steinar. (2000) "Mommy Tracks and Public Policy: on Self Fulfilling Prophecies and Gender Gaps in Promotion" CEPR Discussion Paper No. 2378.

Mincre, Jacob and Polachek, Solomon (1974) "Family investment in Human Capital: Earnings of Women" Journal of Political Economy, 82, 76-108

Orazen Peter.F. and Mattila Peter.J. (1998) "Male-Female Supply to state Goverment Jobs and Comparable Worth" Journal of Labor Economics, 16, 95-121.

Stefania Albanesi and Claudia Olivetti (2006) "Home Production, Market Production and the Gender Wage Gap: Incentives and Expectations" NBER WP12212.

Waldman, Michael. (1984) "Job Assignments, Signaling, and Efficiency" Rand Journal of Economics, 15, 255-267.

Weiss Yoram. and Gronau Reuben. (1981) "Expected Interruptions in Labor Force Participation and Sex-Related Differences in Earning Growth" Review of Economics Studies, 48, 607-619.