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Employee Investment and Screening based on Labor Force Attachment

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Abstract

This paper studies firms' employee investment decisions based on labor force attachment under a screening model. We first characterize the conditions for pooling/separating equilibria and analyze the associated inefficiency. We find that strengthening the worker's labor force attachment does not always improve social welfare because it may lead to over-investment. The implications help us better understand the contributing factors to the gender wage gap since average job turnover rate is higher among women than men.

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1 Introduction

Screening based on employment attachment is prevalent in the labor market. For instance, seasonal workers in logging are often offered a contract that requires workers to pay the cost of transportation (e.g. helicopter) if a worker quits a job in the middle of the contracted term. Investment bankers often receive a one-time signing bonus that must be returned if they leave the firm before the end of the training period (e.g. 6 months). Other potential examples include payback for sabbatical for professors and payback to firms that pay for employee MBAs. These practices share one feature: employers, who cannot discern each individual's level of employment attachment, offer wage contracts to avoid wasting employee investment or hiring costs.

Despite the common practice, little is known about how screening works and the government policy affects market efficiency in the context of wage contracts. Inefficiency in our understanding is misallocation of investment resources, which happens when workers receive investment whose costs exceed the returns. Such inefficiency could arise when there is information asymmetry and uncertainty in voluntary employee turnover; workers whose investment costs exceed the returns in the first-best scenario (with perfect information) end up receiving investment in order to separate from other workers who are more likely to withdraw. This paper contributes to the literature by applying a screening model to wage contracts and studying investment inefficiency in the labor market while incorporating dynamics. Unlike the insurance market, dynamic features of the contracts matter more when the screening is used to distinguish workers with differing levels of employment attachment. We capture such dynamics by modelling employee investment whose return occurs over time into a screening model. Analyzing the screening model is challenging because the equilibrium may not exist. To tackle this issue, we adopt the equilibrium concept from Manove et al. (2001) by defining the equilibrium as a competitive one. The model characterizes the cases in which social inefficiency associated with over-investment arises. Using the framework, we illustrate how government policies can provoke unintended effects that may magnify investment inefficiency.

Specifically, we consider a model in which workers differ in their attachment to the labor market (e.g. a worker's intention to stay in the labor force) and firms cannot discern varying levels of attachment among workers. The setup of the screening model is motivated by the Japanese labor market for female workers. As documented in Tsutsui (2019), Japanese firms let job applicants select one of two courses that predetermine a worker's career path: Sogo-shoku (career course) associated with greater training and significant wage growth and Ippan-shoku (non-career course) with less demanding tasks and little wage growth. After choosing a course, workers are rarely allowed to switch courses. The non-career course attracts almost no men, consisting predominantly of women who plan to leave the labor market upon marriage or motherhood. This is an example of screening in which firms attempt to distinguish differences in workers' labor force attachment.[1] In particular, individual attachment matters to firms deciding whether to invest in their workers. Employee investment, which can be interpreted as firm-sponsored on-the-job training, increases the worker's productivity in the later period. Firms pay the hiring and investment costs up front, but some workers leave the labor force (and the firm) before firms retrieve their return on investment. In our model, a screening takes the form of deferred wage payment. We characterize the conditions for a separating or pooling equilibrium, and the associated deferred payment, investment, and inefficiency.

The findings provide several interesting implications. As such, while the model is tailored to the Japanese female labor market, the implications can be applied to a more general context where firms screen workers' labor force attachment. First, our results indicate the possibility that workers over-invest in their work-related skills in order to reveal their labor force attachment. Our analysis furthers the discussion on over/under-investment of firm-sponsored training (e.g Lazear (2009)). Second, the model implies that initial wages are lower for an individual who belongs to the heterogeneous group, mixed with workers with weaker attachment (e.g. women) than for someone who belongs to the group of homogeneous workers (e.g. men), other things being equal. Such predictions are consistent with the empirical findings that the gender wage gap in the U.S. labor market narrows for workers who continue working without career disruption (Gayle and Golan (2012)).

2 The Competitive Screening Model

The framework modifies the screening model as in Rothschild and Stiglitz (1976) in order to analyze the wage mechanism when the level of individual attachment is not directly observable to his/her employers.

Consider a perfectly competitive labor market where there is a continuum of workers and firms. The price of output is normalized to 1. Risk-neutral workers are endowed with human capital $H(i)$, where $i \in \{0, 1\}$ represents the investment decision from the firm. The worker produces $H(i)$ if she stays with the firm. Each worker is one of two types, C (career-type) or F (family-type), who are presented in the economy with proportions μ and $1 - \mu$. Let p_j be the staying probability of a j-type worker. C-type workers have a higher probability of staying with the firm than F-type workers; i.e. $p_C > p_F$. Worker type is private information, only known to workers. Workers

[1] This system aims at screening employees based on attachment to the firm rather than ability. In fact, the non-career course attracts almost no men, consisting predominantly of women who plan to leave the labor market upon marriage or motherhood. After choosing a course, workers are rarely allowed to switch courses.

have an outside option that is valued at zero; they participate in the labor force if their expected payoff is non-negative.

Firms are risk-neutral profit maximizers endowed with employee investment technology. Firms know the values of all model parameters, but they do not directly observe worker type. Hiring a worker incurs cost Z. Investment takes place with a cost of I per worker, and in return increases the worker's productivity from $H(0)$ to $H(1)$. Firms pay the cost (I and Z) up front, but the worker will produce outputs only if she stays.

Firms offer two kinds of wage contracts to workers: contracts with and without investment.[2] A contract without investment is specified by wage (w), while a contract with investment contains the wage and the amount of deferred payment (w, d) with $d \geq 0$: the worker leaves d as the bond to the firm, and she will recover it if she stays. Workers can apply to one firm and the commitment is assumed. For simplicity, we use (w, d) to stand for both kinds of wage contracts. Based on the worker's choice of contract, the firm infers the probability that she will stay, which is denoted as p.

For each wage contract (w, d), we denote the corresponding contract outcome as (w, d, i, p), which describes the response to the offered contract. Let U_j be the expected utility of a j-type worker from a contract (w, d). The utility is denoted as:

$$U_j = \begin{cases} p_j w & \text{for } i = 0 \\ -d + p_j(w + d) & \text{for } i = 1. \end{cases}$$

Let Π be the expected profits for a firm from a contract outcome (w, d, i, p), which is given by:

$$\Pi = \begin{cases} -Z + p(H(0) - w) & \text{for } i = 0 \\ -Z - I + d + p(H(1) - w - d) & \text{for } i = 1. \end{cases} \tag{1}$$

The timing of events is as follows:

(i) Each firm offers a set of wage contracts (w, d).

(ii) Each worker chooses a firm with the contract (w, d).

(iii) With (w, d), a firm decides whether to invest in the worker.

(iv) Worker j stays with probability p_j. Only if they stay, they produce outputs and receive the payment of $w + d$.

A *competitive labor-market equilibrium* is a set of contract $\Omega = (w, d, i, p)$ such that the following conditions hold:

E1: *No exit.* Each contract in Ω yields non-negative profits to the firms.

[2] Screening similar to this setup is actually implemented in Japan, where statistical discrimination is considered serious. In Japan, two job-courses exist that screen female workers with their future work intentions: career course and non-career course.

E2: *Profit maximization.* For each contract (w, d, i, p) in Ω, the firm's investment decision i is profit maximizing.

E3: *Participation constraint.* Each contract yields at least the value of the outside option to the workers.

E4: *Utility maximization.* Each worker chooses a wage contract such that it maximizes his expected utility among all contracts in Ω.

E5: *No entry.* There is no *viable entrant* that can attract workers from the wage contracts in Ω. We define a wage contract $(w, d, i, p) \notin \Omega$ as a *viable entrant* if it satisfies the following properties:
(i) (w, d, i, p) earns a firm non-negative profits.
(ii) (w, d, i, p) provides at least one worker with a strictly higher expected utility than does every wage contract in Ω.
(iii) p is consistent with the workers' decision in E5 (ii).

3 Equilibrium Characterization

In this section, we characterize the conditions for pooling/separating equilibria in a competitive labor market and illustrate the case in which deferred payment leads to an inefficient investment. Throughout the article, efficiency is defined in terms of the classical utilitarianism.

The benchmark case with complete information. We first consider the case with complete information. The profit-maximizing firms invest in a worker when the benefit of investment exceeds its cost. Define:

$$\bar{I} = p_F(H(1) - H(0)), \text{ and } \tilde{I} = p_C((H(1) - H(0))). \tag{2}$$

For F-type workers, investment takes place if and only if $I < \bar{I}$ and for C-type workers, investment occurs if and only if $I < \tilde{I}$.

The effect of adverse selection. Next, we characterize the equilibrium when the workers' types are private information. We now proceed to demonstrate that there is a range of parameter values when the workers will receive investment and when the investment decision is efficient. To do this, we will apply the above equilibrium conditions (E1 to E5) in order to characterize the equilibrium. Below, we will outline the proof.[3]

First, condition E2 implies that the firm's investment decision follows the threshold rule and depends on the amount of deferred payment. From the expected profit function Π in (1) and condition E5, we can pin down the threshold of deferred payment and the investment decision, as well as the associated wage. Second, no-entry condition

[3] The details are presented in the online appendix.

E5 allows us to limit the possible candidates of an equilibrium to the ones that satisfy zero-profit conditions. Third, among the zero-profit contracts, we will show there exists no partial pooling equilibria. The intuitions are as follows: if there exists a partial pooling equilibrium, it means that the F-type and the C-type choose the same contracts. However, since the C-type is more profitable to firms, some firms will deviate by offering another contracts that only attracts the C-type.

From the above arguments, the number of candidates for possible equilibrium contracts is finite. Then it follows that we must check whether each candidate satisfies all the conditions E1 to E5. It turns out only two threshold values of I matter: $\bar{I}$ and $\hat{I}$,[4] where $\hat{I}$ is

$$\hat{I} = p_C(H(1) - H(0)) + (\frac{p_C}{\bar{p}} - 1)Z. \tag{3}$$

When $I < \bar{I}$, investment is profitable for firms regardless of types. Hence, the equilibrium will be a separating contract with investment. The threshold value of $\hat{I}$ defined above is interpreted as the amount of investment cost with which the C-type workers are indifferent between pooling and separating. When $I > \hat{I}$, the equilibrium will be a pooling contract with no investment. Below, we summarize each equilibrium type by the values of I:

Proposition 1. *The equilibria are classified into the following three cases and characterized as follows:*

(i) For $I < \bar{I}$, equilibrium contracts will take the following forms with $d = I + Z$:

$$\Omega = \{H(1) + \frac{1-p_C}{p_C}d - \frac{I}{p_C} - \frac{Z}{p_C}, d, i^+, p_C), H(1) + \frac{1-p_F}{p_F}d - \frac{I}{p_F} - \frac{Z}{p_F}, 0, i^+, p_F)\}$$

All contracts provide investments.

(ii) For $\bar{I} < I < \hat{I}$, there exists a unique competitive labor-market equilibrium

$$\Omega = \{H(1) + \frac{1-p_C}{p_C}d - \frac{I}{p_C} - \frac{Z}{p_C}, d, i^+, p_C), (H(0) - \frac{Z}{p_F}, 0, i^-, p_F)\},$$
$$d \in [\frac{p_F}{p_C - p_F}(p_C(H(1) - H(0)) - I) + Z, \bar{d}].$$

Only C-type workers receive investment from the firms.[5]

(iii) For $\hat{I} < I$, there is a unique competitive pooling labor-market equilibrium

$$\Omega = (H(0) - \frac{Z}{\bar{p}}, 0, i^-, \bar{p}).$$

No contracts provide investments.

[4] Denote $\bar{p} = \mu \times p_C + (1-\mu) \times p_F$, the average staying probability.

[5] We define $\bar{d}$ as the upper bound for the deferred payment. By zero profit condition, the results will not be changed by different values of $\bar{d}$ and hence no conditions will be imposed on $\bar{d}$.

Until now, we have characterized the type of equilibrium and associated deferred payment and investment using two threshold values $\bar{I}$ and $\hat{I}$. Notice that the values of $\hat{I}$ and $\tilde{I}$ are different, where $\tilde{I}$ determines whether the investment is efficient or not. Hence, the difference between $\tilde{I}$ and $\hat{I}$ informs us whether inefficiency arises. Investment is not efficient in the case with complete information when $I > \tilde{I}$. Results are summarized in Table 1.

Table 1: Investment Efficiency

For I in the Interval		Receive Investment		Investment is Efficient		Type of Equilibrium
From	To	F-type	C-type	F-type	C-type	
0	$\bar{I}$	Yes	Yes	Yes	Yes	(i) Separating
$\bar{I}$	$\tilde{I}$	No	Yes	No	Yes	(ii) Separating
$\tilde{I}$	$\hat{I}$	No	Yes	No	No	(iii) Separating
$\hat{I}$	∞	No	No	No	No	(iv) Pooling

4 Discussion

We discuss the model implications in this section. With information asymmetry, we show that career-type workers use deferred payment as a tool to demonstrate their stronger levels of attachment. As a result, over-investment may occur; while nobody would choose investment in the first-best scenario, investment does take place when the information problem exists. This mechanism is analogue to the over-education problem when college degrees are used as a signaling device. Moreover, the model prediction is consistent with the patterns for the gender wage gap observed in the U.S. labor market. Gayle and Golan (2012) look at those who work without career discontinuity and find that the gender wage gap is largest at the early stage of their career and narrows as job experience grows.

Now, we move to analysis on inefficiency from a social perspective. Inefficiency here is defined as social losses associated with over-investment. In particular, inefficiency is measured by the expected loss ($E[loss]$), which is equal to the investment cost minus its returns. The outcome is efficient when investment is made only when its social return (i.e. the expected increase in human capital) exceeds its social cost (i.e. the investment cost I). By linking the calculated size of inefficiency to the model parameters, we discuss scenarios where the equilibrium outcome is more likely to result in inefficiency.

From Table 1, we know that when $I \in [\tilde{I}, \hat{I}]$, the C-type takes the deferred payment in order to receive investment, but the investment is not optimal in the first-base scenario. It is useful to discuss this senario without fixing the size of I; we allow I to vary between zero and I_{max} where $I_{max} > p_c H(1)$.[6] For simplicity we assume that I is uniformly distributed between $[0, I_{max}]$. The social losses can be stated as follows:

Proposition 2. *If I is distributed uniformly on the interval $[0, I_{max}]$, the expected value of social losses is given by*

$$E[loss] = \frac{\mu}{2 * I_{max}} \Big(\frac{p_C}{\mu * p_C + (1-\mu) * p_F} - 1\Big)^2 Z^2.$$

Proof. The magnitude of inefficiency comes from the difference of investment cost I and the social gain for investment $p_C(H(1) - H(0))$. Hence,

$$\text{loss} = I - p_C(H(1) - H(0)).$$

Observe that $\tilde{I} = p_C(H(1) - H(0))$ and $\hat{I} = \tilde{I} + \big(\frac{p_C}{\bar{p}} - 1\big)Z$. Together with the fact that the probability that I falls in the inefficiency region is given by $(\hat{I} - \tilde{I})/I_{max}$, the expected losses in the region $[\tilde{I}, \hat{I}]$ can be calculated because the value of $E[I \big| I \in [\tilde{I}, \hat{I}]] = \frac{\tilde{I} + \hat{I}}{2}$. □

Proposition 2 implies that expected social losses grow rapidly as the difference between $p_C - p_F$ increases (i.e. p_C increases or p_F decreases). However, the effect of μ is ambiguous; as μ increases, the first part $(\mu/(2 * I_{max}))$ increases where as the second part $\big(\frac{p_C}{\mu * p_C + (1-\mu) * p_F} - 1\big)$ decreases. The intuition behind the results can be summarized as follows. Increasing $p_C - p_F$ means that the difference between the two types becomes larger; and thus the information losses are greater. Since the career type faces larger benefit from separating from the others, the likelihood of falling into the over-investment region increases. The size of μ represents the proportion of career type workers and the direction of the effect on losses is undetermined. On the one hand, the more career-type individuals are, the larger the total amount of over-investment becomes (if at all). On the other hand, with more career-type workers, the chance of over-investment decreases because the average productivity becomes higher in the pooling equilibrium, which in turn reduces the incentive for the career type to separate from the family type.

These results imply that policies that appear to help women pursue their careers could have positive and adverse effects on social efficiency, depending on labor market conditions. In fact, the model shows that a government subsidy that reduces investment costs could alleviate inefficiency by moving from an inefficient separating equilibrium to an efficient separating equilibrium (i.e. switching from equilibrium (iii) to equilibrium (i) or (ii) in Table 1). However, some policies that strengthen women's labor force attachment (such as tax credits for earned income or childcare subsidies) could have effects in both directions. While such policies could reduce social losses when they increase the family type's labor force attachments (p_F), they will enlarge the losses when

[6] The value of I_{max} or the assumption on distribution does not change the results.

they increase the career type's attachment (p_C) or when they increase the percentage of the career type (μ). Of course, our model only looks at efficiency in allocation of employee investment—only one of many criteria to evaluate the cost-benefits of policies. Yet, the model implication highlights potential consequences often-ignored in policy analysis. Policy makers need to pay careful attention to the existing screening mechanism in the market and the undetermined adverse effects before implementing policies.

5 Conclusion

This paper develops a game-theoretical model of screening in the form of labor contracts based on labor force attachment. In our model, employers finance employees without directly observing individuals' intentions to stay in the labor force (and remain at the firm). In an attempt to distinguish quitting probability among female workers, the wage contracts with deferred payments are used as a screening device.

This paper shed lights on the role of implicit wage contracts as labor market arrangements that address information inefficiency. The finding implies that a policy that strengthens women's labor force attachment does not always improve social welfare because it could enlarge allocation inefficiency by causing over-investment. We conclude that, in cases with market-based screening mechanisms already in place, the government should carefully assess policy effects before implementation to avoid interfering with the screening mechanism.

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