General Training and Reciprocity

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Abstract

It is a puzzle that empirical evidence finds that firm sponsors general training, a training that sponsors skills useful elsewhere, which is not explained by standard-preference theories. In this paper, I incorporate worker reciprocity into the analysis to see whether the theoretical conclusion changes. I show that the worker does not have to think the firm is treating her kindly given that she gets trained. Even so, the firm will still train, because the worker will negatively reciprocate—punish unkind behaviors—the firm if it does not train. This implies that the worker's reservation non-training wage will be higher than how much she can earn if she quits, while her reservation post-training wage needs not necessarily be lower than her outside income. I conduct a lab experiment and find support for the empirical implications.

JEL classification: C72, C92, D21, M53.

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1. Introduction

Job training serves as one of the major ways of improving productivity. There is training which increases the worker's productivity not only in the incumbent firm but also in many other firms. This type of training is called *general training*, which is firstly discuss by Becker (1962).[1] General training is commonly observed, for example, Cappelli (2004) estimates that 85% firms attend tuition reimbursement programs, and also lead to policy and law discussions.[2]

Consider a situation where there is no enforceable contract with a tenure requirement. The employer decides whether to train the worker, then offer a take-it-or-leave-it wage. The worker then decides whether to work with the firm or quit.According to standard-preference theories, if training has no asset specificity, a higher value of the training for the current firm than that for others, the firm will not bear the training cost. Since such training boosts the worker's value, the firm needs to pay out all of the benefits it can obtain from the training to make the worker stay. Like a hold-up problem, this causes an incentive issue for the firm to invest in training.

In this paper, I incorporate worker reciprocity into general training problem, applying the sequential reciprocity theory by Dufwenberg and Kirchsteiger (2004). I show that the worker does not have to think the firm is treating her kindly given that she gets trained. Even so, the firm will still train, because the worker will negative reciprocate—punish unkind behaviors—if the firm does not. This is in contrast to a common instinct that a firm invests in training for worker's reward afterward. This result is consistent with the field-experimental findings that the effect of negative reciprocity is significant and lasts long whereas positive reciprocity does not (Kube, Maréchal, and Puppe, 2006; Cohn, Fehr, and Goette, 2014).

Moreover, I run a laboratory experiment to test this theory. I find the support of the empirical implications of my model. The experimental section also contributes to the literature including bulks of lab-experimental testing about reciprocal inclinations in labor relationships, as well as those considering hold-up problems.[3]

My research is not the first study considering reciprocity in the firm's training activity: Leuven, Oosterbeek, Sloof, and Van Klaveren (2005) discuss the situation where the firm faces a binary choice between training or not. However, they do not specifically interested in the training which is general. Whereas I look at the situation which is more consistent with the conventional theoretical analysis of the general training problem. In particular, the firm

[1] On the opposite, training is called *specific* if it gives workers particular skills that are only valuable in the current firm.

[2] E.g., training for licenses, certifications, up-front computer skills, foreign languages program

[3] See Anderhub, Königstein, and Kübler (2003); Dufwenberg, Smith, and Van Essen (2013).

needs to decide the wage, which is crucial in the argument of the incentive issue discussed by Becker (1962).

In section 2, I discuss the empirical background of general training problem. In section 3, I propose a simplest game form preserving the economic essence, and using the sub-game perfect equilibrium with standard preference to reproduce the incentive issue discussed in the general training problem. In section 4, I introduce the sequential reciprocity model developed by Dufwenberg and Kirchsteiger (2004), and apply it to this general training problem. Furthermore, I propose a solution concept to obtain the main results. In section 5, I report the laboratory experiment I conduct to test my theory. Section 6 discusses some novel implications that can be tested empirically in future studies. Concluding remarks are in section 7.

2. Empirical Background

Casual observation provides examples that firms support general training: employers in financial institution get covered of the cost of professional credentials; until 2017, not less than 10000 people obtains the commitment-free college tuition reimbursement from Starbucks.[4] In formal research, there are a bulk of empirical evidences that firms do support general training.[5] For example, Krueger (1993) finds that 59% of the 83 temporary help agencies provide free up-front computer training for workers.

In the sample collected by International Adult Literacy Survey *(IALS)*, 80.9% training in Canada are supported by the firms, and 85.3% in the U.S. are supported by the firm.[6] Leuven and Oosterbeek (2000) figure out that employers often financially supports training provided outside the company, and conclude that firms fund general training. Using the data of British Household Panel Survey (*BHPS*), Booth and Bryan (2002) find that 629 out of 1021 accredited training, which has a large impact on wages in future jobs, are paid by employers. The university education can also be considered as general training. According to the estimation by the American Council of Education, there are roughly 20% of graduate students are receiving some financial assistance from their employer (Babson, 1999). Estimates of firms that support education programs range from 47% (Lynch and Black, 1998) to 85 % (Cappelli, 2004), even for those firms has relative small size of employees. Manchester (2012) indicates that there exists a significant gap between the amount of trainees who received tuition assistance and that of who get post-training tenure requirements. Moreover,

[4] `https://stories.starbucks.com/stories/2017/starbucks-college-achievement-plan-welcomes-its-1000th-g`

[5] See also, for example, Bishop (1996); Bishop and Kang (1996); Loewenstein and Spletzer (1999); Leuven and Oosterbeek (2000); Cappelli (2004); Manchester (2012)

[6] 85.8% in Netherlands and 72.6% in Switzerland

she finds such explicit requirements are not responsible to the retention effect of general training. A research including both a survey and a case study on Australian industry show that most employers are willing to pay for general training despite that it makes those workers more attractive on the labor market (Smith and Hayton, 1999).

The standard-preference theories explain training in the field by considering it is "*de facto* specific"Acemoglu and Pischke (1999b), bypassing the incentive issue in general training problem.[7]. However, with the improvement of information contained in new data, empirical studies find situations where some of those factors which turn general training into specific as discussed do not exist. Also, the generality of training is positively related to higher retention in the long run (Manchester, 2012). Moreover, Smith and Hayton (1999); Booth and Bryan (2002) compare different training with different degree of specificity, and find the specificity has no much explanatory power on employers' training decision. Therefore, the standard-theories does not explain the empirical evidence of general training well, which causes a puzzle. Furthermore, empiricists find that there exists a negative relationship between general training and turnover (Cappelli, 2004; Sieben, 2007), and the firms are actually benefited from training in the form of that workers' productivities are higher than their post-training wages (Barrett and O'Connell, 2001; Frazis et al., 2007). Such evidence help us understand which parts of Becker (1962)'s argument fails.

There are suggestions on explaining the general training by incorporating non-monetary motivations but preserving the generality of training (with no asset specificity). One of the most promising mechanisms in labor relations is reciprocity, which is discussed as early as by Akerlof (1982). The reciprocal inclination has been observed in the lab even in competitive setting (Fehr, Kirchsteiger, and Riedl, 1998), and also observed it has long-term effect in the field (Kube et al., 2006; Kube, Maréchal, and Puppe, 2012; Montizaan, de Grip, Cörvers, and Dohmen, 2015).[8] In the general training problem, the worker reciprocal inclination is believed to play an important role. Some researchers argue that providing training motivates the worker's consideration of the firm's kindness toward herself as well as her affective attachment that she ought to reciprocate such an activity (Tannenbaum, Math-

[7]Under the assumption that workers maximizes their own incomes, they require that the generality is no longer hold. Since these studies agree on the statement that firms will not provide training with no asset specificity, they introduce various of assumptions to weaken the generality of training observed in real world. These assumptions include minimum wage (Frazis, Loewenstein, et al., 2007), firm has bargaining power (Acemoglu and Pischke, 1999b), more skillful workers have higher searching/moving cost (Acemoglu and Pischke, 1999b), information asymmetry so that workers know less about the training than the current firm (Bishop, 1996), future firms know less about the training (Katz and Ziderman, 1990), future firms know less about the worker (Acemoglu and Pischke, 1998). The role of these assumptions is to make general training to be *de facto* specific (Acemoglu and Pischke, 1999a).

[8]This stream of lab experiments starts from Fehr, Kirchsteiger, and Riedl (1993). For a comprehensive survey, see Charness and Kuhn (2011); Rebitzer and Taylor (2011); Becker, Messer, and Wolter (2013).

ieu, Salas, and Cannon-Bowers, 1991; Mueller, Wallace, and Price, 1992; Fevre, Rees, and Gorard, 1999).[9] Barrett and O'Connell (2001) discuss that the transferability is crucial if firm-support training is serves as a *relational investment*, which encourages the worker in return doing things benefiting the firm. Empirical evidences support such views. Leuven et al. (2005) find a positive relationship between employees' reciprocal inclination (obtained from survey data) and the firm-support training he/she receives in the past 12 months. This may imply that reciprocity is one of the main concerns for firms when supporting training. Mueller et al. (1992) find that organizational support increases the training participant in a foreign language training program. Kampkötter and Marggraf (2015) find that participation is related to a lower turnover, suggesting that this could be one possible mechanism how workers "reward" the firm for the investment. Montizaan, de Grip, and Fouarge (2014) use representative survey data for Dutch public sector show that the firm's training intention (irrespective whether the workers actually attend training) are positively related to postponed entry to retirement. Moreover, they find this is driven by employees' positive reciprocity. Using a field experiment, Sauermann (2015) shows that reciprocal workers performances better than their non-reciprocal peers. All of these findings imply that reciprocal motivation, are taken into consideration by employers when investing training.

3. Preliminary: The General Training Game

3.1. Game Form

I use a three-stage game form (Fig. 1) to model the environment throughout this section. The game form shows the scope of this study: I focus on training which is difficult to be achieved by worker herself if it is not provided by the firm. This may be because of lack of worker's knowledge about what is demanded in skills in the industry, worker's credit constraint, lack of qualified institute, or lack of certification. The game form also implicitly describes the situation where the firm finds it difficult to replace the current worker very soon, while the worker does not worry about unemployment whenever she quits.

[9] They use the terms of loyalty and obligation, but the central idea is the same.

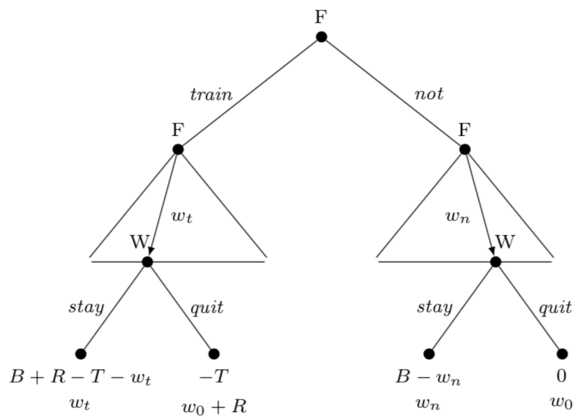


Fig. 1. The Game Form

The game form includes two players, a firm (it) and a worker (she). Thus, the player set $I = \{F, W\}$.

In stage 1, the firm decides whether to train the worker. If it trains, the firm bear the *cost of training*, T. The training will increase the worker's productivity at the level of R, which is the *return of training*.
In stage 2, the firm offers a post-training wage w_t or a non-training wage w_n, depending on its decision in the first stage.
In stage 3, the worker either stays with the firm obtaining the offered wage (w_t or w_n), or quits and obtain a self-employed income ($w_0 + R$ or w_0). If the worker stays, her own *specific human capital* for the firm, B. And the value for hiring her is $B + R$. If the worker quits, the firm's profit is normalized as 0. [10]
Since the training is general, the worker finds her productivity increase is useful/appreciated if she quits, so her outside income increases by R.

I explicitize the assumptions I put on this game form:

1. $R > T$
2. The firm's feasible wages are bounded:
   - $w_t \in [0, B + R - T]$
   - $w_n \in [0, B]$
3. $B - T > w_0$

[10]Because it spends time for the firm to reap the benefits from a worker who producing at her "peak productivity" and instead the firm must investment more in recruiting new workers.

The first condition means that training itself is efficient. The second condition limits the firm's action set in the second stage so that it is not able to charge from the worker (wages are non-negative) or overpay so that losing money by hiring that worker (profits are non-negative). In classical games, this assumption only matters when there exists some "corner solution". However, in this paper, it is important since it affects the player's view about kindness (which I postpone to discuss until the next section), and also serves as a necessity for preventing the worker from arbitrary manipulating her expectation on what the firm *ought to* do.[11] Another justification of $w_t \leq B+R-T$ is that if a firm plans budget ahead, then a strategy/policy which gives negative profit (if $w_t > B+R-T$) regardless the worker's response cannot be approved. It is not crucial for the main findings in this paper if I instead assume $w_t \in [0, B+R]$. The third condition is to ensure the training is affordable for the firm. Otherwise, I need to discuss an uninteresting condition under which the firm does not train simply because it cannot bear the total cost including training and hiring.

In this game form, there is no addition assumption to discount the worker's obtainable return R if she quits. Thus, the training preserves its generality.[12]

3.2. Solution with standard preferences

The following proposition gives the prediction of the sub-game perfect equilibrium.

Proposition 1. *There exists a unique sub-game perfect equilibrium (SPE), where the optimal wages are*

- $\hat{w}_t = w_0 + R$
- $\hat{w}_n = w_0$

and the firm chooses not *in the first stage.*

The assumption that $w_0 + R < B + R - T$ ensures the training is *affordable* for the firm. Whenever the worker maximizes her own material payoff, she stays only if she earns not less than her post-training outside wage $w_0 + R$. In order to make her stay, the firm has to raise the wage at the level of the return of training, R. Thus, it extracts no benefit from the training. As a result, the firm has no incentive to train the worker since the training only cost the firm T but brings no profit. This result reflects the view of the standard preference theories: if the training is perfectly transferable, the firm has no incentive to provide training.

[11] Thus, an alternative but more complicated assumption which gives the same effect is to put such a restriction on the worker's belief.

[12] The theoretical explanation with standard preferences, on the other hand, apply various assumptions so that general training become *de facto* specific Acemoglu and Pischke (1999a,b).

4. Incorporating Worker Reciprocity

4.1. Modelling Reciprocity

In this paper, I consider that the firm maximizes its profits (material payoffs), whereas the worker is motivated by reciprocity. The worker's preference is model by the utility function developed by Dufwenberg and Kirchsteiger (2004).

Their model contains "kindness functions". To decide whether a player, say i, is kind to the other player j needs a reference point. Inheriting the notation from Dufwenberg and Kirchsteiger (2004), I use $a_i \in A_i$ to represent the *strategy* of player $i \in I$. Denoted by $\pi_i : \Pi_{j \in I} A_i \to \mathbb{R}$ player i's expected material payoff function. Denoted by b_{ij} player i's (point) belief about j's strategy. Given i's belief b_{ij} the *equitable payoff* for j is the average of the max and min material payoff that i believes he can give player j.[13]

$$\pi_F^e(b_{ij}) = \frac{1}{2} \cdot [\max_{a_i \in A_i} \pi_j(a_i, b_{ij}) + \min_{a_i \in A_i} \pi_j(a_i, b_{ij})] \tag{1}$$

Let $a_i(h)$ be i's (updated) strategy which is identical to a_i except that the former contains actions that are consistent with achieving history h. Similarly, $b_{ij}(h)$ is player i's updated (point) belief of a_j. Then i's *kindness* to j at h is

$$\kappa_{ij}(a_i(h), b_{ij}(h)) = \pi_j(a_i(h), b_{ij}(h)) - \pi_j^e(b_{ij}(h)) \tag{2}$$

How kind/unkind i to j is captured by the difference between the material payoff i intends to give j and the equitable payoff for j. If $\kappa_{ij}(\cdot) > 0$, i is kind to j. If $\kappa_{ij}(\cdot) < 0$, i is unkind to j. If $\kappa_{ij}(\cdot) = 0$, i is equitable (or zero kindness) toward j.

Besides the kindness function, the reciprocity motivation also influenced by how kind i perceives from j. Let $c_{iji}(h)$ represent i's updated (point) belief about $b_j(h)$—j's (point) belief about i's strategy. Then i's *perceived kindness* of j toward i at history h is

$$\lambda_{iji}(b_{ij}(h), c_{iji}(h)) = \pi_i(b_{ij}(h), c_{iji}(h)) - \pi_i^e(c_{iji}(h)) \tag{3}$$

How kind/unkind i perceives from j is the difference between the material payoff i believes that j intends to give i and the equitable payoff for i. If $\lambda_{iji} > 0$, i perceives j as kind to i, etc.

[13] A reader who is familiar with Dufwenberg and Kirchsteiger (2004) can find that the equitable payoff is not defined upon "efficient strategies" that contains no wasteful moves (see the discussion by Dufwenberg and Kirchsteiger (2004, 2018))—I skip it for pedagogical purpose. I can show that under the second assumption meanwhile focus on any SRE, whether or not to discuss efficient strategies (as what Dufwenberg and Kirchsteiger (2004) defined) does not matter. The proof is upon request.

There are only two players in the game, $i \in I = \{W, F\}$, hence without leading ambiguity, I refer b_W as b_{WF}, c_W as c_{WFW}.

The worker's utility at history h then is given by:

$$\begin{aligned} U_W(a_W(h), & b_W(h), c_W(h)) = \\ & \underbrace{\pi_W(a_W(h), b_W(h))}_{\text{material payoff}} + \theta \cdot \underbrace{\kappa_{WF}(a_W(h), b_W(h)) \cdot \lambda_{WFW}(b_W(h), c_W(h))}_{\text{reciprocity payoff}} \end{aligned} \tag{4}$$

where θ is the worker's sensitivity about reciprocity. The reciprocity payoff is the product of the worker's kindness toward the firm and the kindness she perceives from the firm. The sign-matching feature of the reciprocity payoff reflects mutual kindness or unkindness.

4.2. Reciprocity in the General Training Game

Here I report some feature when applying the D&K model in this particular general training problem:

Recall that Assumption 2 states that the firm cannot pay more than how much it earns from the worker (the training cost counts). Such a restriction does not crucial in standard preference theory. However, it matters when considering worker reciprocity as it limits the highest material payoff that the firm can give the worker. Otherwise, the worker can easily manipulate what is considered as equitable for herself. For example, if the worker thinks that it is feasible for the firm to loan a billion to give her as a wage, then the firm is unkind to her if it pays her less than five-hundred millions.[14]

4.3. Solution Concepts

Dufwenberg and Kirchsteiger (2004) propose *sequential reciprocity equilibrium* as the solution concept for their model.

Definition 1. (SRE) The profile a^* is a *sequential reciprocity equilibrium* (SRE) if for all player i and for each h it holds that

(a) $a_i^* \in \arg\max_{a_i \in A_i(h)} U_i(a_i, b_{ij}(h, a^*), c_{iji}(h))$
(b) $c_{iji} = b_{ji} = a_i$ for $j \neq i$

[14]Since this assumption only influences the worker's reciprocity payoff, I can find an alternative assumption that serves the same role, by instead assuming about the worker's belief on to what extent she believes the firm should do under the current social norm.

Condition (a) implies i best responds given i's belief at each history.[15]Condition (b) requires that all the beliefs are corrects.

In this general training problem, there are multiple SRE. This is because there are multiple beliefs of worker, c_W, are supported by a SRE, all of which are self-confirming.

Lemma 4.1. *(non-monotonic) Suppose* $B > w_0 + R + T$*, if the worker's sensitivity* θ *is large enough, then there are SRE in which the worker plays a strategy s.t. if she gets trained,*

- *the worker stays given a wage* $w_t = w_{t1}$
- *the worker quits given a wage* $w_t = w_{t2}$
- *and these two wages satisfy* $0 < w_{t1} < w_{t2} < B + R - T$

In such type of SRE, the worker who gets trained may reject a wage higher than her acceptable wage. Moreover, she believes the firm is kind if it offers w_{t1}, but unkind if it offers w_{t2} and such belief is self-confirming.

Lemma 4.2. *(no-stay-after-training) Suppose* $B > w_0 + 2R$*, if* θ *is large enough, then there are SRE in which the worker plays a strategy s.t.*

- *she stays if she does not get trained and then is offered some non-too-low wage* w_n *whereas,*
- *she quits once she gets trained regardless what wage* w_t *is offered.*

This type of SRE implies that the worker always believes that the firm is unkind if it provides training. Consider that the worker, for some reason, forms a belief that the firm always expects her to quit once she gets trained so that it intends to give her $w_0 + R$ no matter how high w_t is. $B > w_0 + 2R$ implies that this material payoff is relatively low so that the worker perceives unkind from the firm. If the worker is very reciprocal, she prefers to quit, which gives the firm $-T$, to punish the firm. Therefore, such a belief is correct!

One might curious whether there exists a similar SRE in which the worker never stay if she does not get trained? The answer is no. If $w_n = B$ the worker finds that she cannot be kind or unkind to the firm since the latter is indifferent whether she stays. Thus, her reciprocity payoff are the same regardless her choice, whereas her material payoff is strictly higher if she stays. This does not happen in the SRE in Lemma 4.2 because the firm has budget limits that $w_t \leq B + R - T$, which leads the firm non-negative profit if the worker

[15] In Dufwenberg and Kirchsteiger (2004), $a_i^* \in A_i(h, a^*)$ means that at h, a_i^* is a strategy maximizing U_i among those strategies that agree to a_i^* at all other histories except h. This represents the feature of a SRE that it rules out only profitable *local* deviation, whereas it allows the existence of a profitable multiple-stage deviation, which can improve $U_i(\cdot)$ by deviation at several successive stages.

stays. Therefore, the worker can always punish the firm given any feasible wage w_t by choosing quit, which gives the firm $-T$ profit.

In this study, I limit my scope on SRE that satisfies some condition, which I find it reasonable.

Definition 2. A SRE is *monotonic* if the firm holds a belief s.t.

(a) $\exists w \in (0, B+R-T)$ s.t. the worker who gets trained *stays* if and only if $w_t \geq w$
(b) $\exists w' \in (0, B)$ s.t. the worker who does not get trained *stays* if and only if $w_t \geq w$

In words, in a monotonic SRE[16], the firm's believes that

(a) it can afford a wage that satisfies the worker whether she gets trained.
(b) if the worker accepts some wage, she will accept all wages with higher levels.

Condition (a) rules out the *no-stay-after-training* SRE mentioned in Lemma 4.2. Condition (b) rules out the *non-monotonic* SRE mentioned in Lemma 4.1. When a SRE is monotonic, the equitable payoff for the worker is pinned down:

Recall that the equitable payoff to the worker (from the firm) is denoted by $\pi^e_W(\cdot)$. The next lemma shows that in any monotonic SRE, it is a constant:

Lemma 4.3. *In the monotonic SRE,* $\pi^e_W(a^*_W) = \frac{B+R-T+w_0}{2}$

Recall that it serves as a reference for a worker when calculating her perceived kindness from the firm. It is the middle point between the highest material payoff the worker can receive from the firm, $B+R-T$, and the lowest material payoff she can get, w_0, in a monotonic SRE. However, this is not generally true in any SRE. For example, in the class of SRE given by Lemma 4.2. $\pi^e_W(a^*_W) = \frac{B+w_0}{2}$. Since thereafter I only focus on monotonic SRE, I use $\pi^e_W \equiv \frac{B+R-T+w_0}{2}$ to represent $\pi^e_W(a^*_W)$.

Since the monotonicity excludes the mixed-strategic SRE, the following lemma gives the worker's participation constraints.

Lemma 4.4. *In a monotonic SRE,*

- *the worker who gets trained meets the following participation constraint*

$$w_t - w_0 - R + \theta \cdot (B + R - w_t) \cdot (w_t - \pi^e_W) \geq 0 \tag{5}$$

[16]One can define the monotonic SRE by assuming about a_W or c_W to obtain the equivalent restriction due to the correct-belief condition of SRE ($a_W = b_F = c_W$).

- *the worker who does not get trained meets the following participation constraint*

$$w_n - w_0 + \theta(B - w_n)(w_n - \pi_W^e) \geq 0 \tag{6}$$

The SRE satisfying monotonicity gives a sharp prediction:

Proposition 2. *There exists a unique monotonic SRE.*

This proposition does not specify whether the firm will train or not in the first stage. On the other hand, the participation constraints are binding, meaning that the worker is indifferent between to stay or to quit. However, in the equilibrium, the worker will choose to stay in the last stage. To see this, suppose the worker will quit, the firm can be better off by deviating to another wage under which the worker would stay, thus it is not an equilibrium.

Proposition 3. *(kindness)*

(a) If the firm trains, it treats the worker kindly whenever $R + T > B - w_0$, and it treats the worker unkindly whenever $R + T < B - w_0$.
(b) If the firm does not train, then it is unkind to the worker.

Corollary 1. *Then*

- *if* $R + T > B - w_0$, $w_t^* \in (\frac{B+R-T+w_0}{2}, w_0 + R)$
- *if* $R + T < B - w_0$, $w_t^* \in (w_0 + R, \frac{B+R-T+w_0}{2})$
- *if* $R + T = B - w_0$, $w_t^* = w_0 + R = \frac{B+R-T+w_0}{2}$.
- $w_n^* \in (w_0, \frac{B+R-T+w_0}{2})$,

$w_0 + R$ is the outside value of a worker who gets trained. If this value excesses the equitable payoff the firm is able to give to the worker, the firm needs to offer a w_t^* higher than π_W^e to make this worker stay. From $w_t^* > \pi_W^e$, the firm's movement will be perceived as kind in a monotonic SRE, which allows w_t^* be lower than $w_0 + R$, the worker's outside income. In here, the worker has positive reciprocity payoff, which compensates the material loss by choosing to stay rather than to quit. A similar logic applies if $w_0 + R < \pi_W^e$. On the other hand, if the firm choose not to train, the worker's value is w_0, which is always lower than π_W^e. Thus, the firm is always perceived as unkind by a worker who does not get trained. As a result, it needs to pay more ($w_n > w_0$) in order to stop the this worker from leaving.

This lemma also indicate an important feature of a reciprocity model which is different from the classical model or other distributional social preference models.[17]That is, a player's behavior in a sub-game can depend on the whole game.

For instance, suppose there is another game, where the firm has no ability to choose whether to train, so it is the same as the right-down sub-game described in Figure 1. In a monotonic SRE, the firm's strategy (offering an amount of wage) is not necessarily perceived as unkind. Whereas in this training game, the worker knows that the firm gives up training on purpose, which affects her henceforth view of the firm.

Proposition 4. $w_t^* > w_n^*$, *meaning that getting training raises the worker's income.*

$w_t^* > w_n^*$ implies that both the firm and the reciprocal worker extract positive benefit from the training.

It means that the model incorporating worker reciprocity agrees the empirical observation that the worker who gets trained earns more (Bishop, 1996; Loewenstein and Spletzer, 1998; Barron, Berger, and Black, 1999).

However, does not imply that the firm is worse off by offering training, since now there are more resources for the firm to distribute.

The next proposition answer the question that under what condition a profit-maximizing firm will train the worker:

Proposition 5. *In the monotonic SRE, there exists a* $\overline{\theta} > 0$ *s.t.*

- $\theta > \overline{\theta} \Rightarrow$ *the firm will choose to* train *the worker.*
- $\theta < \overline{\theta} \Rightarrow$ *the firm will choose* not *to train the worker.*

It says that there exists a threshold $\overline{\theta} > 0$ s.t. if the worker's sensitivity θ is higher/lower than $\overline{\theta}$, training returns a higher/lower profit to the worker.

From Proposition 4 and 5. I find that when the worker is sufficiently motivated by reciprocity, the firm will provide training, which gives material benefits to both the firm and the worker.

More than that, an interesting insight is implied if I combine Proposition 3 and Proposition 5

CLAIM 1. If the firm provides training, then it is because the worker will negatively reciprocate whenever the firm does not.

4.4. Comparative Statics

In Corollary 1 it shows the conditions under which the firm is considered as unkind, the following results are intuitive:

[17] A function whose value only depends on the final distribution. For example, Fehr and Schmidt (2000)

Proposition 6. *The comparative statics of θ:*

- *If* $w_0 + R < \pi_W^e$, $\dfrac{dw_t^*}{d\theta} > 0$.
- *If* $w_0 + R > \pi_W^e$, $\dfrac{dw_t^*}{d\theta} < 0$.
- *If* $w_0 + R = \pi_W^e$, $\dfrac{dw_t^*}{d\theta} = 0$.
- $\dfrac{dw_n^*}{d\theta} > 0$

This proposition says that if the firm's movement in the monotonic SRE is perceived as kind (unkind), then the more sensitive the worker to her reciprocal payoffs, the less (more) w_t^* the firm need to offer in order to make the worker stay.

The next lemma shows a feature which distinguish the reciprocity model from other social preference models. That is, the results are sensitive to the global environment. More specifically, the parameter R and T only shows on left sub-game, whereas they affects the variable w_n which is in the right sub-game.

Lemma 4.5. *When* $\theta > 0$,

- $\dfrac{dw_n^*}{dR} > 0$
- $\dfrac{dw_n^*}{dT} < 0$

The logic follows: the worker will face w_n^* once the firm abandons the training option. R (T) is positively (negatively) related to the net benefit of training, meaning that the higher R (T), the more (less) significance of the training on improving the total surplus. Therefore, if the firm abandons the training option, the worker perceives more (less) unkind from the firm. This make the worker be more (less) prone to quit. In return, the firm needs to pay more to prevent the worker from leaving.

4.5. Complementary or Substitutability?

Both providing training and a higher wage affect the worker's response afterward. In this section, I investigate the relationship between them. Are they complements or substitutes?

It is tempting to conjecture there exists substitutability between them, since both providing actions seem to benefit to the worker. By this logic, both actions make the reciprocal worker be more prone to stay. However, from Proposition 4, I get the opposite:

CLAIM 2. For the firm, training and the wage are *complements* even if the worker is highly reciprocal.

This is because the firm's kindness to the worker is determined by the worker's eventual material payoffs. For instance, if the worker obtains an post-training wage that is lower than how much she would get were she does not get trained, the worker is not actually benefited from the training, and the returns of training are totally extracted by the firm. Then the worker will not consider providing training *per se* as the firm's kindness.

Compared with who does not, a worker who gets trained faces a higher material temptation to quit, the firm has to pay more once the worker gets trained. This result agrees with the empirical finding of Cappelli (2004). In his research, Cappelli uses The National Employer Survey II (NES II) administered by the U.S. Bureau of the Census, which contains the information from the side of employers, and finds a positive and significant relationship between wages and tuition reimbursement plans.

This result is robust under a situation where the firm instead provides training whose level is a continuous interval. See Section 6.4.

5. Test The Theory: A Laboratory Experiment

In here I design a lab experiment to test the hypotheses derived from the theory. So that this study also fills in the gap of lab experimental studies on training problems.

Why need a laboratory experiment to test the theory? One main issue of field data comes from the observability of the asset specificity of training, namely, the premium training value for the current firm than for others. Moreover, many factors affect the training's asset specificity, including informational asymmetry, market frictions, bargaining power of either the firm or the worker, and minimum wages (Acemoglu and Pischke, 1999a). Since guaranteeing the asset specificity to be 0 is crucial when testing my theory, I choose a lab experiment to ensure this holds.

5.1. Experimental Design

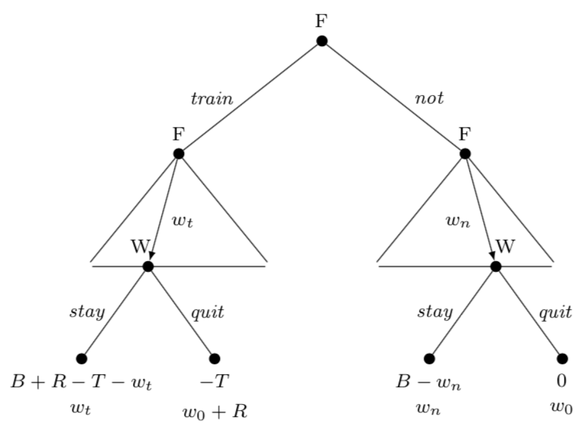
Sessions were conducted in the Economic Science Laboratory at the University of Arizona. The subjects were undergraduate students recruited from its recruiting site. No subject participated in more than one session of this study. The experiment is programmed using o-Tree (Chen, Schonger, and Wickens, 2016).

The experiment consisted of 10 sessions of 15 rounds.[18] The size of each session varies. If its size is large enough, the session is then be broken into two *groups*, and the subjects can

[18]There was one exception. Due to the software codes error, session 2 which is in the high-return treatment terminated at round 10. Except for the terminated round, other parts functioned well.

only match with others within his/her own group. The size of each session varies. If its size is large enough, the session is then be broken into two *groups*, where the subjects can only match with others within his/her own group. The size of those groups varies from six to ten, so in the extreme case, one worker is possible to rematch to three employers. However, subjects are not told once the session is broken into two groups, they are unlikely to think they are interacting with a relative small group of people.

One session lasted about 1 hour. On average a subject receives \$15.6. Instruction is read out loudly, and its copies are sent to every subjects. Subjects' questions are answered by the experimenter in private. In each session, every participant is randomly assigned to be either an employer or a worker at the beginning. Then each participant plays 15 rounds with the role fixed. In each round, an employer and a worker are randomly and anonymously paired up. The experiment is designed to reproduce the game form presented in Figure 1.

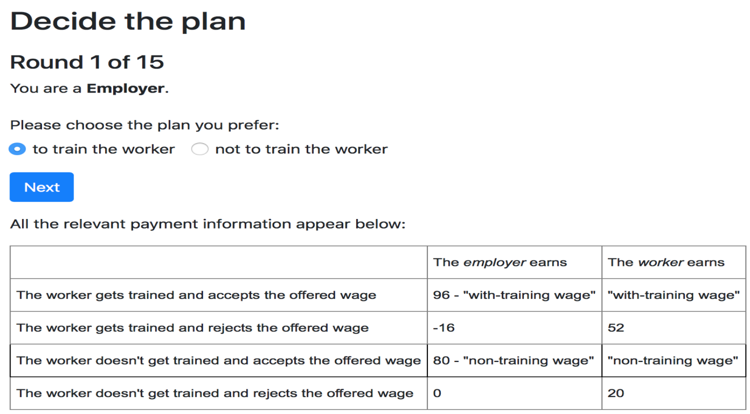


The parameters are chosen as $B = 80$, $T = 16$, $w_0 = 20$ so that the assumptions I made are satisfied. The payoffs are counted in points, and every 5 points is worth \$1. There are two treatments, a high-return treatment, in which $R = 60$, and a low-return treatment, in which $R = 32$. The rest of parameters, B, T, and w_0 are fixed. The experiment is framed suing an employer-worker description.

I use the strategy method to obtain subject's actions in each stage. Subjects simultaneously choose their corresponding strategies (as showing in the next figure):

An employer is first asked to indicate his preferred plan about whether to train the worker. Meanwhile, there is a 1/20 chance that the other plan, rather than the employer's preferred plan, will be implemented.[19] In details, the computer will select a number from 1

[19]When the error probability ϵ is small enough, the predictions are qualitatively the same. It can be shown that when the error rate ϵ is less than $\frac{3}{4}$ or $\frac{4}{11}$, respectively, the hypotheses presented in this paper will not be affected.



	The *employer* earns	The *worker* earns
The worker gets trained and accepts the offered wage	96 - "with-training wage"	"with-training wage"
The worker gets trained and rejects the offered wage	-16	52
The worker doesn't get trained and accepts the offered wage	80 - "non-training wage"	"non-training wage"
The worker doesn't get trained and rejects the offered wage	0	20

Fig. 2. Selecting The Training Plan

to 20. The not-preferred plan is implemented if the number 1 comes up. At the end of each round, the employer will learn this randomly generated number, as well as whether his/her preferred plan is implemented. By introducing the error rate ϵ, an employer has incentives to truthfully report both his with-training wage and his with-training wage. Then a employer offers both a "with-training wage"[20] and a "non-training wage".

A worker, before informed employer's choices, decides on both her lowest acceptable with-training wage and her lowest acceptable non-training wage. Depending on whether or not the worker gets trained, the worker accepts the offer of the employer if the corresponding wage offered by the employer is higher than her corresponding lowest acceptable wage. I ask workers to indicate cutoff strategies since by dragging a slider (as shown in the next figure) it is simpler and more intuitive.

For the purpose of exploration, I ask each worker to gives a rating on how kind she thinks about the employer after he/she observes the payoffs of both players.

Before the experiment, each of them is asked to finish a comprehension quiz. After all of the subjects correctly answer (if necessary, under the help of the experimenter), the software starts.

5.2. Hypotheses

Here I propose several hypotheses derived from my theory. Whereas, before I test them, it's meaningful to ask whether the classical theory (without reciprocity) can predict the subjects' behaviors well.

[20]To avoid confusion, I call it with-training wage than post-training wage in the instruction.

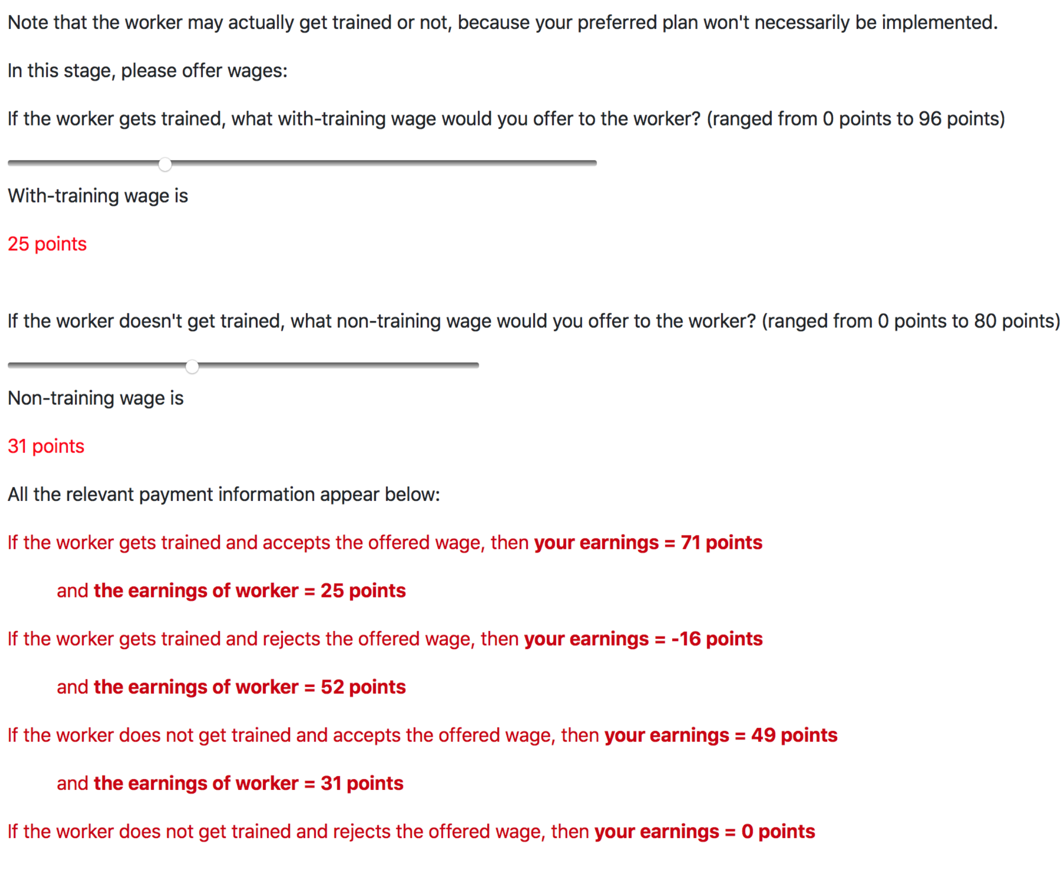
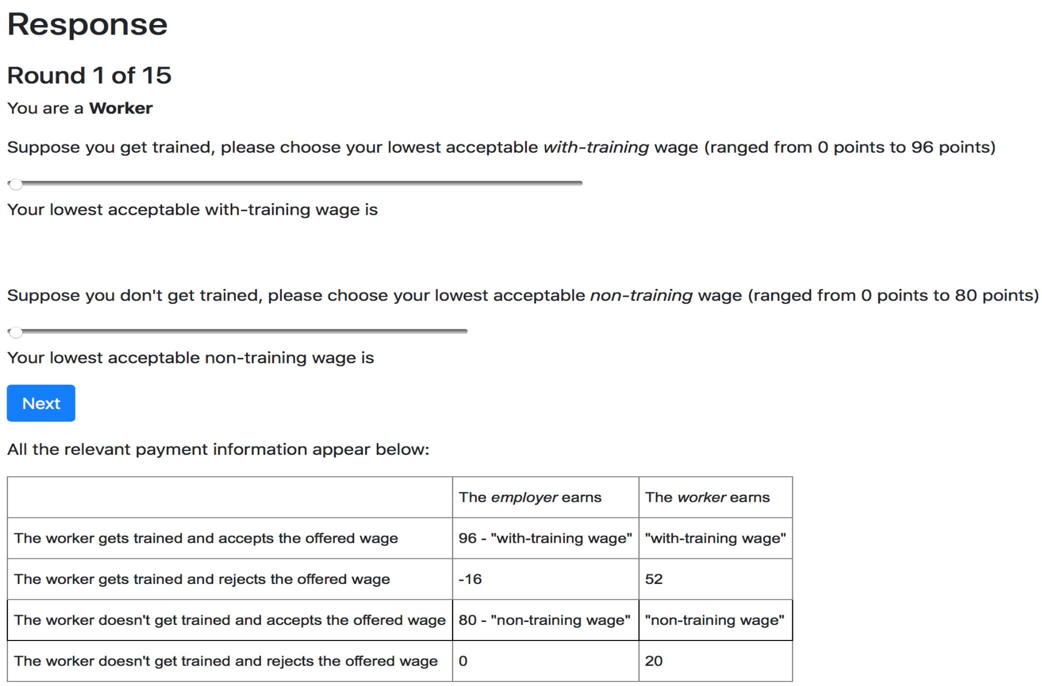


Fig. 3. Offering Wages



Response

Round 1 of 15

You are a **Worker**

Suppose you get trained, please choose your lowest acceptable *with-training* wage (ranged from 0 points to 96 points)

Your lowest acceptable with-training wage is

Suppose you don't get trained, please choose your lowest acceptable *non-training* wage (ranged from 0 points to 80 points)

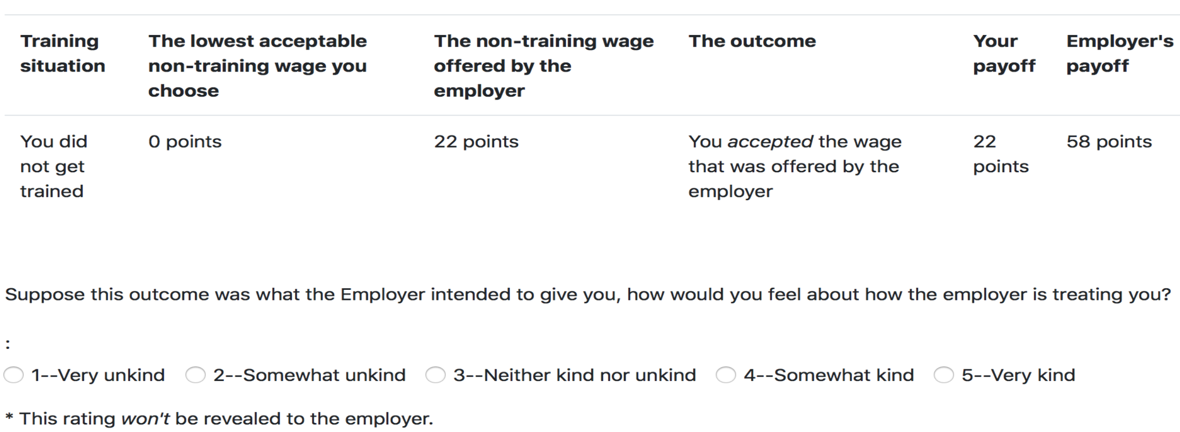
Your lowest acceptable non-training wage is

Next

All the relevant payment information appear below:

	The *employer* earns	The *worker* earns
The worker gets trained and accepts the offered wage	96 - "with-training wage"	"with-training wage"
The worker gets trained and rejects the offered wage	-16	52
The worker doesn't get trained and accepts the offered wage	80 - "non-training wage"	"non-training wage"
The worker doesn't get trained and rejects the offered wage	0	20

Fig. 4. Indicating The Lowest Acceptable Wages



Training situation	The lowest acceptable non-training wage you choose	The non-training wage offered by the employer	The outcome	Your payoff	Employer's payoff
You did not get trained	0 points	22 points	You *accepted* the wage that was offered by the employer	22 points	58 points

Suppose this outcome was what the Employer intended to give you, how would you feel about how the employer is treating you?

:

1--Very unkind 2--Somewhat unkind 3--Neither kind nor unkind 4--Somewhat kind 5--Very kind

* This rating *won't* be revealed to the employer.

Fig. 5. Ratings

The frequency of employers choosing to train the workers is 0 in each session.

Checking whether this statement hold true help to answer whether it is necessary to propose a new model incorporating non-standard preference. Suppose the standard model has a strong power to explain lab observations, the answer seems to be no.

Then, I test the following hypotheses in this paper:

Hypothesis 1. The frequency of employers choosing to train the workers is higher in the high-return ($R = 60$) treatment than the low-return treatment ($R = 32$).

Given the parameters $B = 80$, $T = 16$, $w_0 = 20$, I show that the higher R is, the lower θ is required to support a monotonic SRE that the employer will invest in general training. This is because a higher training return of training implies a more significant role of whether to train. When the training plays a more significant role, on the one hand, if a worker gets trained, he/she perceives more kindness (or less unkindness) from the employer; on the other hand, if a worker does not get trained, he/she perceives more unkindness from the employer. Thus, a higher R requires a lower worker's sensitivity of reciprocity, θ to ensure the firm finds it profitable to train the worker. The proof is in Appendix A. Recall Hypothesis 0, the classical theory predicts that the frequency of the choices to train will be the same for these two treatments.

In section 2, Proposition 2 implies that worker who gets trained requires a higher wage to stay than the non-training wage were she get no trained. This is from the fact that a worker, no matter selfish or reciprocal, will not appreciate the employer's investment in general training if the worker herself does not share any benefit from this training. Using the strategic method describe above, I can directly test this result:

Hypothesis 2. For workers, indicated lowest acceptable with-training wages are higher than indicated lowest acceptable non-training wages.

In an equilibrium, players have correct beliefs. This means that an employer who offers two wages which should satisfy that the with-training wage is higher than the non-training wage.

Hypothesis 3. For employers, the with-training wages are higher than the non-training wages.

Furthermore, as a significant feature of reciprocity theory, a player's strategy in a subgame can be affected by the actions those are outside of this subgame.[21] This is because the more

[21] This is not, whereas, a feature of the "distributional" social preference model, e.g. Fehr and Schmidt (1999).

significant the effect of the training on productivity improvement is, the more unkind a worker perceives from her employer if the employer abandons the training option. This results in that the worker is more prone to quit to negatively reciprocate her employer. The following two hypotheses are derived from this feature

Hypothesis 4. The indicated lowest acceptable non-training wages by workers in the high-return treatment are higher than those in the low-return treatment.

Hypothesis 5. The non-training wages offered by the employers in the high-return treatment are higher than those in the low-return treatment.

These last two hypotheses derived from the property of my model which is disagreed by other distributional preference models.

distinguish the prediction of my model from other social preference models.

5.3. *Experimental Results*

Here are the summary of the observed experimental data. The employers' training decision is given below:

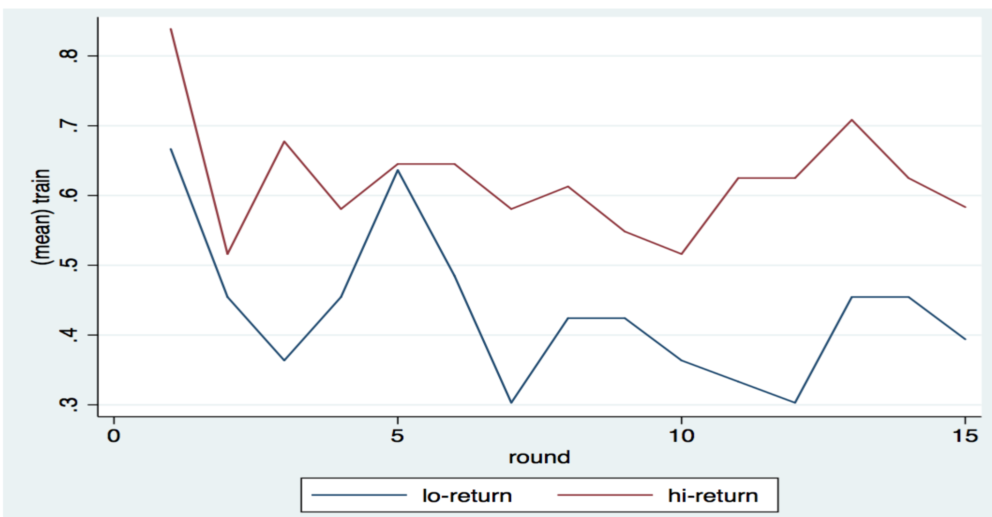


Fig. 6. Training rate

Then these two figures separately show the trends of with-training wages and non-training wages. The dash curves are the workers' indicated lowest acceptable wages. The solid curves are the wages offered by employers. Blue color means it is low-return treatment data, and red color means it is high-return treatment data.

From these figures, except the workers' acceptable with-training wages, other wages are significantly deviate from the long-dash curves—the wages predicted by the sub-game perfect

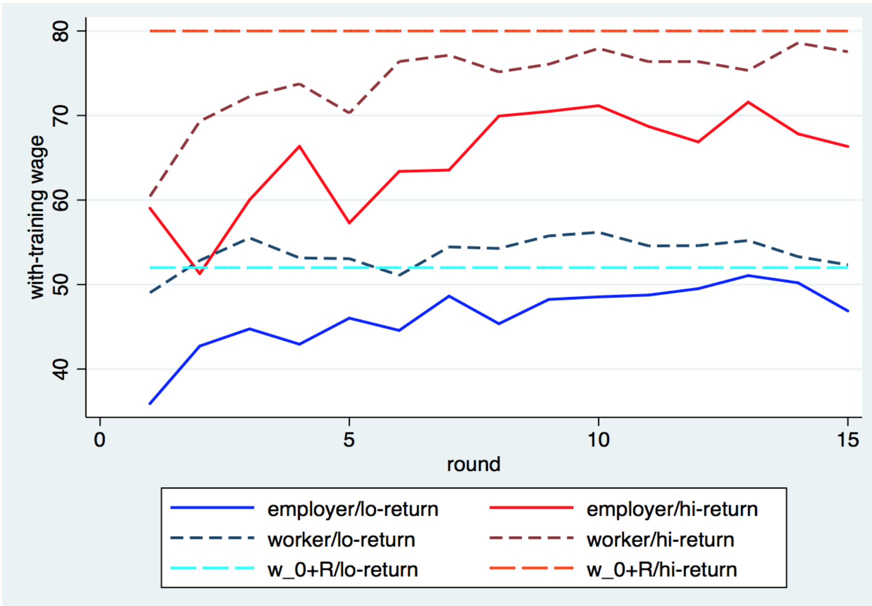


Fig. 7. With-training Wages

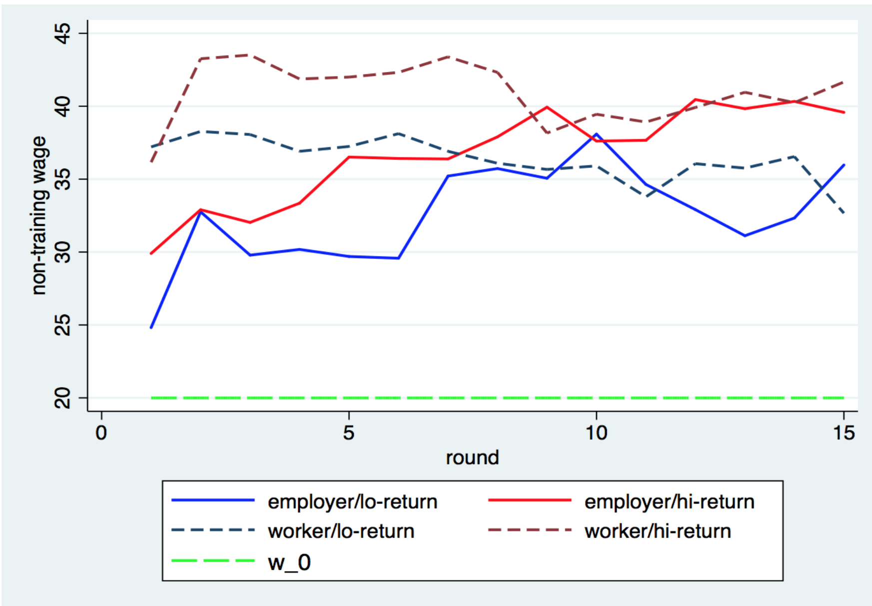


Fig. 8. Non-training Wages

equilibrium (with standard preference). These deviations contain interesting information, which I will come back to discuss later.

Do employers train?

Figure 6 shows that even they drop a few, the training rates of both treatments are not less than 30%. If I check the *group-wise* data, where each subjects can only possible match to others within his/her own group, then the training rate ranges from 35% to 72% in low-return treatment, and 40% to 77% in high-return treatment.

Result 1. The high-return training rate is greater than the low-return training rate.

H1	proportion of training	p-Value	Sample
MW Test	0.617 vs. 0.438	.0177	8 (H) vs. 8 (L) (groups)
Proportion Test	0.839 vs. 0.667	.0561	31 (H) vs. 33 (L) (employers 1st-round)

Table 1: Training Rate

I run two different tests. The Mann-Whitney test using the group-wise data, which contains information about subjects' behaviors after the first round. And the one-side Mann-Whitney test gives P-value 0.018. I also run the proportion test using subjects' first-round data. The result shows mild evidence with its P-value 0.056. Figure 6 shows that the treatment effect described in the Hypothesis 1 is as predicted—the red curve (training rate in the high-return treatment) should be above of the blue curve (training rate in the low-return treatment).

This result implies that subjects must be motivated by social preference.

For the firm, does training complement the wage?

The theory predicts that $w_t > w_n$. In the experimental observation, this means (a) a worker's lowest acceptable with-training wage is than his/her lowest acceptable non-training wage; (b) being aware of that, an employer offers a higher with-training wage than his/her non-training wage. So if I look at the scatters of each subject's wages (or indicated), they should be located in the left north-western area of the 45-degree line.

By the Sign Rank test using either the first-round individual-level data or the group-wise data, I find overwhelming evidence (P-values strictly less than 0.001) for the next two results:

Result 2. The workers' acceptable with-training wages are higher than the acceptable non-training wages.

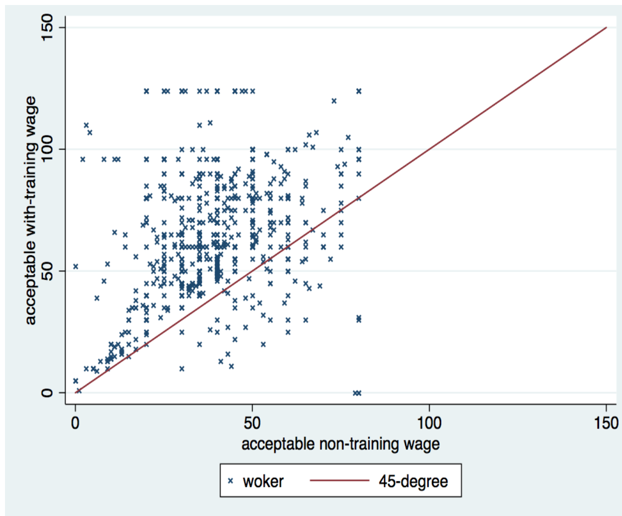


Fig. 9. Indicated Wages (by workers)

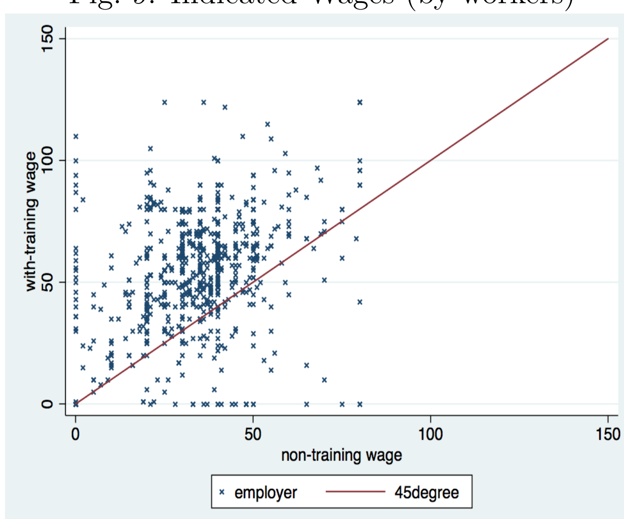


Fig. 10. Offered Wages (by employers)

Result 3. The with-training wages offered by the employers are higher than the non-training wages.

Sign Rank	Sample	$w_t > w_n$	p-Value
worker	group-wise	16/16	.0004
worker	1st round	57/64	.0000
employer	group-wise	16/16	.0004
employer	1st round	55/64	.0000

Table 2: With-training Wage vs. Non-training Wage

These results agree with the complementarity of the training and wage for the firm, which is summarized by Claim 2.

Reciprocity or Other Mechanism?

From Result 1, I find support that subjects are motivated by social preference, but do employers training activity incentivized by reciprocal mechanism?

The following results show that workers' responses are driven by reciprocity.

	non-training wage	p-Value	Sample
worker	40.99 vs. 36.35	.0371	group-wise
employer	36.49 vs. 32.53	.0708	group-wise

Table 3: Non-training Wages in Two Treatments

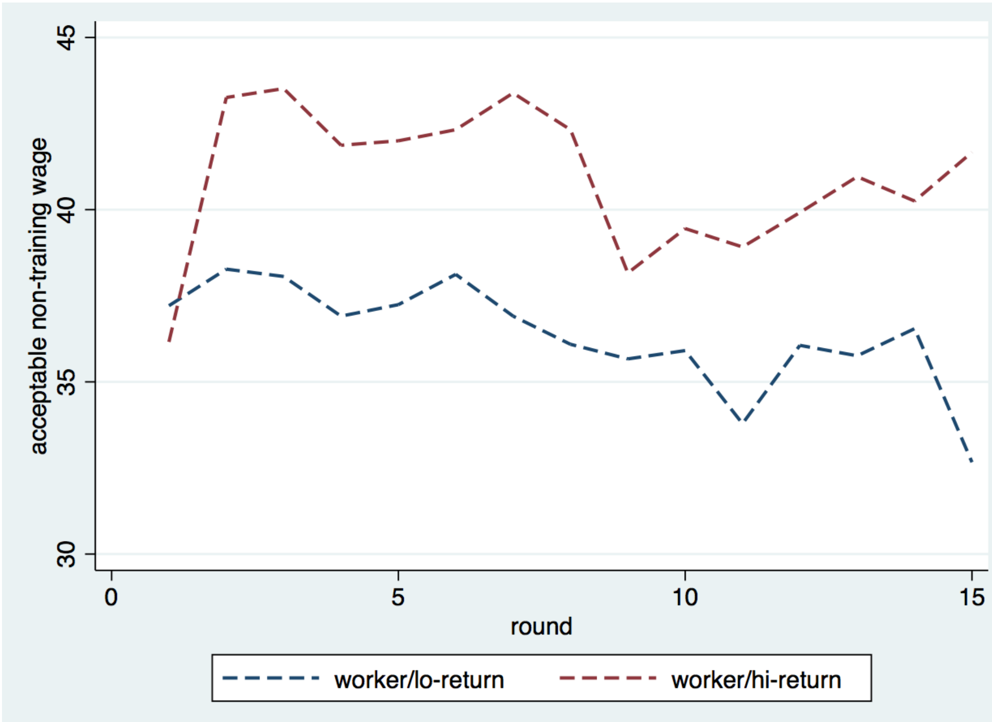
Result 4. The workers' acceptable non-training wages are higher in high-return treatment than the low-return treatment.

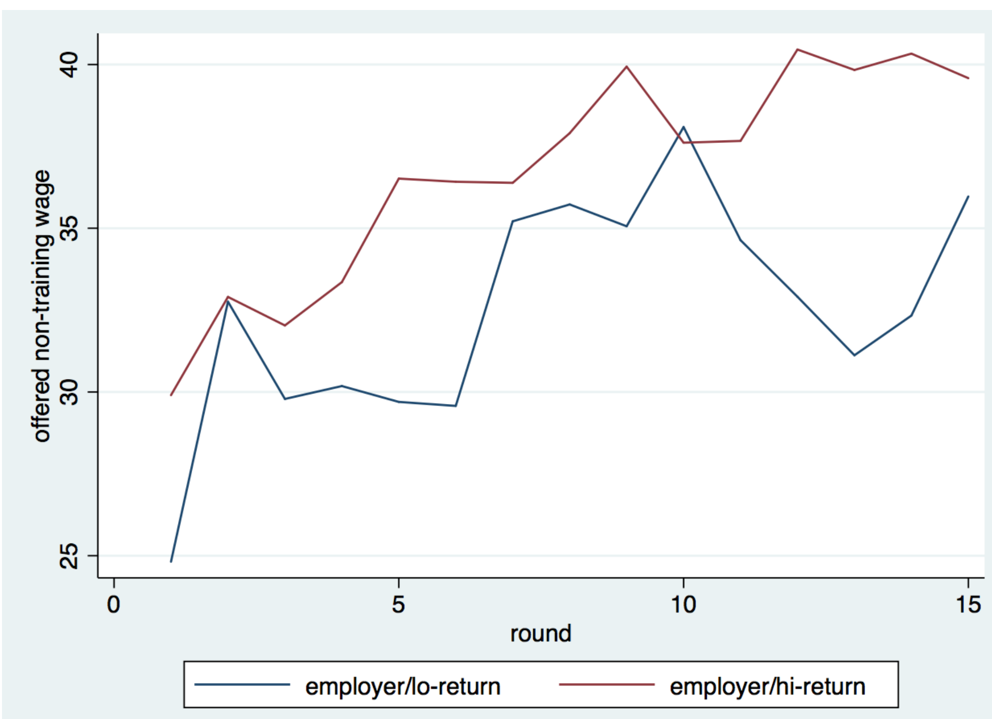
Result 5. There is mild evidence (P-value=0.07) that the non-training wages offered by employers are higher in the high-return treatment than in the low-return treatment.

5.4. Additional Observations

Training Decisions

As Figure 6 shows, the training rate is equaled to or above 30%. Do employers learn to train, or the reverse? By observing the subjects' behaviors, I find that in the aspect of training decisions, two third employers can be categorized into four types: those train almost


45
40
35
30
acceptable non-training wage
0
5
10
15
round
worker/lo-return
worker/hi-return


40
35
30
25
offered non-training wage
0
5
10
15
round
employer/lo-return
employer/hi-return

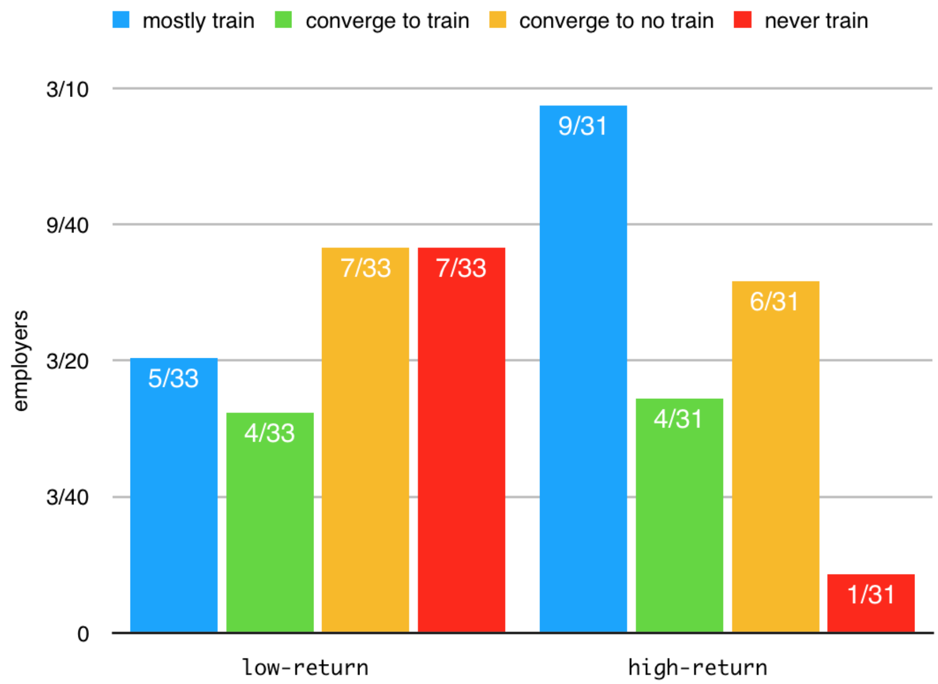


Fig. 11. Individual Training Behaviors

every round, those converge to train, those converge to no train, and those never train. The next figure illustrates the ratio of these four types:

The comparison of two treatments shows an increase of training types when switching from the low-return treatment to the high-return treatment. Is this switching rewarding? The next graph shows a high variation of payoffs if an employer trains almost every round or converges to train. This implies that an employer bears the risk which comes from the worker's disagreement with the offer. Despite the high variation, observe that the means of payoffs share a similar shape as the numbers of each training-related type. This indicates that such switching across treatments might be rewarding for employers.

6. Extensions and Implications

6.1. Subsidize the Firm

There are ways the government can encourage firms to provide training. One is to subsidize a firm whenever it provides training.[22] by making direct transfers or giving tax deductions. Such a subsidy has its direct effect that it reduces the training cost T.

[22]For example, the modern apprenticeship program in Scotland bears the training costs for the firm,

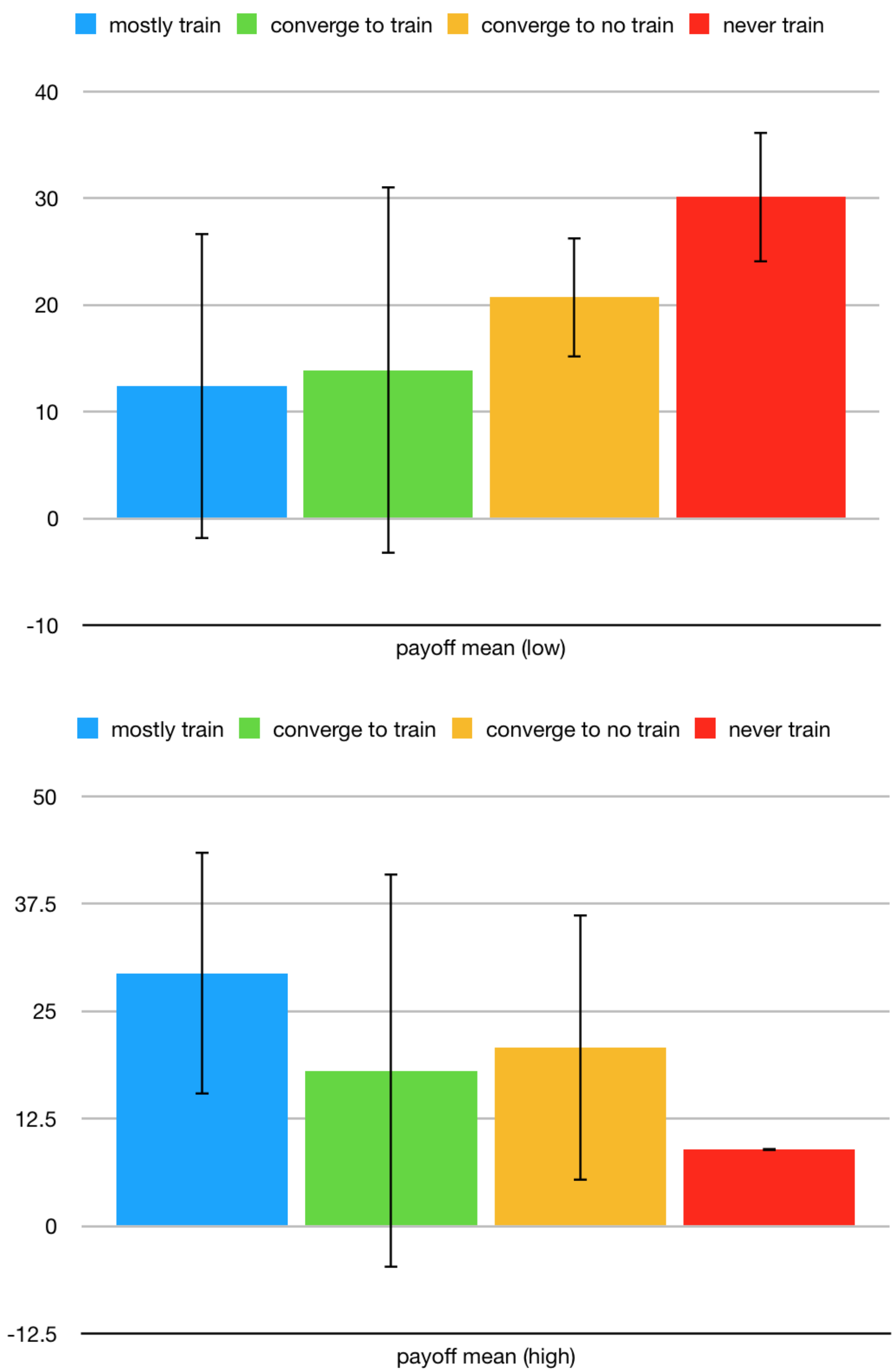


Fig. 12. Payoffs for Four Types of Employers

Remark 1. If $\theta = 0$, the monotonic SRE coincides to a standard sub-game perfect equilibrium. It predicts that the firm would provide training only if the subsidy is high enough to fully cover the training cost T.

What if the worker is reciprocal? Which party will gain from the subsidy, the firm, the worker, or both?

Proposition 7. *The subsidy on providing training leads*

- w_n^* *to increase,*
- w_t^* *to increase,*
- *the threshold* $\bar{\theta}$ *to decrease.*

The first two statements are true since a lower T increases the material payoff that the worker would think to be equitable, which determines whether the worker consequently perceives the firm's policy as kind or unkind. Thus, under a lower T, the worker is harder to satisfied so that both of the wages should rise.

The third statement is beyond the intuition which states that the firm is more likely to train simply because the training becomes cheaper. A lower T turns out to have more impacts. Note that this proposition also gives that both of the post-training wage and non-training wage rise when T goes down. The rising of both wages complicates the total effect of T on the firm's tendency to train. However, as a result of the calculation, the increment of w_t^* will not exceed the reduction of the training cost; put differently, $\frac{dw^*}{dT} < 1$. Thus, the firm's aggregated losses are decreased by the subsidy. As a result, any positive subsidy makes the firm more prone to train, which is different from the case when $\theta = 0$.

From this proposition, when the firm receives a subsidy and

- if θ is low so that the firm will not provide training (the red area in Figure 13), the worker receives a higher non-training wage and thus, the firm's profit *decreases*;
- if θ is medium so that the firm is "crowded in" to provide training (the blue triangle area), both the firm and the worker obtain higher earnings;
- if θ is high so that the firm will train even if there is no such a subsidy (the blue rectangle area), the firm obtains a higher profit meanwhile the worker receives a higher post-training.

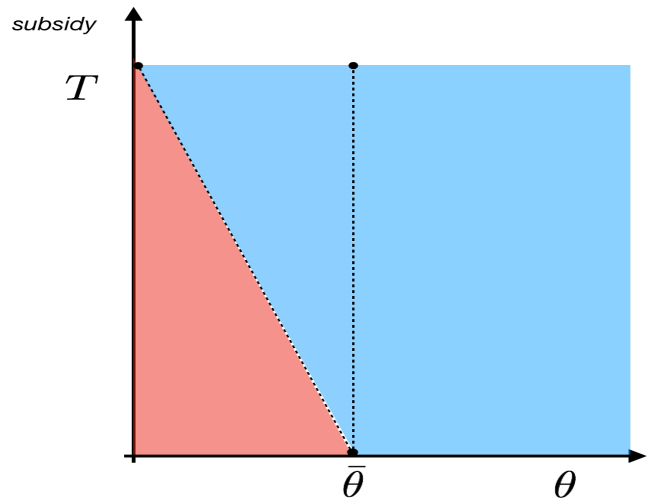


Fig. 13.

Therefore, I obtain the result of this section.

CLAIM 3. Subsidizing the firm increases the worker's earnings, but it does not necessarily increase the firm's profit.

6.2. Breach Remedies

To reduce the losses from the post-training turnover, firms may use contract of breach remedies, which is enforced across the U.S., and instances are reported in U.K. as well as Ireland (Kraus, 1993, 2008; Lavetti, Simon, and White, 2014). The contract, once enforced, imposes a quit penalty to a worker who leaves the firm after training.[23] Such a penalty has two effects (1) it encourages workers to stay as the attractiveness of quitting is (in the aspect of material payoff) less; (2) it helps to (partially) recover the training cost if the worker who gets trained quits.

One would expect a rational firm should always impose such a penalty whenever it can. However, this remedy is not always effectiveness since it is common that firms cannot collect all of the remedies meanwhile the accusation is costly. When the firm collects very few penalties, the situation is approximated by the original model in the previous section.[24]

[23]Hoffman and Burks (2017) study the effect of training contract on retention in the truck industry. Cappelli (2004) reports that in those firms who provide tuition assistant to their employees, about 20% of U.S. employers have stay requirements, and the average length of which is six months (IFEBP 2002).

[24]The firm Hoffman & Burks investigates collects roughly 30% of the penalty.

Reimbursement afterward does not ensure the firm obtain all of those remedies either, for it cannot prevent the worker from leaving after several months.

Given that breach remedies may or may not be effective in a particular industry, I investigate the impact of whether breach remedies are enforceable, rather than discuss what the optimal remedy design is. To see the impacts, I compare both of the situations with and without this enforceability Will a policy of breach remedies backfire? Which party is benefited? Hereafter, I give a generalization of the model in the previous section by introducing breach remedies if the worker who gets trained quits.

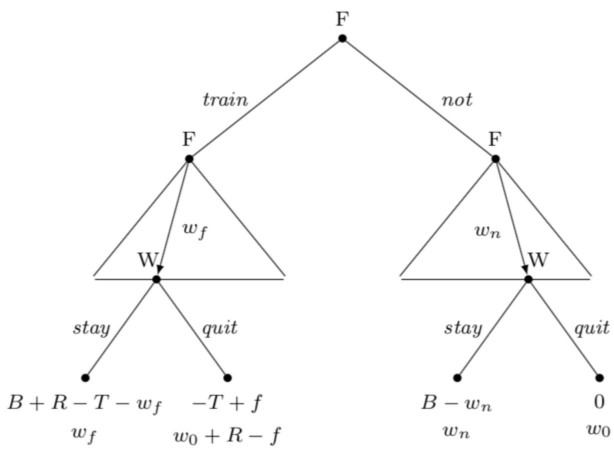


Fig. 14. General Training with Breach Remedies

Denoted by $f \geq 0$ the breach remedies, which will only be placed if the worker quits after training. If $f = 0$, it becomes the original game form. I assume $f < T$ for two reasons. The technical reason is to avoid the non-interesting case where the fine is so high that the firm finds it more profitable if the worker quits. The real-world reason has two aspects: first, courts have ruled that the amount owed under training contracts for an early exit must be *no larger than the cost of training for firms*[25] second, the firm cannot 100% collect the penalty in reality. These two aspects together mean that f is strictly less than the training cost T. w_f is the post-training wage. To simplify the analysis, I first assume the firm does not have a choice to *waive* the remedies. This assumption can be loosed and I will come back to it.

I obtain the following result predicted the unique monotonic SRE.

Remark 2. When $\theta = 0$, the monotonic SRE coincides to a standard sub-game perfect equilibrium. It gives that

- $\hat{w}_f = w_0 + R - f$

[25] see e.g. Chung (1992)

- $\hat{w}_n = w_0$
- the firm chooses not to train, which gives it the profit $B - w_0$, higher than the profit if the firm trains, $B - w_0 - T + f$.

The next proposition is a generalization of the Propositions (2,4,5) in the original model.

Proposition 8. *There exists a unique monotonic SRE in this problem, in which*

- $w_f^* > w_n^*$
- *there exists a* $\bar{\theta}_f > 0$ *s.t. the firm trains if and only if* $\theta > \bar{\theta}_f$.

The two properties hold: (1) receiving training increases the worker's income; (2) when the worker is sufficiently reciprocal, the firm will train.

Since the game in this section generalizes the original model, the influence when f changes from 0 to a positive number helps shedding light on the effect from whether or not breach remedies are enforceable in a market.

Proposition 9. *In the monotonic SRE, if* $\theta > 0$, *then*

- $\frac{dw_n^*}{df} = 0$
- $\frac{dw_f^*}{df} < 0$
- $\bar{\theta}_f$ *decreases as* f *increases.*

This proposition implies:

1. Whether or not breach remedies are enforceable does not affect the non-training wage. This result is not trivial in a game including a reciprocal player, since global environmental changes may or may not affect the equilibrium (e.g., Lemma 4.5).
2. The firm pays a lower wage for the worker who gets trained when the breach remedies are enforceable. It is obvious when $\theta = 0$, but how come when $\theta > 0$?
   One may think relative to the situation where breach remedies exist, the worker who gets trained is easier to be satisfied by the same level of offered wage under the situation where there's no remedy, as the training without remedy looks "nicer" than the training with breach remedies. However, this logic cannot be true as we have learned from Proposition 4 that providing training is not strategic substitute for offering a higher wage. Let alone the statement that the training without remedy is "nicer" is incorrect. This is because when the post-training wage is fixed, f will not affect (a) the material payoff the firm on-path expectation on the worker's material payoff; (b) the highest and lowest payoffs the firm *is able to* give the worker.

In fact, the breach remedies f *ceteris paribus* have two effects: (i) it reduces the worker's material temptation from leaving, thus give a negatively impact on w_f^*; (ii) it scales down the role of the worker's reciprocal payoffs, in that the worker has a weaker punishment power to the firm if she deviates to quit. Thus, the worker motivated fewer from her reciprocal concern during she is making decisions. Effect (ii) has an undetermined impact, depending on whether or not the worker perceives kindness.[26] However, whenever it has a positive impact on w_p^*, it is dominated by the negative impact of the effect (i) (Lemma B.5). So in aggregate the imposition of breach remedies f lowers the on-path post-training wage.

3. The breach remedies encourage firm investing in training. This directly answer the first question in above—NO, breach remedies will not backfire. In other words, it *will not* crowd out a firm which would train the worker when there is no remedy.

So far these implications haven't say something dramatically different from our "intuition" obtained from the analysis of a standard model where the worker is selfish, namely, the case when $\theta = 0$. However, I get an interesting result if I combine together the two propositions in this section:

CLAIM 4. Breach remedies increase the firm's profit, but do not necessarily increase the worker's earnings.

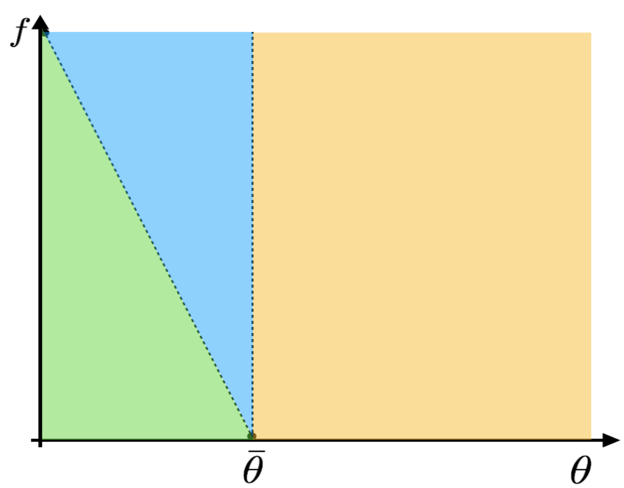


Fig. 15.

In detail, when the breach remedies are enforceable,

[26]From Proposition 3, this is determined by the industrial environment (the parameters).

- if θ is low enough so that the firm will not provide training (the green area in Figure 15), the breach remedies have *no* effect on the incomes of both parties;
- if θ is medium so that the firm is "crowded in" to provide training (the blue area in Figure 15), the earnings of both parties go up;
- if θ is high enough that the firm will train even if there is no breach remedies (the yellow area in Figure 15), the firm's profit increase whereas the worker's income *decreases*.

Discuss: Endogenizing the Fine

Till now, I have assumed the remedies level f is exogenous. Hereafter I lose this assumption by allowing the firm to decide the level of breach remedies $\mathfrak{f} \in [0, \bar{f}]$ which is continued restricted to be strictly lower than T ($\bar{f} < T$). Given the worker is reciprocal, what is the optimal level? Is the firm willing to waive the breach remedies?

It turns out that the firm will choose the highest possible level $\mathfrak{f} = \bar{f}$ when optimal. From Proposition 9, increasing or decreasing the breach remedies *ceteris paribus* will not directly affect the firm's kindness to the worker, which is directly influenced by (a) the worker's on-path material payoff and, (b) the firm's equitable payoff to the worker. Thus, the "generosity" of waiving the remedy will not lower the worker's acceptable post-training wage. And that proposition implies that the firm prefers to choose the highest possible breach remedies level.

6.3. Accreditation

Accreditation (e.g. General National Vocational Qualifications (GNVQ)) is sometimes argued to be a manner to overcome market failure where there is informational asymmetry about the value of training. Booth and Bryan (2002) find training that transformed from specific to general by government's qualification.[27] Then I ask if an accreditation turns training from specific to general, how will it impact the firm's and the worker's earnings.

In this section, I focus on this kind of training and investigate the impacts of the accreditation. To do this, I make a comparison *across* two games, before and after the conveying of training value. The after-convey game is exactly the general training game in Figure 1. To obtain the before-convey game tree, which is in fact a specific training problem, I slightly modify end-node material payoff s.t. if the worker who gets trained quits, she obtains w_0 instead of $w_0 + R$ due to the asymmetry of information about the value of training.

Denoted by w_{st}, w_{sn} the wages before conveying.

[27] In the British Household Panel Survey (BHPS) data they investigate, accredited training increases the trainees' wages in their future firms, whereas non-accredited training does not.

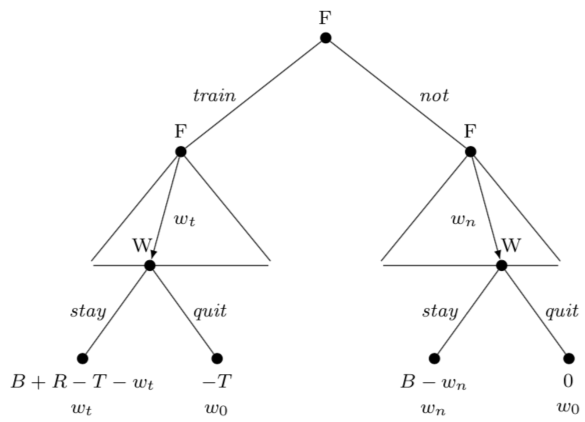


Fig. 16. Before Conveying

Remark 3. If $\theta = 0$, the monotonic SRE coincides to a standard sub-game perfect equilibrium. It gives that (a) $\hat{w}_{st} = \hat{w}_{sn} = w_0$—the training will not affect the wage, as the latter is determined by the worker's outside income; (b) the firm will train the worker, and obtain the total share of the training net return, $R - T$.

It is notable that the theory implies that if the worker is egoistic, (government's) conveying of training value *will not* increase the worker's benefit, for it crowds out the firm's training investment. This finding is not beyond what has been discussed by Katz and Ziderman (1990).

Proposition 10. *There exists a unique monotonic SRE. It states that a firm strictly prefer to provide training whenever $\theta > 0$. Also, the worker is income is higher if she gets trained, that is, $w^*_{st} > w^*_{sn}$.*

In the proof of the proposition, I also observe that

Lemma 6.1. *Recall that w^*_t and w^*_n are wages in the general training problem. For the same parameters,*

- $w^*_{st} < w^*_t$
- $w^*_{sn} = w^*_n$

This lemma says that whether or not the training value is private information of the current firm will not affect the wage received by the worker who *does not* get trained. However, for a worker who gets trained, publicizing the training value increases the benefit the worker can extract from the training.

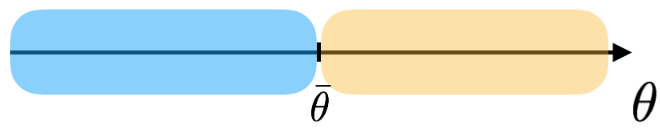


Fig. 17.

In sum, I obtain the following claim.

CLAIM 5. There is training such that accreditation may crowd out firms that would provide training. However, worker reciprocity can mitigate such crowding out.

In addition, those workers who therefore gets trained obtain higher incomes due to the accreditation.

6.4. Continuous-Training Model

In a more general case, a firm decides the level of training to offer. I analyze this situation where the firm chooses $\tau \in [0, T]$ in the first stage. And I will show that the continuous-training model will not provide us more implications than the binary-choice training model

The main insight of this paper still holds: the firm will sponsor the training, and its investment is mainly driven by the worker's negative reciprocity if the firm does not train.

In the first period of this model, the firm chooses a level of training $\tau \in [0, T]$. Denoted by r *the rate of training return* where r is a constant strictly greater than 1. $w(\tau)$ represents the wage(s) offered after τ is provided. $w(\tau)$ is assumed to be a function of τ. This assumption does not affect the results since in a monotonic SRE the firm will not offer two different wages after it chooses τ.[28] Similar to the original model, $w(\tau)$ satisfies that $w(\tau) \in [0, B+n(r-1)\tau]$. This model is illustrated by Figure 18. Suppose $\theta = 0$, $\tau = 0$ in the unique sub-game perfect equilibrium.

[28]Recall that in a monotonic SRE, the worker plays a cutoff (sub-)strategy given any τ. Consequently, offering multiple wages given a training level of τ cannot be optimal for the firm.

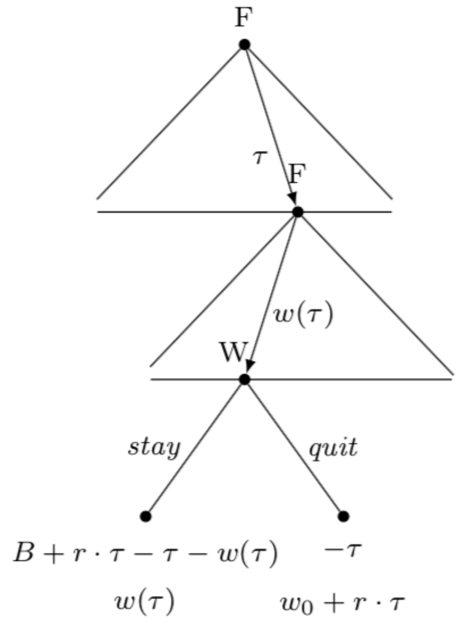


Fig. 18. Continuous-training model

With $\theta > 0$, main properties in section 4 are preserved:

Lemma 6.2. *The following statements remain true in continuous-training version model:*

1. $A_F = E_F$
2. *In a monotonic SRE,* $\pi_W^e(\cdot) = \frac{B+rT-T+w_0}{2}$
3. *In a monotonic SRE, let* $w^*(\tau)$ *be the optimal wage policy function of the firm, then* $w^*(\tau)$ *exists for any* $\tau \in [0, T]$

Directly, I obtain the existence and uniqueness of monotonic SRE.

Proposition 11. *There exists a unique monotonic SRE in the continuous-training problem.*

The following result shows that the finding of complementarity of training and the wage for the firm is robust.

Proposition 12. $w^*(\tau)$ *increases as* τ *goes up.*

Proof. I show that $\frac{dw^*(\tau)}{d\tau} > 0$.

$$\frac{dw^*}{d\tau} = \frac{1}{2\theta}\left(\theta r - \frac{(B + r\tau - \pi_W^e)\theta^2 r - r\theta}{\sqrt{(B + r\tau - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0 - 2r\tau)\theta + 1}}\right)$$

For any $\theta \geq 0$, since $(B + r\tau - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0 - 2r\tau)\theta + 1 > 0$, the following statement is true:

$$
\begin{aligned}
& B > w_0 \\
& \Rightarrow (2\pi_W^e + 2B - 4w_0 - 2r\tau)\theta > (-2B - 2r\tau + 2\pi_W^e)\theta \\
& \Rightarrow (B + r\tau - \pi_W^e)^2\theta^2 + (2\pi_W^e + 2B - 4w_0 - 2r\tau)\theta + 1 > (B + r\tau - \pi_W^e)^2\theta^2 - 2(B + r\tau - \pi_W^e)\theta + 1 \\
& \Rightarrow \sqrt{(B + r\tau - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0 - 2r\tau)\theta + 1} > (B + r\tau - \pi_W^e)\theta - 1 \\
& \Rightarrow \left(\theta r - \frac{(B + r\tau - \pi_W^e)\theta^2 r - r\theta}{\sqrt{(B + r\tau - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0 - 2r\tau)\theta + 1}}\right) > 0
\end{aligned}
$$

□

The continuous-training model seems richer than the main model in section 4. The next result shows that even the firm is feasible to give any training level within $[0, T]$, it will train all or nothing.

Proposition 13. *The optimal training level is $\tau^* \in \{0, T\}$*

Proof. Let $\Pi = B + (r - 1)\tau - w^*(\tau)$,

$$
\frac{d\Pi}{d\tau} = \frac{r[(B + r\tau - \pi_W^e)\theta - 1]}{2\sqrt{(B + r\tau - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0 - 2r\tau)\theta + 1}} + r/2 - 1
$$

Note that the first order condition does not implies optimal τ, since the function Π is not concave. In fact, for $\theta > 0$, this first order derivative implies that Π is monotonic increasing, monotonic decreasing, or with a U-shape. Therefore τ^* is a corner solution.

□

Immediately, it implies that there is no under-investment of training once the firm is willing to support the training.

Corollary 2. *If the firm invests some training, then it invests the full training.*

7. Concluding Remarks

Intuition may suggest that the widely observed firm-sponsored general training can be explained by worker's post-training reciprocal behaviors. I show that a firm would train if the worker has a strong reciprocal inclination. However, my analysis suggests that rather than the worker's positive reciprocating, the investment is mainly driven by the worker's negative reciprocal behavior if the firm does not train. This finding helps to coordinate the empirical evidences that (a) employers consider workers' reciprocal inclinations when providing training (Dohmen, Falk, Huffman, and Sunde, 2009; Sauermann, 2015); (b) only the *negative* reciprocity last long in the field (Kube et al., 2006). In additional, I show that the worker always extracts some benefit from the training, no matter how reciprocal she is.

To test my theory, I conduct a laboratory experiment. It shows that deviating from standard model's prediction, the training rate is significantly higher than 0. Also, The workers' incomes boost if they get trained. Furthermore, the observations provide at least mild evidences (significance presents when using the worker-side data, but not for the employer-side) for the reciprocity mechanism I propose.

Moreover, I extend my main model into different situations and propose implications about the effect of breach remedies (typically with training contracts), training subsidy, and accreditation when the worker is reciprocal. If the worker has a standard preference, these policies seem harmless in the sense that if they fail to crowd in the firm to provide training, the incomes of both parties will not be affected. However, I suggest that the harmlessness of these policies may not hold if the worker is reciprocal—either the firm's or the worker's income can be reduced whenever there is no crowding in. These implications inspire further (both theoretical and empirical) studies about the interaction between training-related policies and reciprocity.

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Appendix A. Deriving Hypotheses

- Hypothesis 0 is from the prediction of standard theory that the firm will not provide training.
- Hypothesis 1 is from the Lemma showing below:

Lemma A.1. *Let $\bar{\theta}$ be the threshold sensitivity above which will the firm provide training. Then* $\frac{d\bar{\theta}}{dR} < 0$

Proof. Let $\mathcal{G} := R - T + w_n^*(\theta) - w_t^*(\theta)$, where I treat the optimal wages w_t^* and w_n^* as functions of θ and R; $\bar{\theta}$ is the solution of $\mathcal{G} = 0$.

$$\begin{aligned}
\frac{d\mathcal{G}(\bar{\theta})}{dR} &= \frac{\partial \mathcal{G}(\bar{\theta})}{\partial w_n^*}\frac{dw_n^*}{dR} + \frac{\partial \mathcal{G}(\bar{\theta})}{\partial w_t^*}\frac{dw_t^*}{dR} + \frac{\partial \mathcal{G}(\bar{\theta})}{\partial R} \\
0 &= \frac{dw_n^*}{dR} - \frac{dw_t^*}{dR} + 1 \\
0 &= \frac{\partial w_n^*}{\partial \bar{\theta}}\frac{d\bar{\theta}}{dR} + \frac{\partial w_n^*}{\partial R} - \frac{\partial w_t^*}{\partial \bar{\theta}}\frac{d\bar{\theta}}{dR} - \frac{\partial w_t^*}{\partial R} + 1
\end{aligned}$$

Thus,

$$\frac{d\bar{\theta}}{dR}[\frac{\partial w_t^*}{\partial \bar{\theta}} - \frac{\partial w_n^*}{\partial \bar{\theta}}] = 1 + \frac{\partial w_n^*}{\partial R} - \frac{\partial w_t^*}{\partial R}$$

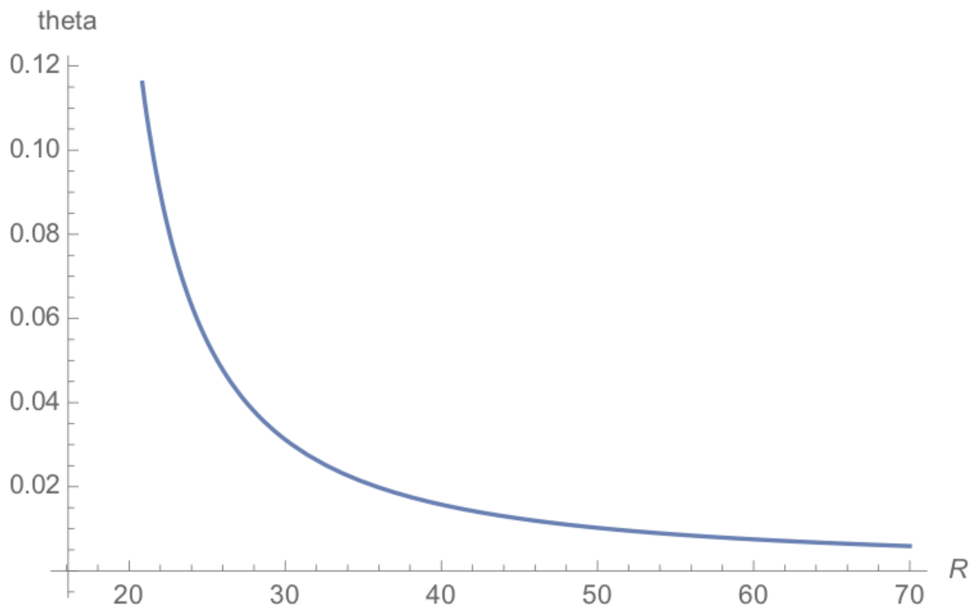
Denoted by $G = w_t - w_0 - R + \theta(B + R - w_t)(w_t - \pi_W^e)$, the left-hand-side of PCT, where w_t^* makes $G = 0$. Apply the implicit function theorem again, and get $\frac{\partial w_t^*}{\partial R} = -\frac{\frac{\partial G}{\partial R}}{\frac{\partial G}{\partial w_t^*}}$. Then it turns out that

$$\frac{\partial w_t^*}{\partial R} = \{1 + \theta(B + R - w_t^*)\frac{d\pi_W^e}{dR} - \theta(w_t^* - \pi_W^e)\}/[1 - \theta(w_t^* - \pi_W^e) + \theta(B + R - w_t^*)]$$

$\Rightarrow$

$$1 - \frac{\partial w_t^*}{\partial R} = \frac{\frac{1}{2}\bar{\theta}(B + R - w_t^*)}{1 - \bar{\theta}(w_t^* - \pi_W^e) + \bar{\theta}(B + R - w_t^*)} > 0$$

By Proposition 3, at $\theta = \bar{\theta}$, it must be $\frac{\partial w_t^*}{\partial \theta} - \frac{\partial w_n^*}{\partial \theta} < 0$.
Therefore, $\frac{d\bar{\theta}}{dR}$ must be *negative*—a higher return of training encourages the firm to provide training.
An illustration of the relationship between $\bar{\theta}$ and R is shown in the next Figure A



□

- Hypothesis 2 & 3 are directly from Proposition 4.
- Hypothesis 4 & 5 are directly from Lemma 4.5.

Appendix B. Proofs

First I give a useful Lemma which is useful when calculating the on-path equitable payoff to the worker:

Lemma B.1. *In a SRE, the minimum material payoff that the firm believes it can give the worker equals* w_0*.*

Proof. Suppose there is a SRE contains a strategy profile a_F, a_W s.t. the minimum payoff that the believes it can give the worker is strictly lower than w_0, then by the correctness of beliefs: $b_{FW} = a_W$, the worker should chooses to stay given a wage lower than w_0. This wage can be either a post-training wage w_t, or a non-training wage w_n. Denoted by $\underline{w_t}$ the lowest acceptable post-training wage; by $\underline{w_n}$ the lowest acceptable non-training wage. Then $\min\{\underline{w_t}, \underline{w_n}\} < w_0$. This is, however, not true in a SRE:
If $\underline{w_t} \geq \underline{w_n}$, then $\underline{w_n} < w_0$, which means the worker will choose to stay if she gets no training and is offered $\underline{w_n}$. In this case, the worker is not treated kindly, since she gets the worst possible material payoff the firm can give her, which is strictly lower than the equitable payoff to the worker, π_W^e. By *staying*, however, is a kindly action to the firm, since it gives the firm strictly positive profit, which is greater than 0—the material payoff she can give if

she chooses to *quit*. Thus, the worker's reciprocity payoff can turn from negative to (weakly) positive by deviating to *quit*. On the other hand, such a deviation can also increase her material payoff, from $\underline{w_n}$ to w_0. Thus, the worker will prefer to deviate from such a strategy. The argument is the same if $\underline{w_t} < \underline{w_n}$. Therefore, such a strategy cannot be survive in a SRE. Meanwhile, the firm is feasible to choose *not* to train and then gives a w_n too low to be accepted. By doing so, the firm can give the worker the minimum material payoff, which is equal to w_0.

□

Proof for Lemma 4.1. To show at $h = train$, there is $w_{t2} > w_{t1}$ s.t. the worker will reject w_{t2} but accept w_{t1}, I need to find a pair (w_{t1}, w_{t2}) s.t.

- Her utility at $h = (train, w_{t2})$ is weakly higher if she chooses quit than stay
  $\Leftrightarrow$
  $w_0 + R \geq w_{t2} + \theta(B - w_{t2} + R)(w_0 + R - \frac{B+R-T+w_0}{2})$
- Her utility at $h = (train, w_{t1})$ is weakly lower if she chooses quit than stay
  $\Leftrightarrow$
  $w_{t1} + \theta(B - w_{t1} + R)(w_{t1} - \frac{B+R-T+w_0}{2}) \geq w_0 + R$

In above, $\frac{B+R-T+w_0}{2}$ turns out to be the equitable payoff π_W^e (given the correct beliefs) in this SRE. To complete the proof, consider $w_{t1} = \frac{B+R-T+w_0}{2}$, and some $w_{t2} > w_{t1}$. Moreover, by $B > w_0+R+T$, $w_0+R < \frac{B+R-T+w_0}{2}$. This implies that the second condition: $w_{t1}+\theta(B-w_{t1} + R)(w_{t1} - \frac{B+R-T+w_0}{2}) > w_0 + R$ is always true for any $\theta \geq 0$; and the first condition: $w_0 + R \geq w_{t2} + \theta(B - w_{t2} + R)(w_0 + R - \frac{B+R-T+w_0}{2})$ can be true if θ is large enough.

□

Proof of Lemma 4.2. Now I show a strategy of worker, $\tilde{a}_W$ s.t.

- after she gets trained, she rejects all $w_t \in [0, B + R - T]$
- after she gets no training, she plays a cutoff strategy where there is a value in $[0, B]$ that she will choose to stay if and only if w_n offered is greater than that value.

can be in a SRE. I first figure out the equitable payoff for the worker. Given this strategy, the maximum payoff the firm can give her is $\max \pi_W(a_F, \tilde{a}_W) = \max\{B, w_0 + R\}$, who are from (a) the firm chooses *not* to train, and then offers $w_n = B$, and (b) the firm chooses to train the worker. The minimum payoff the firm can give is w_0, by Lemma B.1. Thus, the equitable payoff to the worker is $\pi_W^e = \frac{\max\{B,w_0+R\}+w_0}{2}$.

I skip the check after $h = not$. If the firm trains, and gives any w_t, by the correctness of the firm's beliefs, it now expects the worker choosing to *quit*. Thus, the perceived kindness from the firm to the worker is $\lambda(\cdot) = w_0 + R - \pi_W^e$, which is a constant. When $B > w_0 + 2R$, this term is strictly negative, meaning that the firm's move is perceived as unkind. For the worker, $u_W^{quit} \geq u_W^{stay} \Leftrightarrow w_0 + R \geq w_t + \theta \cdot \lambda(\cdot)(B + R - w_t)$, which can be true when $\theta > 0$ is large enough.

□

Proof of Lemma 4.3. Recall its definition:

$$\pi_W^e(b_{FW}) = \frac{1}{2}(\max\{\pi_W(a_F, b_{FW})|a_F \in A_F\} + \min\{\pi_W(a_F, b_{FW})|a_F \in A_F\})$$

By Lemma B.1, in a SRE, $\min\{\pi_W(a_F, b_{FW})|a_F \in A_F\}) = w_0$. On the other hand, by monotonicity, if the firm offers the highest feasible offer, that is, supporting the training and pay all it earns to the worker: $w_t = B + R - T$, the worker will accept it and get the material payoff $B + R - T$. Plugging in both terms, I get the result. □

Proof of Proposition 2. First I show the profile given by Proposition 2 is a SRE. From the above two Lemmata, I can calculate the kindness of the worker (W) to her employer (F), κ_{WF} and the worker's perceived kindness from her employer to herself, λ_{WFW}.

Here, I focus on the profile s.t. the firm (correctly) expects the worker will reply *stay* at $h = (train, w_t)$ and $h' = (not, w_n)$. Thus,

- at $h = (train, w_t)$
  -
  $$\lambda_{WFW}(\cdot) = w_t - \frac{B + R - T + w_0}{2}$$
  -
  $$\kappa_{WF}(h, stay) - \kappa_{WF}(h, quit) = (B + R + w_0)$$
- at $h' = (not, w_n)$
  -
  $$\lambda_{WFW}(\cdot) = w_n - \frac{B + R - T - w_t}{2}$$
  -
  $$\kappa_{WF}(h', stay) - \kappa_{WF}(h', quit) = (B - w_n)$$

At $h = (train, w_t)$, in order to make the worker chooses to stay, w_t should satisfies the participation constraint after training (PCT): $u_W(h, stay) - u_W(h, quit) \geq 0$. Similarly, at $h' = (not, w_n)$, in order to make worker chooses to stay, w_n should satisfies the participation constraint if she is not trained (PCN): $u_W(h', stay) - u_W(h', quit) \geq 0$.

At $h = (train, w_t)$, the worker will chooses to stay if the following **PCT** holds:

$$u_W(h, stay) - u_W(h, quit) = w_t - w_0 - R + \theta \cdot (B + R - w_t) \cdot (w_t - \frac{B + R - T + w_0}{2}) \geq 0 \tag{7}$$

At $h' = (not, w_n)$, the worker will chooses to stay if the following **PCN** holds:

$$u_W(h, stay) - u_W(h, quit) = w_n - w_0 + \theta(B - w_n)(w_n - \frac{B + R - T + w_0}{2}) \geq 0 \tag{8}$$

To see why the equitable note that

$$\begin{aligned}
&u_W(h, stay) - u_W(h, quit) \\
&= w_t + \theta \cdot \kappa(h, stay) \cdot \lambda(h, stay) - [w_0 + R + \theta \cdot \kappa(h, quit) \cdot \lambda(h, stay)] \\
&= w_t - w_0 - R + \theta \cdot \lambda(h, stay)[\kappa(h, stay) - \kappa(h, quit)]
\end{aligned}$$

where

$$\begin{aligned}
&\kappa(h, stay) - \kappa(h, quit) \\
&= \pi_F(stay, b_{WF}(h)) - \pi_F^e(b_{WF}(h)) - [\pi_F(quit, b_{WF}(h)) - \pi_F^e(b_{WF}(h))] \\
&= \pi_F(stay, b_{WF}(h)) - \pi_F(quit, b_{WF}(h))
\end{aligned}$$

which is irrelevant to the value of $\pi_F^e(b_{WF}(h))$.

As a profit-maximizer who want to introduce the worker chooses to stay after h and h', the firm chooses the optimal wage scheme s.t both the PCT and PCN are binding.

Hereafter, I use π_W^e to represent $\frac{B+R-T+w_0}{2}$. By calculation, w_t^* solves PCT exists:

$$w_t^* = \frac{[(\pi_W^e + B + R)\theta + 1] - \sqrt{(B + R - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0 - 2R)\theta + 1}}{2\theta} \tag{9}$$

and $w_t^* \in (0, B + R - T)$

w_n^* solves PCN exists:

$$w_n^* = \frac{[(\pi_W^e + B)\theta + 1] - \sqrt{(B - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0)\theta + 1}}{2\theta} \tag{10}$$

and $w_n^* \in (0, B)$

$w_t^* \in (0, B + R - T)$ and $w_n^* \in (0, B)$ indicate that the optimal wage scheme is always feasible for any available parameters.

Note that when PCT/PCN are binding, there are two solutions. However, the larger one is not feasible (why?).

Lemma B.2. *For $\theta > 0$, w_t^* and w_n^* always exists, and satisfy that $w_t^* \in (0, B+R-T)$, $w_n^* \in (0, B)$.*

Proof. Here I only prove the statement relevant to w_t^*,

- if $B \geq w_0 + R + T$, then
  - $2\pi_W^e + 2B - 4w_0 - 2R = B + R - T + w_0 + 2B - 4w_0 - 2R = 3B - T - R - 3w_0 \geq 2(B - w_0) > 0$
    $\Rightarrow \forall\theta \geq 0, (B + R - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0 - 2R) \cdot \theta + 1 > 0$
    $\Rightarrow w_t^*$ exists.
  - since that the left-hand-side of PCT is monotonic increasing w.r.t. w_t, and that it is strictly negative when $w_t = 0$, $w_t^* > 0$
  - $w_t^* < \pi_W^e < B + R - T$
- if $B < w_0 + R + T$, then
  - $\pi_W^e - w_0 - R < 0 \Rightarrow \forall\theta, (B + R - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0 - 2R)\theta + 1 > 0$
    $\Rightarrow w_t^*$ exists.
  - since that the left-hand-side of PCT is monotonic increasing w.r.t. w_t, and that it is strictly negative when $w_t = 0$, $w^* > 0$
  - $w_t^* \leq w_0 + R < B + R - T$

The proof of statement relevant to w_n^*, which is similar and relative easier, are left for the readers.

□

Lemma B.3. *There are some properties of w_t^* and w_n^* are useful in those proofs in below.*

- *w_t^* and w_n^* are continuous w.r.t. θ on its domain* $[0, +\infty)$
- *If $\theta = 0$, $w_t^* = w_0 + R$, $w_n^* = w_0$.*
- *As $\theta \to +\infty$, $w_t^* \to \frac{B+R-T+w_0}{2}$, $w_n^* \to \min\{B, \frac{B+R-T+w_0}{2}\}$*

Under such a wage scheme, the firm decides whether to train the worker at the first period. On the other hand, the worker has no incentive to deviate to quit at either $h = (train, w_t^*)$ or $h' = (not, w_n^*)$. Note that when PCT (PCN) is binding, the worker is indifferent to choose stay or quit, however, I do not make an additional tie-breaking assumption here, as next what I will show that if the worker replies quit, it cannot be a SRE. In summary, I show that the profile I proposed in Proposition 2 is a SRE.

Now I show there are not other SRE which satisfies monotonicity. The two classes of SRE shown in Lemma 4.1 and 4.2 are excluded. Suppose the firm offers a post-training wage w_t' s.t. the worker will reply to *quit*, then the firm's profit at $h = (train, w_t')$ is $-T$. By monotonicity and $w_t' \in [0, B+R-T]$, w_t' is not a local optimal strategy for the firm. Then after trains the worker, the firm would like to deviate to a higher w_t under which the worker will stay, since this new w_t gives the firm a non-negative profit. Similarly, if the firm chooses not to train, by the definition of SRE, a wage w_n under which the worker will quit is not a local optimal strategy. Therefore, in a monotonic SRE, the firm will offer a wage scheme s.t. the worker will reply *stay* no matter she gets trained or not.

At last, note that in a monotonic SRE, the worker will not play a mixed strategy when she is indifferent between to stay or to quit. Otherwise, by the property of monotonicity, the firm can deviate to a ϵ-higher wage in order to make her stay for sure.

□

Proof of Proposition 4. To show $w_t^* > w_n^*$, by Corollary 1, if $B \leq w_0 + R + T$, then done. Otherwise, $B > w_0 + R + T$, note that PCT (7) is monotonically increasing w.r.t. w_t on $[0, \frac{B+R-T+w_0}{2}]$. Since if I plug $w_t \leq w_n^*$ into the left-hand-side of PCT (7), it is strictly negative, I show that $w_t^* > w_n^*$.

□

Proof Sketch of Proposition 5. The training returns a higher profit to the firm if the following equation holds

$$w_n^* + R - T > w_t^* \tag{11}$$

There are two ways to get the result. One way is direct, by using computing device one can obtain the threshold $\bar{\theta} > 0$ above which $w_t^* - w_n^*$ is lower than $R - T$. Since $w_t^* - w_n^*$ is strictly decreasing w.r.t θ on positive domain (when the parameters satisfy the assumption in this model). There is another way, obtaining this result indirectly. That is, to plug in $w_n^* + R - T$ to the left-hand-side of PCT (7), if it is greater than zero, I show $w_n^* + R - T$ is greater than w_t^*. The plugging in trick works because both of the following statement are true: (a) for $w_t \in [0, B+R-T]$, there is only one solution for PCT, and the left-hand-side of PCT in strictly increasing w.r.t w_t on its domain; (b) for $w_n \in [0, B]$, there is only one solution for PCN, and the left-hand-side of PCN in strictly increasing w.r.t w_n on its domain.

□

Proof of Proposition 6. It is easier to show the sign of $\frac{\partial w_n^*}{\partial \theta}$.

Since when optimal, (8) is binding, let $G := w_n - w_0 + \theta(B - w_n)(w_n - \frac{B+R-T+w_0}{2})$, I apply the implicit function theorem,

$$\frac{dw_n^*}{d\theta} = -\frac{\partial G}{\partial \theta} / \frac{\partial G}{\partial w_n^*} \tag{12}$$

$$= \frac{-(B - w_n^*)(w_n^* - \frac{B+R-T+w_0}{2})}{1 - \theta(w_n^* - \frac{B+R-T+w_0}{2}) + \theta(B - w_n^*)} \tag{13}$$

From Corollary 1, $w_n^* < B$ and $w_n^* < \frac{B+R-T+w_0}{2}$, this term is positive.

Applying the implicit function theorem (using the left-hand-side of (7)), I get

$$\frac{dw_t^*}{d\theta} = \frac{-(B + R - w_t^*)(w_t^* - \frac{B+R-T+w_0}{2})}{1 - \theta(w_t^* - \frac{B+R-T+w_0}{2}) + \theta(B + R - w_t^*)} \tag{14}$$

If $B > w_0 + R + T$, immediately, $\dfrac{dw_t^*}{d\theta} > 0$.

The next lemma is useful:

Lemma B.4. *In a monotonic SRE,* $1 - \theta(w_t^* - \pi_W^e)$ *is always positive whenever* $\theta > 0$*, where* π_W^e *is the equitable payoff to the worker supported by a monotonic SRE.*

Proof. Suppose $1 < \theta(w_t^* - \pi_W^e(\cdot))$, then the left-hand-side of PCT is stictly greater than $w_t^* - w_0 - R + (B + R - w_t^*) = B - w_0 > 0$, contradict that PCT is binding under w_t^*. ☐

This lemma together with $B + R \geq w_t$ implies that the sign of $\frac{dw_t^*}{d\theta}$ is always the same as the sign of $w_t^* - \frac{B+R-T+w_0}{2}$. Moreover, by Corollary 1, its sign is as same as that of $B - (w_0 + R + T)$.

☐

Proof of Lemma 4.5. Since R (T) only affects the term π_W^e. A higher R (a lower T) makes PCN harder to be satisfied, forcing w_n^* to increase.

☐

Proof of Proposition 8. It's easy to obtain the participation constraints under the monotonic SRE.

$$w_f - (w_0 + R - f) + \theta(B + R - f - w_f)(w_f - \pi_W^e) \geq 0 \tag{15}$$

$$w_n - w_0 + \theta(B - w_n)(w_n - \pi_W^e) \geq 0 \tag{16}$$

where $\pi_W^e = \frac{B+R-T+w_0}{2}$—as argued in the main context below the Proposition 9 (2nd point), the equitable payoff to the worker in the monotonic SRE is irrelevant to the value of f.

Since both constraints should be binding, the monotonic SRE must be unique. By observing the first participation constraint, it shares the same function form as (7) (replace w_f by w_t, R by $R-f$). Thus, the proof of the two statements in the proposition is same as those of Proposition 4 and Proposition 5.

□

Lemma B.5. $w_f^* - \pi_W^e \leq \frac{1}{\theta}$

Proof. Suppose $w_f^* - \pi_W^e > \frac{1}{\theta}$, the left-hand-side of participant constraint for a worker who gets trained is greater than $w_f^* - (w_0 + R - f) + (B + R - f - w_f^*) = B - w_0 > 0$, contradict w_f^* makes the constraints binding. □

Proof of Proposition 9. The first point is immediately from the participation constraint for non-training wage are the same as (8).

Apply the implicit function theorem,

$$\frac{dw_f^*}{df} = -\frac{1 - \theta(w_f - \pi_W^e)}{1 + \theta(B + R - f - w_f) - \theta(w_f - \pi_W^e)}$$

which is strictly negative when $\theta > 0$ (from the above Lemma).

Lastly, $\frac{d[w_n^* - w_f^*]}{df} = -\frac{dw_f^*}{df} > 0$, and $\frac{d[w_n^* - w_f^*]}{d\theta} > 0$ (the more reciprocal, the more likely to train), the last statement follows.

□

Proof of Proposition 10. Similar to the general-training problem, one can show that in a monotonic SRE, the participation constraints are as followed:

PCT:

$$w_{st} - w_0 + \theta(B + R - w_{st})(w_{st} - \frac{B + R - T + w_0}{2}) \geq 0 \tag{17}$$

PCN:

$$w_{sn} - w_0 + \theta(B - w_{sn})(w_{sn} - \frac{B + R - T + w_0}{2}) \geq 0 \tag{18}$$

If PCT is satisfied, a worker who gets trained will stay in the firm, if PCN is satisfied, a worker who does not will stay in the firm. When these two participant constraints are binding, I get the wages (w_{st}^*, w_{sn}^*) in the monotonic SRE satisfies that

w_{st}^* solves

$$w_{st}^* = \frac{[(\pi_W^e + B + R)\theta + 1] - \sqrt{(B + R - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B + 2R - 4w_0)\theta + 1}}{2\theta}$$

w_{sn}^* solves

$$w_{sn}^* = \frac{[(\pi_W^e + B)\theta + 1] - \sqrt{(B - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0)\theta + 1}}{2\theta}$$

The following lemma shows that it is always profitable for the firm to give a specific training when facing a reciprocal worker.

Lemma B.6. *In a SRE, if $\theta > 0$, then it is always true that $B + R - T - w_{st}^* > B - w_{sn}^* \Leftrightarrow w_{sn}^* + R - T > w_{st}^*$*

Proof. To show $B + R - T - w_{st}^* > B - w_{sn}^* \Leftrightarrow w_{sn}^* + R - T > w_{st}^*$ plugging $w_{sn}^* + R - T$ into left-hand-side of PCT. This gives

$$\begin{aligned}
&w_{sn} + R - T - w_0 + \theta(B + T - w_{sn})(w_{sn} - \pi_W^e + R - T) \\
=&w_{sn} - w_0 + \theta(B - w_{sn})(w_{sn} - \pi_W^e) + R - T + \theta R - T(B + T - w_{sn}) + \theta T(w_{sn} - \pi_W^e) \\
=&R - T + \theta R - T(B + T - w_{sn}) + \theta T(w_{sn} - \pi_W^e)
\end{aligned}$$

Now I show there is no $\theta' > 0$ making $w_{sn}^* + R - T = w_{st}^*$.

Suppose there is such a $\theta' > 0$, then the following equation is true:

$$\frac{\frac{R}{T} - 1}{\theta'} + (2 - \frac{R}{T}) \cdot w_{sn}(\theta') - \pi_W^e + (\frac{R}{T} - 1)(B + T) = 0$$

$\Rightarrow$

$$\begin{aligned}
&\frac{\frac{R}{T} - 1}{\theta'} + (2 - \frac{R}{T}) \cdot \frac{[(\pi_W^e + B)\theta + 1] - \sqrt{(B - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0)\theta + 1}}{2\theta} \\
&- \pi_W^e + (\frac{R}{T} - 1)(B + T) = 0
\end{aligned}$$

$\Rightarrow$

$$\begin{aligned}
&2(\frac{R}{T} - 1) + 2\theta(\frac{R}{T} - 1)(B + T) + (2 - \frac{R}{T})[(\pi_W^e + B)\theta + 1] \\
&- (2 - \frac{R}{T})\sqrt{(B - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0)\theta + 1} - \theta 2\pi_W^e = 0
\end{aligned}$$

$\Rightarrow$

$$\frac{R}{T}(B - \pi_W^e)\theta + 2R - T\theta = (2 - \frac{R}{T})\sqrt{(B - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0)\theta + 1} - \frac{R}{T}$$

If $\frac{R}{T} > 2$, this equation never hold, for the left-hand-side is positive but the right-hand-side is negative. Consider $1 < \frac{R}{T} < 2$. One can show that the curves on the left-hand-side and the curve on the right-hand-side never meet on $\theta \in (0, +\infty)$, contradict.

Thus, $w^*_{sn} + R - T \neq w^*_{st}$ for $\theta > 0$. Since $w^*_{sn}(\theta)$ and $w^*_{st}(\theta)$ are continuous on $(0, +\infty)$, and when θ is small, $w^*_{sn}(\theta) + R - T > w^*_{st}(\theta)$, I show that there is no $\theta' > 0$ which makes $w^*_{sn}(\theta') + R - T < w^*_{st}(\theta')$. $\square$

The rest of the proof is that a worker who gets trained has a higher wage than who does not, or

Lemma B.7. *$w^*_{st}(\theta) > w^*_{sn}(\theta)$ for $\theta > 0$*

Proof. Plugging w^*_{sn} into the left-hand-side of (17), $\theta R(w^*_{sn} - \frac{B+R-T+w_0}{2}) < 0$, it does not satisfies. By the monotonicity of the left-hand-side, w^*_{st} who makes (17) binding should be greater than w^*_{sn} $\square$

By these two lemmata, I prove Proposition 10.

$\square$

Proof of Lemma 6.2. For the first statement: suppose $\exists a \in A_F \backslash E_F$, then there is a strategy of firm a' s.t. $\forall b \in A_W$, both parties have weakly higher material payoffs, with some h that at least one side has strictly higher material payoff. Suppose a and a' disagree their wages at some τ', which can be off-path, then consider a feasible strategy for the worker s.t. she chooses to stay whenever $\tau = \tau'$. Then in the sub-game forthcoming τ', either the firm or the worker has a higher material payoff. On the other hand, suppose a and a' agree on any wages, but they disagree on the training level τ. Consider a feasible strategy for the worker s.t. she will stay given the firm plays a, but she will quit after a', then a' fails to dominates a.

For the second statement: it is obvious that in the monotonic SRE, the maximized material payoff the firm can give the worker is $B + rT - T$ (where $\tau = T$), and the minimized material payoff the firm can give is w_0. This statement implies that:

The worker's participation condition given a level of training τ can be re-written to be

$$w(\tau) - w_0 - r\tau + \theta \cdot (B + r\tau - w(\tau)) \cdot (w(\tau) - \frac{B + rT - T + w_0}{2}) \geq 0$$

For the third statement: $w^*(\tau)$ can be directly obtained by solving $w(\tau) - w_0 - r\tau + \theta \cdot (B + r\tau - w(\tau)) \cdot (w(\tau) - \frac{B+rT-T+w_0}{2}) = 0$. The solution is

where $\pi^e_W = \frac{B+rT-T+w_0}{2}$ is a constant. The rest of the proof is, whether $(B + r\tau - \pi^e_W)^2 \cdot \theta^2 + (2\pi^e_W + 2B - 4w_0 - 2r\tau)\theta + 1 > 0$ for any $\theta \geq 0$:

- if $B \geq w_0 + rT - T - 2r\tau$
  $\theta \geq 0 \Rightarrow (B + r\tau - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0 - 2r\tau)\theta + 1 > 0$
- if $B < w_0 + rT - T - 2r\tau$,
  $\forall\theta$, $(B + r\tau - \pi_W^e)^2 \cdot \theta^2 + (2\pi_W^e + 2B - 4w_0 - 2r\tau)\theta + 1 > 0$

By the third statement of the Lemma above, the rest of proof is similar to the proof of Proposition 2.

□