Wage Bargaining when Workers Have Fairness Concerns*

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Abstract

We analyze optimal labor contracts when workers are inequity averse towards the employer. Welfare is maximized for an equal sharing rule of surplus between the worker and the firm. That is, profit sharing is optimal even if effort is contractible. If the firm can make a take-it-or-leave-it offer, the optimal contract is also dependent on output but always involves a deadweight loss of inequity aversion. When the parties bargain over the contract, the optimal division of surplus is more equitable compared to the purely self-regarding case. Moreover, the agreement approaches the welfare-optimal contract as the parties' bargaining power converges. Our findings imply that raising the bargaining power of the less powerful party may increase welfare.

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Keywords: Nash bargaining, principal-agent, inequity aversion, performance pay, profit sharing, labor contracts, wage

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"Workers want to [...] bargain for more money. [...] a community organizer in St. Louis said 'Unless we can figure out how to make highly profitable companies pay a fair wage to their workers, we're just going to watch them pull all the blood, sweat, tears and money out of our communities.'"

Daily Mail Online (2013, August 29)

1 Introduction

In many real-world situations, wage levels and compensation plans are established via bargaining procedures between workers (or unions as their representatives) and firm owners. The result of these bargaining procedures over productive rents will be determined by the parties' relative bargaining power as, e.g., affected by the institutional framework of the labor market, the parties' patience to reach an agreement, and their fallback positions in case of disagreement. Another important aspect, which has, however, not received much attention in the theoretical debate on wage bargaining so far is that fairness concerns may play an important role when it comes to the distribution of productive surplus between labor and firm owners.

Empirical evidence suggests that relative income comparisons affect people's individual satisfaction and that workers attach value to wage justice and pay equity.[1] More specifically, workers not only care for horizontal fairness among peers but also for vertical pay equity when comparing their wages to firm profits. As suggested by the introductory quotation on recent strikes in the U.S. fast-food industry, workers often call for fairness in wage bargaining situations, thereby demanding a wage level that awards them a reasonable part of the productive rent. The foregoing is also supported by survey studies in the manufacturing and service industry. Blinder and Choi (1990) find strong support for the importance of relative wages and fair wage considerations when interviewing human-resource managers in New Jersey and Pennsylvania. In particular, "managers believe that perceptions of fairness play a major motivational role in labor markets" (p. 1008). Interestingly and in line with notions of vertical pay equity, "wage reductions made to save the firm from failure or to align wages with those of competitors are viewed as justifiable and fair while those made just to raise profits are not" (p. 1008). Accordingly, workers tend to accept lower wages in times of crisis but demand higher pay in times of economic rise. Similarly, Agell and Lundborg (1995) find that notions of fairness play an important role for wage setting in Swedish manufacturing companies and "firm-specific factors like profitability and 'ability to pay' seem to affect wage settlements" (p. 297).

In this paper, we propose a bargaining model that takes the foregoing evidence into account. More precisely, we investigate how a preference for equitable payoff distributions on the side of the workers affects the parties' shares in bargaining and the welfare properties of the negotiated contract.[2] So far, the existent literature has extensively examined the impact of social preferences

[1] See, e.g., Clark, Frijters, and Shields (2008) or Akerlof and Yellen (1990) for an overview of the extensive literature on the effects of relative pay comparisons on well-being. An overview of the experimental literature on other-regarding preferences is provided by, e.g., Camerer (2003) or Fehr and Schmidt (2006).

[2] That is, in line with most papers on vertical social preferences, we consider the firm as an unemotional entity. Notably, Rees (1993) argues that "employers do not insist on fairness - workers and their unions do."

on optimal labor contracts in principal-agent models in which the whole bargaining power is assigned to the principal. In such a situation, the principal makes the worker a take-it-or-leave-it offer that is accepted by the worker if it makes him just as well off as in his next-best alternative.[3] We abandon the extreme assumption regarding the distribution of bargaining power and consider a situation in which both parties may possess some bargaining power. This allows us to analyze the distributional characteristics of the resulting contracts. Obviously, the foregoing is of particular relevance in the context of social preferences.

We present a model in which the optimal labor contract is determined by Generalized Nash bargaining[4] (see Nash (1950)) between a firm and its worker in the absence of moral hazard.[5] We model fairness concerns by assuming the worker to exhibit inequity aversion towards the firm.[6] More precisely, after exerting productive effort and observing the resulting production output, the worker compares his own net income under the contract with firm profit and dislikes inequitable surplus distributions in any productive state. Our study highlights an interesting novelty regarding the impact of inequity aversion on the optimal labor contract. In particular, the negotiated wage contract endogenously determines the level of surplus to be shared in the process of bargaining over the optimal contract. That is, in contrast to the case with purely selfish preferences, there is an essential difference between the productive surplus and the joint surplus from an agreement during negotiation. This difference arises from the fact that the worker may suffer a disutility, depending on how his negotiated share relates to firm profit, thereby affecting the level of overall welfare.

Our analysis proceeds in three steps. As a benchmark, we first determine the welfare-maximizing contract. We choose the joint surplus of the employment relationship, hence the sum of firm profit and worker utility, as the relevant welfare criterion.[7] That contract stipulates an equal sharing rule of surplus in each productive state. Intuitively, a contract that awards the worker half of the surplus in each state avoids income inequity altogether and thus prevents any welfare loss due to inequity aversion. Notably, that result deviates from the case of purely self-regarding workers where a simple fixed-wage contract suffices to implement the Pareto-efficient solution. Second, we derive the profit-maximizing contract offered by the firm if it has all the bargaining power. Despite the absence of moral hazard, the optimal contract depends on the realized output level. Yet, in contrast to the welfare-maximizing contract, the contract never

[3]For convenience and without any discriminatory intent, we will use the male personal pronoun for the worker throughout the paper.

[4]Generalized (or asymmetric) Nash bargaining resolves bargaining situations in which parties possess different levels of bargaining power due to, e.g., different levels of patience or discount factors. Binmore, Rubinstein, and Wolinsky (1986) show that the solution to the Generalized Nash-bargaining problem generates the same qualitative results as that of the alternating offer game by Rubinstein (1982) if the frictions in the bargaining process are small. See also Muthoo (1999, pp. 59-67) for an elaborate proof.

[5]For a discussion of the possible effects of moral hazard in our model, see Section 6.

[6]Regarding the formalization of the worker's utility function, we follow Englmaier and Wambach (2010) so that the worker's disutility due to inequity aversion is convex in income inequity. In contrast to that paper, we assume the worker to compare his own net income with net firm profit while, in line with Fehr and Schmidt (1999), the worker's feelings of envy are assumed to exceed his feelings of empathy.

[7]While considering other criteria is conceivable, using the unweighted sum of utilities is rather general and moreover in line with the welfare criterion for deriving the first-best solution in agency models and that for calculating consumer surplus. Obviously, when assigning more weight to one party's utility, the optimal solution would be tilted in this direction. See also the discussion on the egalitarian and utilitarian solutions below.

implements the first-best solution. The reason is that, for any degree of inequity aversion, the firm sets a wage that provides it with a share of surplus higher than that of the worker in any state. Interestingly, the foregoing implies a deadweight loss of inequity aversion under the profit-maximizing contract even when effort is contractible, that is, 'agency costs' arise due to the worker's inequity aversion.

Finally, we solve the Generalized Nash-bargaining problem for the optimal wage contract and examine the impact of the parties' bargaining power and the strength of the worker's social preference on the parties' relative income levels as well as the efficiency of the negotiated contract. We find that the contract is also state-dependent, involves profit sharing, and entails a deadweight loss of inequity aversion whenever bargaining power is not equally distributed among the parties. Notably, compared to negotiating with a purely selfish worker, the optimal contract with an inequity averse worker implements a more egalitarian distribution of surplus. The reason is that such a contract lowers the welfare loss due to inequity aversion and thus increases the overall surplus to be distributed in the negotiation. The optimal agreement from the negotiation approaches the welfare-optimal contract as the parties' bargaining weights converge.

Altogether, in line with the empirical evidence presented above, our paper shows that fairness concerns explain why workers are willing to accept lower wages in times of crisis but demand higher pay in times of economic rise. Our results highlight a novel function of performance pay beyond the provision of work incentives. In the presence of fairness considerations, bonus pay may be implemented to distribute productive rents from firm owners to labor across states. Accordingly, our model predicts that profit sharing might be observed in jobs, where the relation between rewards and performance is negligible. Of course, our model is a strong simplification of the complex issue of production, employment and wage negotiations, so practical implications should be considered with care. Yet, our findings indicate that raising the bargaining power of the less powerful party may increase overall welfare in the presence of social preferences. Accordingly, designing institutions on the labor market in order to achieve a well-balanced distribution of bargaining power among firm owners and productive workers may be socially efficient from a welfare perspective. Finally, our results show that employing inequity averse workers may be costly to the firm. Firms might hence wish to test the social preferences of their workers upon employment. By contrast, workers might have an interest to wrongly state their preference type since doing so can raise their wage. The investigation of these issues is a promising direction for further research.

The present paper brings together the literature on wage bargaining and that on social preferences. Optimal labor contracts in Nash-bargaining settings have been extensively discussed (e.g., Pissarides (2000)). Typically, the optimal sharing rule awards each party its outside option and divides the additional surplus of the relationship proportionally to the players' bargaining power. We contribute to that literature by showing that inequity aversion on the side of labor affects the parties' sharing proportion and the efficiency of the agreement. In a setting with moral hazard and financial constraints on the side of the worker, Demougin and Helm (2006) show that raising the bargaining power of labor initially increases the efficiency of the contract and is thus beneficial from a welfare perspective. The result is in line with our findings, yet their finding is driven by the associated mitigation of the moral-hazard problem in the absence of social preferences. Rachmilevitch (2011) analyzes the Nash-bargaining solution regarding its fairness and efficiency properties as compared to the utilitarian and egalitarian solutions.[8] He shows that the Nash solution balances fairness and efficiency in the sense that a player's payoff lies between the minimum and the maximum payoff assigned by the aforementioned solutions. We complement this result by showing that fairness preferences drag the Nash solution even more towards the egalitarian solution.[9] Dur and Tichem (2012) study the effects of altruism and spite among principal and agent on relational incentives in a repeated bargaining-setting. von Siemens (2009) analyzes the impact of heterogeneous privately known fairness preferences on investment incentives and bargaining behavior in the presence of relationship-specific investments.

During recent years, a steadily evolving literature investigates the effects of other-regarding preferences on optimal incentive contracting in principal-agent models.[10] Most of the work is concerned with inequity aversion as proposed by Fehr and Schmidt (1999) or envy among workers.[11] Related to our work, Dur and Glazer (2008) and Englmaier and Wambach (2010) examine optimal labor contracts when workers care about inequality relative to the principal. While Englmaier and Wambach (2010) analyze inequity aversion with moral hazard, Dur and Glazer (2008) focus on envy towards the firm and, in line with our work, consider an environment with contractible effort. Both papers also study the impact of the worker's risk aversion. In line with our results, both studies find that the firm benefits from profit sharing due to the worker's social preference. While the foregoing papers, however, focus on the profit-maximizing wage contract, we extend the discussion to optimal labor contracts in a bargaining setting. This allows us to demonstrate an important difference: With an inequity averse worker, the agreement from negotiation always yields a higher total welfare level than the profit-maximizing contract. Bargaining may even reestablish Pareto-efficiency when worker and firm are equally powerful in the negotiation.

The remainder of the paper proceeds as follows. The next section introduces the model. In Sections 3 and 4, we derive the welfare-maximizing contract and the profit-maximizing contract, respectively. In Section 5, we derive our main results concerning the optimal labor contract with

[8] Note that both solutions can be generalized to non-symmetric bargaining solutions. More precisely, the utilitarian solution is obtained by maximizing a weighted sum of utilities while the egalitarian solution assigns payoffs according to fixed proportions (see the explanations in Rachmilevitch (2011), pp. 3-4). In that sense, Rachmilevitch refers to the utilitarian solution as 'efficient' and to the egalitarian solution as 'fair'.

[9] Rachmilevitch (2011) argues that the Nash-solution is in some sense 'more utilitarian than egalitarian', that is, biased in favor of the rich or more powerful player. For a more extensive discussion of the Nash solution and distributive justice, see pp. 14-16 in the aforementioned paper and the references therein.

[10] For example, Demougin, Fluet, and Helm (2006), Bartling and von Siemens (2010a), and Neilson and Stowe (2010) analyze the impact of envy or inequity aversion on optimal independent incentive contracts. Inequity aversion in rank-order tournaments is analyzed by, e.g., Demougin and Fluet (2003) and Grund and Sliwka (2005). Other contributions compare the efficiency of different peer-dependent incentive regimes with social preferences (e.g., Itoh (2004), Demougin and Fluet (2006), Goel and Thakor (2006), Rey-Biel (2008), Bartling (2011)). The impact of envy on different types of relational incentive contracts is studied in Kragl and Schmid (2009), Kragl (2015), and Kragl (2016). Bartling and von Siemens (2010b) show that an equal sharing rule may arise endogenously as an optimal solution to the incentive problem in partnerships when partners are inequity averse and renegotiations are possible.

[11] Other notable approaches to model social preferences include Rabin (1993), Bolton and Ockenfels (2000), Dufwenberg and Kirchsteiger (2004), and Falk and Fischbacher (2006).

bargaining and analyze the impact of the worker's bargaining weight and concern for equity on the results. Finally, Section 6 presents a discussion and Section 7 concludes.

2 The Model

We model the interaction between a profit-maximizing firm (principal) and a utility-maximizing worker (agent). The worker exerts effort e in order to produce verifiable output Q and incurs effort costs $c(e)$, where $c(0) = c'(0) = 0$, $c'(e) > 0$ if $e > 0$, $c''(e) \geq 0$, and $\lim_{e \to 1} c'(e) = \infty$. Output can take a high or low value, i.e., $Q \in \{L, H\}$ with $H > L \geq 0$. The level of output is low if the worker exerts 'normal' effort ($e = 0$), and high output is realized with probability $\Pr[Q = H|e] = e$. We denote by $S_Q = Q - c(e)$ the ex-post productive surplus of the employment relationship.

The worker is risk neutral but inequity averse towards the firm in the sense of Fehr and Schmidt (1999). Formally, we employ the utility function proposed by Englmaier and Wambach (2010) but depart by assuming that the agent is concerned with relative *net* income, i.e., in any state the worker compares his wage net of effort costs to net firm profit.[12] Accordingly, the agent's utility of wage W is given by:

$$\begin{aligned} &U(Q, W, e) = W - c(e) - \gamma G(D), \\ &\text{where } D := D_Q = [Q - W] - [W - c(e)], \\ &\qquad G(0) = G'(0) = 0, \\ &\qquad G'(D) < 0 \text{ if } D < 0,\ G'(D) > 0 \text{ if } D > 0, \\ &\qquad G''(D) > 0, \\ &\qquad G(-D) < G(D) \text{ for } D > 0 \end{aligned} \tag{1}$$

Denoting by D the ex-post income inequity, i.e., the difference in net firm profit $(Q - W)$ and the worker's net payoff $(W - c(e))$, the function $G(D)$ captures the worker's preference for equitable income distributions in any state. Figure 1 illustrates the basic properties of the function as stated above. Accordingly, the worker's disutility from income inequity is represented by a strictly convex function which is positive whenever $D \neq 0$ and not symmetric around the equitable allocation of net surplus ($D = 0$). In the remainder, we speak of income inequity whenever $D \neq 0$. The asymmetry of the function $G(D)$ implies that the worker suffers more from disadvantageous inequity ($D > 0$) than he dislikes advantageous inequity ($D < 0$) for some given absolute difference in net payoffs. Intuitively, in line with Fehr and Schmidt (1999), the worker's propensity for envy is thus assumed to exceed his feelings of compassion. Finally, the parameter $\gamma > 0$ denotes the individual weight the worker puts on achieving equitable outcomes.

[12] Former papers on vertical inequity aversion (Englmaier and Wambach (2010), Dur and Glazer (2008)) focus on the case where the agent compares his gross wage to firm profit. Implicitly, income inequity is hence measured as income inequality. As also highlighted by Englmaier and Wambach (2010) in their discussion (and formally considered in the working paper version of their article), we argue that the worker's effort costs play an important role when comparing income levels, given that the considered parties are not symmetric. Intuitively, an agent who perceives his wage as unfair may reduce effort to reestablish equity. By contrast, an equal split of surplus may be perceived as unfair if the agent's associated productive effort is huge.

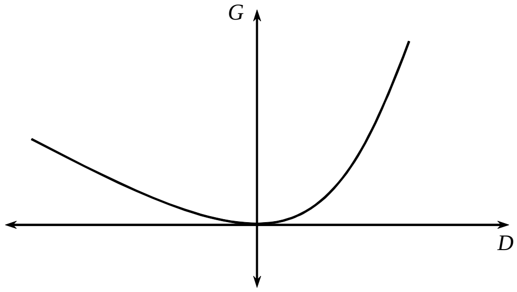

Figure 1: Disutility due to inequity aversion $G(D)$

We focus on the case where the worker's effort is contractible, i.e., there is no moral hazard, and, thus no need for providing effort incentives contingent on observed output measures (i.e., since the firm can contract upon effort, it will pay out the agreed-upon wage only if the desired effort level is observed). Yet, as we will show in the following, in contrast to the case with a purely self-regarding worker, the distribution of surplus across states (as affected by output-dependent pay) is important in two respects. First, it affects the worker's willingness to accept a contract, and second, it has an impact on the size of the overall surplus to be shared in the process of bargaining. We hence allow the wage contract $(\tilde{e}, w, \Delta)$ to stipulate some desired effort level $\tilde{e}$ and moreover specify payments that depend on the output level. Accordingly, the worker's wage W is given by:[13]

$$W = \begin{cases} 0 & \text{if } e < \tilde{e} \\ w & \text{if } e \geq \tilde{e} \text{ and } Q = L \\ w + \Delta & \text{if } e \geq \tilde{e} \text{ and } Q = H \end{cases}$$

The worker is paid a base wage w in any state and obtains an additional amount of Δ if realized output is high. In the remainder, we will refer to Δ as the wage spread. Under such a contract, the worker's expected net payoff π_W and expected firm profit π_F are given by:

$$\pi_F = e\left(H - w - \Delta\right) + (1 - e)\left(L - w\right), \tag{2}$$

$$\pi_W = w + e\Delta - c\left(e\right) \tag{3}$$

The worker's utility depends on π_W and the level of ex-post income inequity D_Q in the two productive states H, L. Accordingly, the worker's expected utility is given by:

$$EU = \pi_W - e\gamma G\left(D_H\right) - (1 - e)\gamma G\left(D_L\right) \tag{4}$$

[13] It is well known that, in standard principal-agent models with purely self-regarding workers and contractible effort, the first-best solution is implemented by a state-independent fixed-wage contract. As we will show in the following sections, this does not hold true for the case of inequity averse workers (see also Dur and Glazer (2008) and Englmaier and Wambach (2010)). In particular, we find that Δ is positive in the optimal contract whenever $\gamma > 0$.

The timing is as follows. First, the worker and the firm bargain over the wage contract $\{e, w, \Delta\}$. Formally, we apply the Generalized Nash-bargaining framework (Nash (1950)) and denote with $\alpha \in [0,1]$ the bargaining power of the worker. In Section 4, we separately analyze the case where $\alpha = 0$, that is, we derive the profit-maximizing contract. If bargaining fails, both parties receive their respective outside options which we, for simplicity, set to zero.[14] If bargaining is successful, the worker undertakes effort. Afterwards output Q is realized and the worker is paid. In the next section, as a benchmark, we initially determine the welfare-maximizing contract.

3 Welfare-maximizing Contract

The welfare-maximizing contract maximizes the joint surplus of the employment relationship, hence the sum of expected firm profit π_F and the worker's expected utility EU. We denote the expected joint surplus, i.e., total welfare by $S(e, w, \Delta)$. Accordingly, the welfare-maximizing contract (e^*, w^*, Δ^*) solves:

$$\begin{aligned} \max_{e,w,\Delta} \quad & S(e,w,\Delta) = L + e(H-L) - c(e) - e\gamma G(D_H) - (1-e)\gamma G(D_L) \\ \text{s.t.} \quad & \pi_F, EU \geq 0 \end{aligned} \tag{I}$$

By inspection of the objective function, total welfare S is decreasing in the worker's disutility due to inequity aversion.[15] The following proposition states the solution to problem (I) and shows that the first-best wage payments w^* and Δ^* are such that $D_H = D_L = 0$.[16] That is, under the welfare-maximizing contract, both parties split the ex-post productive surplus S_Q equally in any state so that income inequality does not arise.

Proposition 1 *The welfare-maximizing contract stipulates an equal sharing rule in any state. In particular, under the welfare-maximizing contract* (e^*, w^*, Δ^*)*:*
(i) effort is first-best, i.e., $e^* = \arg\max_e S(e, w^*, \Delta^*) \iff H - L = c'(e^*)$*,*
(ii) income inequity does not arise in any state, $D^* := D_H = D_L = 0$*,*
(iii) the optimal base wage is $w^* = \dfrac{S_L}{2} + c(e^*)$*,*
(iv) the optimal wage spread is $\Delta^* = \dfrac{H-L}{2}$*,*
(v) the first-best expected surplus is achieved:

$$S^* := S(e^*, w^*, \Delta^*) = L + e^*(H-L) - c(e^*) \tag{5}$$

Proof. See the Appendix. ■

[14] This may appear like a strong assumption. Doing so, however, greatly simplifies the exposition of the paper. Allowing for non-zero outside options does not change our main results but adds complexity to the model. In particular, as long as both parties' outside options do not exceed half of the surplus, our results reestablish. For a discussion, see Section 6.

[15] Note the difference to productive surplus. In particular, it holds that $E[S_Q] = L + e(H-L) - c(e)$, which exceeds total expected welfare exactly by the amount of expected disutility due to inequity aversion.

[16] Throughout the analysis, we assume that the output levels H, L and the worker's effort cost $c(e)$ are such that the first-best expected surplus from the employment relationship, as defined in (5), is positive.

The contract (e^*, w^*, Δ^*) maximizes total welfare by avoiding the occurrence of inequity aversion (and related welfare losses) altogether. Under that contract, both the worker's ex-post net income $W - c(e)$ and the firm's ex-post profit $Q - W$ amount to $S_L/2$ in state L and $S_H/2$ in state H. Hence, in contrast to the case with a purely self-regarding worker, the first-best contract is not a fixed-wage contract but awards the worker half of the productive surplus in each state in excess of his cost of effort. This implies that not only the firm earns more when output is high but also the worker ($\Delta^* > 0$). Moreover, the contract implements first-best effort e^* for which marginal productivity equals marginal costs of effort, as shown in Proposition 1(i).

4 Profit-maximizing Contract

In this section, we analyze the benchmark case where the firm possesses all the bargaining power ($\alpha = 0$) and thus makes the worker a take-it-or-leave-it offer. In the following, we hence replicate and extend some of the findings from the existent literature on principal-agent games with vertical inequity aversion in the absence of bargaining (Dur and Glazer (2008), Englmaier and Wambach (2010)).

The firm's optimization problem is given by:

$$\max_{e,w,\Delta} \quad \pi_F = L + e(H - L) - (w + e\Delta) \tag{II}$$

$$\text{s.t.} \quad EU \geq 0 \tag{PC}$$

Condition (PC) denotes the worker's participation constraint. In the proof of Proposition 2 in the Appendix, we verify that condition (PC) is binding in the optimal contract. Accordingly, the firm's expected wage costs $w + e\Delta$ amount to the worker's cost of effort plus the worker's expected disutility due to income inequity in both productive states. The latter is known as the inequity premium and represented by the sum of the absolute values of the last two terms in EU as defined in equation (4). Notably, due to its impact on D_H and D_L, the level of wage payments w, Δ affects the size of the inequity premium. In choosing wage payments w, Δ optimally, the firm faces an interesting trade-off. For some given optimal effort level e^{**}, increasing the worker's net income towards half of the productive surplus in any state ($S_Q/2$) reduces the inequity premium and thus expected wage costs. At the same time, however, doing so directly increases wage costs and hence reduces firm profit. The contract $(e^{**}, w^{**}, \Delta^{**})$ optimally trades off these two counteracting effects. In particular, it is optimal for the firm to set w, Δ such that income inequity D_Q is positive (i.e., the firm earns more than the worker) but equal across states. The following proposition characterizes the optimal contract and the associated welfare level.

Proposition 2 *Suppose that the firm possesses all the bargaining power. Then under the optimal contract* $(e^{**}, w^{**}, \Delta^{**})$*:*
(i) effort is first-best, i.e., $e^{**} = e^*$*,*
(ii) income inequity is equal across states; $D_H = D_L =: D^{**}$*,*

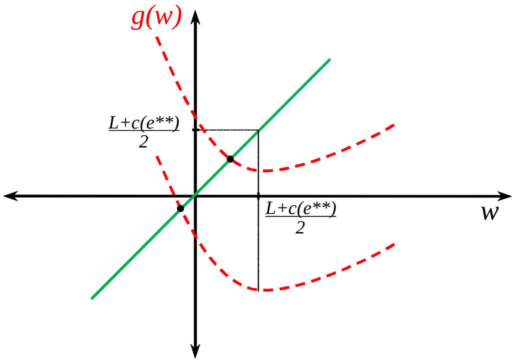

Figure 2: Equation (6) and the optimal fixed wage w^{**}

(iii) firm profit exceeds the worker's net income in any productive state; $D^{**} =: D^{**}(w) > 0$,
(iv) the optimal wage spread is $\Delta^{**} = \Delta^* = \dfrac{(H-L)}{2}$,
(v) the optimal base wage w^{**} *is uniquely defined by the solution to*

$$w = c(e^{**}) - e^{**}\Delta^{**} + \gamma G(D(w)), \text{ and} \tag{6}$$

(vi) total surplus is reduced by the amount of the inequity premium:

$$S^{**} := S\left(e^{**}, w^{**}, \Delta^{**}\right) = S^* - \gamma G\left(D^{**}\right) \tag{7}$$

Proof. For the proof of (i),(ii), and (iv) see the Appendix. There we show that the participation constraint (PC) is binding, and thus, the optimal base wage w^{**} is implicitly defined by equation (6), where D is a function of w as stated in (v). Moreover, if a solution w^{**} exists, then $\gamma G'(D(w^{**})) > -1/2$ must be satisfied.[17] To prove (iii), observe that the left-hand side of equation (6) is the identity function, $id(w)$, and thus, strictly increasing in w with a slope of 1 (see Figure 2). Defining by $g(w)$ the right-hand side of equation (6) and noting that $c(e^{**}) - e^{**}\Delta^{**}$ is a constant, one can verify that $g'(w) = -2\gamma G'(D)$. Hence, a solution for the optimal base wage, w^{**}, is at the intersection of both functions and exists only if, at the intersection, it holds that $g'(w^{**}) < 1$. Further investigation shows that $g(w)$ is a convex function, strictly decreasing for $w < \frac{L+c(e^{**})}{2}$, i.e., for $D > 0$, and increasing for $w > \frac{L+c(e^{**})}{2}$, with a minimum value $g\left(\frac{L+c(e^{**})}{2}\right) = c(e^{**}) - e^{**}\Delta^{**}$, i.e., for $D = 0$. Figure 2 shows two examples of the function $g(w)$, depending on whether its minimum value is negative or positive.
To more specifically characterize the solution to equation (6), we compare the values of both continuous functions, $id(w)$ and $g(w)$, for different intervals of w. At $w = \frac{L+c(e^{**})}{2}$, it holds that that $id(w) = \frac{L+c(e^{**})}{2} > c(e^{**}) - e^{**}\Delta^{**} = g(w)$ since $S^*/2 > 0$. If $w \in \left(\frac{L+c(e^{**})}{2}, \infty\right)$, both functions can intersect only if $g'(w) > 1$ so that the solution to (6) cannot be in the foregoing interval. If $w \in \left(-\infty, \frac{L+c(e^{**})}{2}\right]$, $id(w)$ is negative for $w < 0$, strictly increasing and lies above

[17] The condition ensures that expected-utility theory is applicable also with the given type of social preference. For the intuition, see Footnote 32 in the Appendix.

$g(w)$ at $w = \frac{L+c(e^{**})}{2}$. The function $g(w)$ is positive for relatively small w and strictly decreasing. Therefore, there is a unique solution to equation (6) such that $w^{**} < \frac{L+c(e^{**})}{2}$, i.e., the solution is such that the firm's payoff exceeds the worker's, thereby implying that $D^{**} > 0$ for any γ.[18] In the two examples in Figure 2, the optimal base wage is once negative and once positive. Notably, as γ rises, $g(w)$ becomes steeper, thereby implying that the profit-maximizing contract converges towards the welfare-maximizing contract, i.e., $w^{**} \to \frac{L+c(e^{**})}{2}$, where $\frac{L+c(e^{**})}{2} = w^*$. In addition, $EU^{**} = 0$ implies that $S^{**} = \pi_F^{**}$, and claim (vi) directly follows by substituting Δ^{**} from equation (6) in firm profit as given in (2). ■

By Proposition 2(i), the firm implements the first-best effort level e^* if it has all bargaining power. First-best effort is optimal since there is no moral-hazard problem, and the firm thus demands an effort level that, ceteris paribus, maximizes the overall expected productive return. Yet, in sharp contrast to the case of self-regarding agents, the profit-maximizing wage contract does not implement the first-best solution although effort is contractible. Notably, with an inequity averse worker, agency costs arise despite the contractibility of effort.[19] The reason is that the optimal wage contract assigns the firm a higher share of productive surplus in any state (Proposition 2(iii)), thereby imposing a deadweight loss in the amount of the expected inequity premium (Proposition 2(vi)). More specifically, the worker suffers from envy in any productive state and must hence be compensated accordingly.[20] As in the case with a self-regarding worker, the firm extracts all the expected surplus from the relationship

$$\pi_F^{**} = L + e^{**}(H - L) - c\left(e^{**}\right) - \gamma G\left(D^{**}\right) = S^{**}. \tag{8}$$

Accordingly, the worker's expected net income is given by

$$\pi_W^{**} = \gamma G(D^{**}). \tag{9}$$

Observe that, by Proposition 2(iv), with an inequity averse worker, the optimal contract is state-dependent ($\Delta^{**} > 0$). More specifically, the optimal wage spread Δ^{**} is such that the income difference between the parties D^{**} becomes invariant in output. Again, the result is in sharp contrast to the case of self-regarding agents in which a fixed-wage contract ($\Delta = 0$) implements the first-best solution. Why is it, however, that the income difference is independent of the productive state in the optimal contract? To understand this, initially assume that the optimal net income difference in both states is different, i.e., $D'_H \neq D'_L$, and that w', Δ' are the corresponding optimal wage payments. Note that the associated expected inequity premium in equation (4) is a convex combination of $\gamma G(D'_H)$ and $\gamma G(D'_L)$. Now consider an

[18]Note that $D^{**} = 0$ if and only if $S^* = 0$ which we exclude by assumption. Obviously, any $D > 0$ would then imply $EU < 0$, which violates condition (PC).

[19]In contrast to the given scenario, the principal usually induces an effort level below first-best if agency costs arise under moral hazard. However, with contractible effort, agency costs are not due to costly motivational incentives and thus have no effect on the effort margins.

[20]Note that the optimal contract never imposes to $D^* < 0$. Intuitively, this is never optimal for the firm because it then not only earns less than the worker but also needs to pay inequity-premium costs (as in the case with $D > 0$) because the worker would suffer from empathy in such a case.

alternative net income difference that is invariant in output, $D'' = eD'_H + (1-e)\,D'_L$, and the corresponding wages, w'', Δ''. Under both contracts, the worker's expected wage is the same (i.e., $w' + e\Delta' = w'' + e\Delta''$), and thus, also the expected profit of the firm in (2) stays unchanged. By convexity of the function $G(D)$ it, however, holds that:

$$e\gamma G\left(D'_H\right) + (1-e)\,\gamma G\left(D'_L\right) > \gamma G\left(D''\right) \tag{10}$$

By the above inequality, with D'', we thus have $EU'' > 0$ (compare equation (4) and recall that, if D'_H, D'_L had been chosen optimally, it has to hold that $EU' = 0$). That is, the firm could reduce the worker's expected utility (and hence raise its expected profit) by reducing the wage payments. The foregoing, however, contradicts the optimal choice of the payments (w', Δ') in the first place. Altogether, the expected inequity premium is hence minimized by equalizing the parties' net income difference across both productive states.

In the remainder of the section, we will take a closer look at the impact of the worker's concern for income equity, γ, on wage payments, relative income levels, and total welfare. By the foregoing proposition, the optimal level of effort, e^{**}, and the wage spread, Δ^{**} are unaffected by γ. By contrast, equation (6) implies that the optimal base wage w^{**} and hence also the optimal level of income inequity D^{**} implicitly depend on γ, as stated in the following lemma.

Lemma 1 *The optimal base wage w^{**} is increasing in the individual weight the worker puts on achieving equitable outcomes, γ. Consequently, the level of income inequity D^{**} is decreasing in that parameter.*

Proof. Applying the Implicit-Function Theorem to equation (6) yields:

$$\frac{\partial w^{**}}{\partial \gamma} = -\frac{-G(D)}{1 + 2\gamma G'(D)} \tag{11}$$

As shown in the proof of Proposition 2 in the Appendix, feasible solutions are such that $\gamma G'(D) > -1/2$, and thus, the denominator of equation (11) is positive. Together with $G(D) > 0$ for $D \neq 0$, this implies that $\partial w^{**}/\partial \gamma > 0$. The second statement follows directly from inspection of the derivative of D^{**} w.r.t. γ. ■

Intuitively, the more inequity averse the worker, the more he suffers from the fact that the firm earns more, which, ceteris paribus, raises expected wage costs. The optimal wage contract balances this increase in inequity-premium costs by reducing income inequity D^{**}. That is, the worker's wage is optimally increased by the same amount in both productive states, resulting in a raise of the optimal base wage w^{**}.[21] Indeed, if the individual weight the worker puts on achieving equitable outcomes γ is extremely large ($\gamma \to \infty$), the worker earns almost half of the surplus in both productive states ($D^{**} \to 0$). However, as stated in 2(*iii*), the firm will never implement a contract that results in equal sharing of the productive surplus ($D = 0$). To see

[21] The result is directly related to Lemma 1 in Dur and Glazer (2008), who find that, for a given level of effort and bonus pay, an increase in the worker's propensity for envy induces the employer to pay a higher base salary.

why, note that, with no income inequity, the worker would obtain a strictly positive expected utility since then $EU = \pi_W = S^*/2 > 0$. This, can, however, not be optimal since the firm can always increase its profit by setting the worker's expected utility to zero, i.e., adjust the base wage so that the participation constraint is binding (see the proof of Proposition 2 in the Appendix).

The foregoing result allows to draw conclusions regarding the consequences of an increase in γ on firm profit, income and expected utility of the worker as well as total welfare under the profit-maximizing wage contract.

Proposition 3 *Suppose that the firm possesses all the bargaining power. Then under the optimal contract* $(e^{**}, w^{**}, \Delta^{**})$*, expected firm profit decreases in the worker's concern for income inequity,* γ*. At the same time, the worker's expected net payoff increases in* γ *while his expected utility stays, however, unaffected. Consequently, total surplus from the employment relationship is decreasing in* γ*.*

Proof. Differentiating both parties' expected net payoffs, as given in equations (8) and (9), with respect to γ, and using $\partial w^{**}/\partial\gamma$ from Lemma 1, yields:

$$\frac{\partial \pi_W^{**}}{\partial \gamma} = \frac{G(D)}{1 + 2\gamma G'(D)}, \quad \frac{\partial \pi_F^{**}}{\partial \gamma} = \frac{\partial S^{**}}{\partial \gamma} = -\frac{G(D)}{1 + 2\gamma G'(D)} \tag{12}$$

Thus, we have $\partial \pi_W^{**}/\partial\gamma > 0$, while $\partial S^{**}/\partial\gamma < 0$ and $\partial \pi_F^{**}/\partial\gamma < 0$. Finally, in the optimal contract, condition (PC) is binding for any γ, yielding $EU^{**} = 0$. ■

The intuition is straightforward. As the worker's concern for income inequity rises, the firm needs to pay a larger inequity premium to ensure his participation, thereby raising the worker's net income and reducing its own profit. Since the firm will always choose the wage to make the worker just participate (hence guarantee him an expected utility of just zero), the impact of inequity aversion on total welfare coincides with its negative effect on firm profit.

As already mentioned earlier, the foregoing results are related to the findings by Dur and Glazer (2008) and Englmaier and Wambach (2010). In particular, both studies also find that surplus sharing is optimal with an inequity averse or envious worker, respectively, so that firm profit and welfare fall below first-best.

5 Optimal Contract with Nash Bargaining

In this section, we turn to the case where the firm engages in Generalized Nash bargaining with the worker. Denoting with $\alpha \in (0, 1)$ the bargaining power of labor, the optimal contract is defined accordingly as:

$$e^N, w^N, \Delta^N = \arg\max_{e,w,\Delta} \ (EU)^{\alpha} (\pi_F)^{1-\alpha} \tag{III}$$

As explained in Section 3, in the presence of inequity aversion, the expected productive surplus $E[S_Q]$ does not necessarily coincide with total expected welfare $S(e, w, \Delta) = EU + \pi_F$, i.e., the surplus to be shared in the process of bargaining (see Footnote 15). More specifically, in contrast to models with purely selfish workers, total surplus S is (weakly) decreasing in the level of income inequity among the parties. Consequently, S endogenously depends on the result of bargaining, that is, the parties' negotiated shares as determined by the contract $\left(e^N, w^N, \Delta^N\right)$. Due to this endogeneity, solving problem (III) is more elaborate than the standard case.

For expository purposes, initially consider the case of a purely self-regarding worker; $\gamma = 0$. In such a case, it holds that $EU = \pi_W$ and problem (III) corresponds to the standard Nash-bargaining problem. Thus, total surplus becomes $S(e, w, \Delta) = S^*$, as given in equation (5), and it is well-known that the optimal contract then assigns both parties a share of this surplus that corresponds to their relative bargaining power. More specifically, the worker obtains αS^* while the firm earns $(1-\alpha)S^*$.[22]

By contrast, with an inequity averse worker ($\gamma > 0$), the total surplus S generally falls below first-best surplus S^*. Moreover, the parties' optimal shares of total surplus depend (not only on α but also) on γ and are in general different from those in negotiations with a purely selfish worker. The following proposition presents the solution to problem (III), and thus, characterizes the optimal contract from Nash bargaining with an inequity averse worker.

Proposition 4 *Suppose that the firm and the worker engage in Nash bargaining and the worker's bargaining power is given by $\alpha \in (0, 1)$. Then under the optimal contract (e^N, w^N, Δ^N):*
(i) effort is first-best, i.e., $e^N = e^*$,
(ii) income inequity is equal across states; $D_H = D_L =: D^N$, where

$$\begin{aligned} &D^N > 0 \text{ if } \alpha \in (0, 0.5), \\ &D^N < 0 \text{ if } \alpha \in (0.5, 1), \\ &D^N = 0 \text{ if } \alpha = 0.5, \end{aligned} \tag{13}$$

(iii) the optimal wage spread is $\Delta^N = \Delta^* = \dfrac{(H-L)}{2}$,
(iv) the optimal base wage w^N is uniquely defined as a function of α and γ, and
(v) the total surplus is reduced by the amount of the inequity premium unless $\alpha = 0.5$:

$$S^N := S(e^N, w^N, \Delta^N) = S^* - \gamma G(D^N) \tag{14}$$

Proof. See the Appendix. ■

As before, due to the absence of moral hazard, the optimal effort level is first-best also with Nash bargaining. Similar to the profit-maximizing contract, the optimal contract with bargaining is state-dependent and equalizes the difference in net payoffs across states. Yet, different from the former contract, income inequity is not always positive under the latter. By contrast, the optimal level of income inequity D^N depends on the distribution of bargaining power among the parties (see Proposition 4(ii)). More precisely, the more powerful party earns

[22] For the Nash-bargaining solution in economic modelling see, e.g., Nash (1950), Binmore, Rubinstein, and Wolinsky (1986), or Muthoo (1999).

the higher net income (more than $S_Q/2$), and both parties earn the same net income ($S_Q/2$) if they are equally powerful.

By Proposition 4(i) and (iii), the optimal level of effort, e^N, and the wage spread, Δ^N, are unaffected by the worker's concern for income equity, γ, and the worker's bargaining power, α. Yet, by Proposition 4(iv), the worker's optimal base wage w^N (as defined in equation (41)), and hence, his payment in both states reacts to changes in inequity aversion as well as bargaining power. Note that, by equation (4) and (2), expected utility EU and expected firm profit π_F are strictly increasing, respectively, decreasing in w. Consequently, a change in γ or α affects EU in the same direction as w while it affects π_F in the opposite direction.[23] The following proposition states the associated comparative statics.

Proposition 5 *The worker's optimal base wage with Nash bargaining* w^N
(i) is strictly increasing in the worker's bargaining power α,
(ii) is strictly increasing in the worker's concern for inequity γ *if* $\alpha \in (0, 0.5)$, *and*
(iii) is decreasing in the worker's concern for inequity γ *if* $\alpha \in (0.5, 0.5 + \bar{\varepsilon}]$ *where* $\bar{\varepsilon} \in (0, 0.5)$.

Proof. See the Appendix. ∎

The intuition of the first claim of the proposition is straightforward. The more powerful the worker is in the process of bargaining, the higher is also his total wage in both states for some given $\gamma > 0$. Since the wage spread Δ^N is set optimally so that $D_H = D_L$, the base wage rises accordingly. With respect to claims (ii)-(iii), note that the optimal base wage w^N will adjust so as to maximize the Nash product in problem (III) for any γ. Intuitively, a change in the base wage not only directly affects the parties' income but also has an indirect effect due to the impact on total welfare to be shared via the inequity premium. Depending on the distribution of bargaining power, we can distinguish two different scenarios. An increase in the base wage entails a lower expected inequity premium if $D > 0$, hence if $\alpha < 0.5$, while the opposite is true if $\alpha > 0.5$ and $D < 0$. In the first case, the firm earns a higher net income than the worker, and an increase in the base wage lowers the worker's disutility due to envy. By contrast, in the second case, the worker obtains a relatively higher net income, and his disutility due to empathy is raised as the base wage is increased. Accordingly, raising the base wage has a positive impact on total surplus if $\alpha < 0.5$ but reduces total surplus if $\alpha > 0.5$.

Claim (ii) states that the optimal base wage rises if the worker's inequity aversion gets stronger and $\alpha < 0.5$. That finding implies that the associated increase in the worker's wage and total surplus yield an overall positive impact on the Nash product (despite the negative direct effect on firm profit). If $\alpha > 0.5$, the opposite may be true. More precisely, in the proof of Proposition 5 in the Appendix, we prove analytically that, in the beginning of the interval $\alpha \in (0.5, 1)$, the optimal base wage is decreasing in γ, as stated in claim (iii). Intuitively, lowering the base wage then has an overall positive impact on the Nash product due to the associated direct increase in firm profit and the indirect positive effect on total surplus (despite the negative direct effect on the worker's wage). The analytical inspection is not conclusive

[23] Consider the derivatives of functions (4) and (2) with respect to w and recall that $G'(D^N) > -0.5$.

about the whole interval, however, it is worth noting, that our numerical solutions all suggest that $\partial w^N/\partial\gamma < 0$ for any $\alpha \in (0.5, 1)$.

From the fact that the optimal base wage is a function of α and γ, it directly follows that also the worker's expected utility, firm profit, and total surplus vary in both parameters. We can derive the functions EU^N and π_F^N from the proof of Proposition 4, in particular equations (44) and (45). Accordingly, under the contract (e^N, w^N, Δ^N), the worker's expected utility becomes

$$EU^N := EU\left(e^N, w^N, \Delta^N\right) = \alpha S^N \frac{1 + 2\gamma G'(D^N)}{1 + 2\alpha\gamma G'(D^N)}, \tag{15}$$

while expected firm profit is given by

$$\pi_F^N := \pi_F\left(e^N, w^N, \Delta^N\right) = (1-\alpha) S^N \frac{1}{1 + 2\alpha\gamma G'(D^N)}. \tag{16}$$

Closer inspection of equations (14), (15) and (16) allows for comparing the parties' relative shares of total surplus under the optimally negotiated contract with an inequity averse worker ($\gamma > 0$) to the case of bargaining with a purely selfish worker ($\gamma = 0$).

Corollary 1 *Under the optimal contract (e^N, w^N, Δ^N), with an inequity averse worker, the following holds for the parties' optimal shares from bargaining:*

$$\begin{array}{llll} EU^N > \alpha S^N & \textit{and} & \pi_F^N < (1-\alpha) S^N & \textit{if } \alpha \in (0, 0.5), \\ EU^N = 0.5 S^N & \textit{and} & \pi_F^N = 0.5 S^* & \textit{if } \alpha = 0.5, \\ EU^N < \alpha S^N & \textit{and} & \pi_F^N > (1-\alpha) S^N & \textit{if } \alpha \in (0.5, 1) \end{array} \tag{17}$$

Accordingly,
(i) if $\alpha = 0.5$, both parties earn exactly half of the surplus, and
(ii) if $\alpha \neq 0.5$, the parties' shares differ but the optimal division of total surplus is more equitable as compared to the case of a purely selfish worker. Moreover,
(iii) the worker's expected utility EU^N is increasing in α while expected firm profit π_F^N is decreasing in α.

Proof. By equation (15), the worker's expected utility amounts to a share of total surplus S^N. It is obvious that, with $\gamma = 0$, that share would correspond to the worker's bargaining power, α. However, with $\gamma > 0$, that share is multiplied by a factor $\frac{1+2\gamma G'(D^N)}{1+2\alpha\gamma G'(D^N)}$, that depends on γ. One can easily verify that this factor is greater than 1 if and only if $(1-\alpha)G'(D^N) > 0$, or equivalently, $G'(D^N) > 0$, i.e., $D^N > 0$. If $D^N < 0$, the factor is smaller than 1. Thus, for $\alpha \in (0, 0.5)$, an inequity averse worker obtains a share larger than αS^N while, for $\alpha \in (0.5, 1)$, he obtains less than αS^N. Accordingly, the firm's share falls below $(1-\alpha) S^N$ in the former case and above in the latter. In addition, if $\alpha = 0.5$, it holds that $D^N = 0$, and equations (15) and (16) imply that both parties share the first-best surplus equally. Claim (iii) follows directly from Proposition 5(i) and the fact that $EU^N$and π_F^N are increasing, respectively, decreasing in w^N. ∎

The foregoing corollary presents a comparison of the parties' relative utility levels under bargaining with and without inequity aversion. More specifically, the results in (17) imply that, with an inequity averse worker, the party with less bargaining power obtains a larger share of the surplus compared to the case with a purely selfish worker, respectively. Obviously, the opposite is true for the more powerful party. That is, inequity aversion leads to a more egalitarian distribution of surplus. The reason is that the associated optimal shares lead to an increase in the overall surplus to be distributed in the process of bargaining. To grasp the intuition, suppose that one party - say the worker - has less bargaining power than the other party - say the firm.[24] Now consider the impact of an increase in the two party's bargaining power on both parties' shares and overall surplus, respectively: Since the worker's bargaining power is below one half initially, by Proposition 4(ii), he earns less net income than the firm. An increase in the worker's bargaining weight thus not only increases his share but, at the same time, reduces the level of income inequity and thus raises total surplus. Obviously, the latter has a favorable effect on both parties' income. Consequently, the worker's optimal share from bargaining is larger compared to the case without inequity aversion. By contrast, the firm's bargaining power is above one half so that a further increase in the bargaining weight raises income inequity even further and thus reduces overall surplus. Accordingly, the firm's optimal share is lower compared to the case of bargaining with a purely selfish worker.

Figure 3 illustrates the foregoing results. It plots the worker's expected utility (a) and expected firm profit (b) as functions of the workers bargaining power for different values of inequity aversion.[25] In both figures, the solid line represents the case in which the firm bargains with a purely self-regarding worker ($\gamma = 0$). It is a straight line, respectively, since the worker's utility is linearly increasing in his bargaining power while the opposite holds true for firm profit. The dashed and dash-dotted curves show an intermediate and relatively large concern for income inequity, respectively. In both figures, all functions intersect at the equal distribution of bargaining power ($\alpha = 0.5$) between worker and firm because inequity aversion has no effect if both parties share the net surplus evenly. However, when the worker feels envy ($\alpha < 0.5$ and $D^N > 0$), the optimal contract (e^N, w^N, Δ^N) provides him with an expected utility level that exceeds the expected utility of a purely selfish worker (see Figure 3(a)). Accordingly, firm profit is smaller when the worker is inequity averse as compared to purely selfish workers (see Figure 3(b)). By contrast, when the worker feels compassion for the firm ($\alpha > 0.5$ and $D^N < 0$), the worker's inequity aversion has the opposite effect on expected utility and profit, respectively. Moreover, the figures show that the magnitude of the effect of γ on the two functions is smaller for $\alpha > 0.5$ than for $\alpha < 0.5$. The reason is the asymmetry in the disutility function $G(D)$. Importantly, the numerical solutions illustrated in the two subfigures suggest that the distribution of surplus among the parties in the negotiation gets the more even, the larger the worker's concern for income inequity, γ. That is, the worker's expected utility is increasing in γ for $\alpha \in (0, 0.5)$ and decreasing for $\alpha \in (0.5, 1)$ while the opposite holds true for the expected firm profit.[26]

[24] The same reasoning holds if the parties are exchanged.

[25] We restrict Figures 3 and 4 to some representative values of inequity aversion. The results shown are, however, robust for various values of γ.

[26] This result is robust for various degrees of inequity aversion and model parameters.

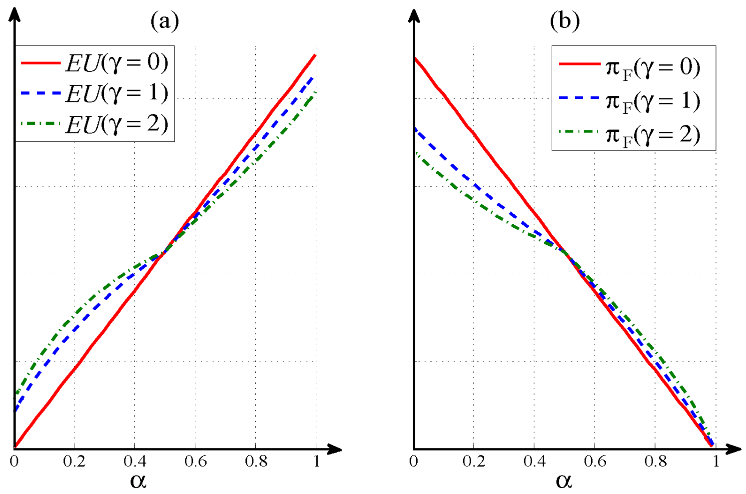

Figure 3: Expected utility EU^N (a) and expected firm profit π_F^N (b)

Finally, in the next corollary, we summarize the welfare implications of the foregoing analysis. In particular, we compare total surplus under Nash bargaining to the first-best welfare level and that under the profit-maximizing contract.

Corollary 2 *Under the optimal contract* (e^N, w^N, Δ^N)*, with an inequity averse worker*
(i) total welfare coincides with first-best welfare if $\alpha = 0.5$*;* $S^N = S^*$*,*
(ii) total welfare falls below first-best if $\alpha \gtrless 0.5$*;* $S^N < S^*$*,*
(iii) total welfare strictly exceeds total welfare under the profit-maximizing contract $(\alpha = 0)$*;* $S^N > S^{**}$*.*

Proof. By Proposition 4(ii), the optimal contract with Nash bargaining implements $D^N \neq 0$ whenever $\alpha \neq 0.5$. Claims (i)-(ii) then directly follow from equation (14) and the definition of $G\left(D^N\right)$. To prove (iii), consider in addition Proposition 2(vi), and note that in general, $D^N < D^{**}$. To prove the latter, observe that, in the optimal contract with bargaining, the worker obtains a positive rent while his rent is zero under the profit-maximizing contract, i.e., $EU^{**} < EU^N$. By Propositions 2 and 4, the foregoing is equivalent to $w^{**} - \gamma G(D(w^{**})) < w^N - \gamma G(D(w^N))$. Since the function $w - \gamma G(D(w))$ is strictly increasing in w, it follows that $w^{**} < w^N$, or equivalently $D^{**} > D^N$. ■

Figure 4 illustrates the results from Corollary 2. It plots total surplus from bargaining S^N, depending on different degrees of the worker's inequity aversion. The straight line represents the case of a purely selfish worker, in which total surplus is first-best; $S^N = S^*$, and independent of the relative distribution of bargaining power (and hence the final allocation of surplus between the parties). The other strictly concave curves show total surplus S^N with an inequity averse worker. In line with Corollary 2(i), all curves intersect at $\alpha = 0.5$ because inequity costs are completely avoided in this case. However, $\alpha < 0.5$ and hence $D^N > 0$, the worker suffers from envy, which reduces total surplus below the first-best level. If $\alpha > 0.5$ and hence $D^N < 0$, the

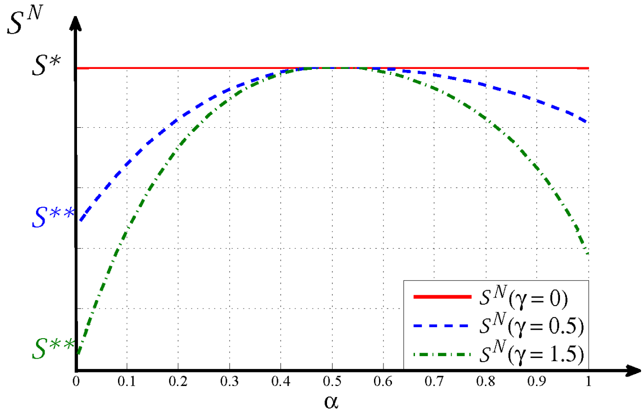

Figure 4: Total welfare with Nash-bargaining

worker feels compassion for the firm, which also reduces total welfare. Both foregoing results are summarized in Corollary 2(ii). Similar to Figure 3, the impact of γ on total surplus is stronger in the former case because envy triggers relatively higher inequity costs than compassion. By noting that the function value for S^N at $\alpha = 0$ corresponds to total surplus S^{**} under the profit-maximizing contract, the foregoing directly implies the result in Corollary 2(iii): In the figure, S^{**} is always lower than the value for S^N at the very right of the figure ($\alpha \to 1$) if $\gamma > 0$.

Finally, similar to the results in Figure 3, our numerical solutions in Figure 4 suggest the degree of the worker's inequity aversion to have a continuous negative impact on total surplus.[27]

The last figure provides a different illustration of our results by graphically representing the Nash-bargaining solution for some given degree of inequity aversion $\gamma > 0$. More precisely, the figure plots firm profit and surplus as functions of the worker's expected utility. The inner of the two concave functions is firm profit, hence the Pareto frontier. The convex indifference curves (IDC) plot all combinations of expected utility and firm profit that yield a constant Nash product for some given value of α (compare problem (III)). Accordingly, the Nash-bargaining solution is at the point where firm profit is tangent to the indifference curve, respectively. The outer of the concave curves is total surplus S^N. Notably, with $\gamma = 0$, that curve would be a straight horizontal line. Yet, as argued above, with $\gamma > 0$, total surplus is a function of the parties' negotiated shares. As can be seen from the figure, total surplus is maximized at S^* for $\alpha = 0.5$, i.e., where expected utility and firm profit are of the same size and hence on the 45° line.

6 Discussion

In the following, we reconsider some assumptions of our model and discuss whether and how changing them would affect out results.

[27]The result is again robust for various degrees of inequity aversion and model parameters.

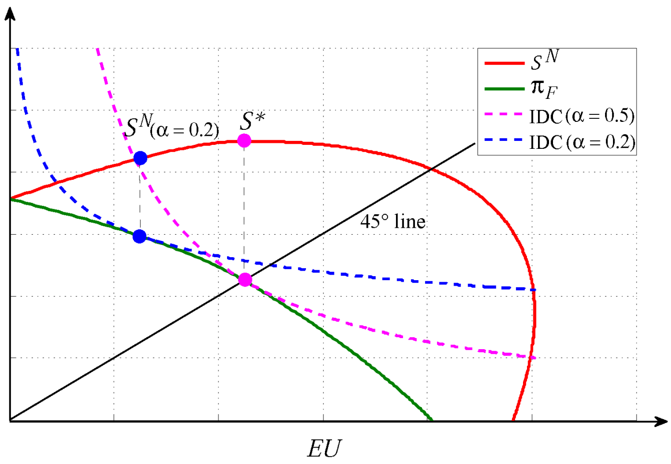

Figure 5: The Nash-bargaining solution with inequity aversion

Bilateral vs. Multilateral Bargaining Our analysis focuses on the case with just one worker and one principal. The analysis, however, also captures the multilateral case if considering representative agents. For example, in our model, the worker would be represented by a union and the firm by an employer association. Of course, in that case, possible conflicts of interest between the parties and their respective representatives should also be taken into account. Moreover, firms often employ several workers. Our analysis is then still applicable if the firm's problem is additively separable in the individual employment relationships (which, however, neglects possible complementarities in the production process). It is plausible to assume that each worker would then evaluate pay equity by comparing the firm's share of surplus to the whole workforce's net income. With many workers, horizontal pay inequality is likely to become an additional issue. In that respect, Metcalf, Hansen, and Charlwood (2001) show that pay dispersion is lower among union members than among non-unionists.

Outside Options Throughout the analysis, we have assumed that the parties' outside options are zero. The reason is that doing so allows us to keep the exposition simple by singling out the impact of inequity aversion on the optimal distribution of surplus among the parties. Obviously, non-zero outside options affect the optimal income distribution in bargaining regardless of the worker's social preference. Our main qualitative results extend to that case as long as the parties' outside options fall below half of the expected productive surplus, respectively. A positive outside option of either party will then lead to an according adjustment of the worker's base wage in our model. This does not affect our results regarding the impact of inequity aversion on total welfare and the parties' relative shares in bargaining.[28] If one party's outside option exceeds half of the expected productive surplus, additional frictions are introduced.[29] First, consider the worker's outside option. If it exceeds half of the surplus, the worker participates in the contract only if

[28] A similar argument applies when considering an exogenous minimum wage.

[29] If both parties' outside option is greater than half of the surplus, no value is created by the relationship and no optimal contract exists.

his net payoff strictly exceeded that of the principal. Thus, our results regarding the impact of compassion apply while envy never occurs. The opposite holds true if the firm's outside option is larger than half of the surplus.

Capital Investments and Entrepreneurial Risk In our model, only the worker generates productive returns while possible capital investments by the principal are not taken into account. Obviously, similar to the worker's effort costs, capital investments reduce the firm's net income and, as compared to our model, would shift the optimal distribution of productive returns more towards the firm. Moreover, capital investments can introduce an interesting effect in a multi-period setting. Suppose that inequity assessments by the worker are made on a myopic (period by period) basis also in a repeated employment setting. Then the firm may have countercyclical investment incentives since doing so evens out net profits which, in turn, may reduce overall inequity premium costs. Further investigation of these dynamics as well as other intertemporal aspects are certainly a promising direction for future research.

Moreover, in our model, we assume risk neutrality for both parties and the same risk is imposed on both parties in the optimal contract.[30] In reality it is, however, often the firm which carries a higher entrepreneurial risk. It may be argued that this might prompt the worker to accept some pay inequity as fair in return.

Moral Hazard and Risk Aversion Our work could be extended to also include non-contractible effort and risk aversion on the side of the worker.[31] In such a case, the wage spread Δ would serve several conflictive functions. Not only does the size of incentive pay determine how surplus is shared (thereby affecting the level of income inequity across states) but also does then the well-known incentive-insurance trade-off arise. In particular, with moral hazard, the bonus provides the worker with effort incentives, dragging the optimal reward towards the full productive return. Even bargaining power would then tilt contracts towards equal sharing rules, thereby diluting effort incentives and reducing expected material outcome. Moreover, risk aversion drags the optimal wage spread downwards to reduce the risk imposed on the worker and hence risk-premium costs for the firm. This again has an adverse effect on effort incentives and expected production. Finally, inequity aversion is known to raise the firm's costs of providing incentives so that the firm would induce less than first-best effort (see, e.g., Kragl and Schmid (2009)).

In line with former studies, including moral hazard in our model highlights that the worker's social preference can substitute for explicit incentive payments. For example, early work by

[30] The result follows from the optimal wage spread Δ in the different contracts.

[31] Englmaier and Wambach (2010) analyze moral hazard in the profit-maximizing contract with an inequity averse worker. The impact of risk aversion in the absence of bargaining is analyzed by Dur and Glazer (2008) and Englmaier and Wambach (2010). In a recent article, Li, Xiao, and Yao (2013) study a bargaining model in a moral-hazard framework with a risk neutral principal and a risk averse agent.The authors consider purely self-regarding workers and focus on binary effort. In addition to the standard incentive-insurance trade-off, they find that an increase in the agent's bargaining power leads to a less frequent implementation of high effort but may also raise the power of the incentive contract. In a related paper, Li, Sun, Yan, and Yin (2012) analyze the impact of either party's risk aversion on the distribution of surplus in a symmetric Nash-bargaining model with uncertainty.

Akerlof (1982) models the labor relation as a gift exchange, where workers exert more than minimal effort in response to generous wages. In a recent study, Englmaier and Leider (2012) show that generous compensation can substitute for performance-based pay in a model with reciprocal agents. Also dynamic considerations such as career concerns can explain high effort levels in the absence of performance pay. In our model, an intrinsic work incentive may occur due to inequity aversion. To see this, note that there are two opposing effects of raising effort on the worker's utility: On the one hand, for some given wage, working harder increases the worker's effort costs (and thus lowers his net income) while raising expected production (and hence the firm's income). The associated increase in income inequity either raises the worker's disutility from envy or reduces his disutility from empathy. On the other hand, raising effort, ceteris paribus, increases the worker's expected wage in the presence of incentive pay and, at the same time, lowers the firm's income. This has a negative impact on income inequity and thus either raises the worker's disutility due to empathy or lowers his disutility from envy. Altogether, the worker might thus be willing to raise work effort because doing so may reduce his expected disutility due to envy or empathy. Accordingly, even when just paid fixed wages, workers may work hard because they gain utility when the firm also obtains some positive return.

7 Conclusion

We introduce social preferences in a bargaining setting by considering the productive relationship between a firm and an inequity averse worker. The latter compares his own net income under the contract with firm profit and dislikes inequitable surplus distributions in any productive state. We show that, in such a case, the welfare-maximizing contract stipulates an equal sharing rule in each productive state. If the worker possesses no bargaining power, the profit-maximizing contract never implements the first-best solution while converging the bargaining power of the parties may reestablish the efficient contract. Moreover, we show that employing an inequity averse worker is costly to the firm because the social preference raises the worker's expected wage. Our results highlight a novel function of performance pay beyond the provision of work incentives: In the presence of fairness considerations, bonus pay may be implemented to distribute productive rents from firm owners to labor across states. Altogether, our findings show that an increase in the worker's concern for equity leads to a more equitable income distribution in the bargaining process and thus, a more even overall distribution of the productive surplus from the employment relationship.

In our model, the parties' respective bargaining power and the worker's inequity aversion are both exogenous. Obviously, in reality, the former will be influenced by the regulator, for example through the design of labor market institutions. In this respect, our results imply that a well-balanced distribution of bargaining power among firm owners and productive workers may be in the regulator's interest. Moreover, our results indicate that firms may wish to screen their workforce in their recruitment process with respect to their social preference type since the latter has implications for optimal compensation policies and profit of the firm.

Finally, it is worth noting that our analysis is performed at the firm level and does hence not allow to directly draw conclusions at the aggregate level. Analyzing the effects of (heterogenous) social preferences on the aggregate labor market is yet another promising direction for future research.

Appendix

Proof of Proposition 1. We initially ignore the constraints in maximization problem (I) and compute the optimal solution. Then we show that the solution satisfies the constraints. The first-order conditions with respect to e, w, Δ are given by

$$H - L - c'(e)[1 + e\gamma G'(D_H) + (1-e)\gamma G'(D_L)] - \gamma G(D_H) + \gamma G(D_L) = 0, \tag{18}$$

$$2e\gamma G'(D_H) + 2(1-e)\gamma G'(D_L) = 0, \tag{19}$$

$$2e\gamma G'(D_H) = 0, \tag{20}$$

respectively. To prove (*ii*), note that, by equation (20), for a positive level of effort, it is optimal for the firm and the worker to split productive surplus equally if high output is realized, i.e., $G'(D_H) = 0$, and thus, $D_H = 0$. It follows that, for any $e > 0$, the second term in (19) must be zero as well, hence productive surplus is split equally also if output is low, i.e., $G'(D_L) = 0$, or equivalently, $D_L = 0$, which concludes the result in (*ii*). Consequently, we must have $w = \frac{L-c(e)}{2} + c(e)$ and $\Delta = \frac{H-L}{2}$, as given in (*iii*) and (*iv*). Substituting $D_L = D_H = 0$ in equation (18) yields $H - L = c'(e)$, i.e., the optimal effort level is such that its marginal productivity equals its marginal costs, which proves (*i*). Obviously, at the optimum, firm profit and the worker's expected utility are both strictly positive. Furthermore, since both parties split the productive surplus equally, the last two terms in the objective function in problem (I) become zero, i.e., there is no welfare loss due inequity aversion, and the total surplus is first-best, as given in equation (5). ■

Proof of Proposition 2. The Lagrangian of maximization problem (II) is given by:

$$\mathcal{L} = L + e(H-L) - (w + e\Delta) + \lambda[w + e\Delta - c(e) - e\gamma G\left(D_H\right) - (1-e)\,\gamma G\left(D_L\right)] \tag{21}$$

The first-order conditions with respect to e, w, Δ and the Kuhn-Tucker conditions are:

$$\mathcal{L}_e = H - L - \Delta + \lambda[\Delta - c'(e)[1 + e\gamma G'(D_H) + (1-e)\gamma G'(D_L)] - \gamma G(D_H) + \gamma G(D_L)] = 0, \tag{22}$$

$$\mathcal{L}_w = -1 + \lambda[1 + 2e\gamma G'(D_H) + 2(1-e)\gamma G'(D_L] = 0, \tag{23}$$

$$\mathcal{L}_\Delta = -e + \lambda[e + 2e\gamma G'(D_H)] = 0, \tag{24}$$

$$\lambda \geq 0 \text{ and } \lambda[w + e\Delta - c(e) - e\gamma G\left(D_H\right) - (1-e)\,\gamma G\left(D_L\right)] = 0, \tag{25}$$

$$0 \leq w + e\Delta - c(e) - e\gamma G\left(D_H\right) - (1-e)\,\gamma G\left(D_L\right) \tag{26}$$

With $e > 0$, rearranging condition (24) yields:

$$\lambda[1 + 2\gamma G'(D_H)] = 1 \tag{27}$$

If $\gamma G'(D_H) = -1/2$, the latter equation has no solution, and if $\gamma G'(D_H) < -1/2$, we have $\lambda < 0$ and hence condition (25) is violated. Thus, it must hold that $\gamma G'(D_H) > -1/2$,[32] and

$$\lambda = \frac{1}{1 + 2\gamma G'(D_H)}. \tag{28}$$

By condition (25), $\lambda > 0$ implies that the participation constraint (PC) is binding. Rearranging equation (23), we obtain:

$$\lambda[1 + 2e\gamma G'(D_H) + 2(1-e)\gamma G'(D_L)] = 1 \tag{29}$$

Similar to the foregoing argument regarding equation (27), for equation (29) it must hold that $1 + 2e\gamma G'(D_H) + 2(1-e)\gamma G'(D_L) > 0$.[33]

Combining equations (28) and (29) yields

$$1 + 2e\gamma G'(D_H) + 2(1-e)\gamma G'(D_L) = 1 + 2\gamma G'(D_H), \tag{30}$$

or equivalently,

$$G'(D_L) = G'(D_H). \tag{31}$$

The foregoing equality implies that, in the optimal contract, the parties' net income inequity is the same in each productive state, and consequently $\Delta^{**} = (H - L)/2$, as stated in (ii) and (iv). We denote by $D^{**} := D_H = D_L$ the difference in net payoffs at the optimum. Substituting λ from equation (28) and Δ^{**} in equation (22) and simplifying, we obtain:

$$\frac{1 + \gamma G'(D^{**})}{1 + 2\gamma G'(D^{**})}(H - L - c'(e)) = 0 \tag{32}$$

Since $\gamma G'(D^{**}) > -1/2$, the result in (i) follows , i.e., $H - L = c'(e)$. ■

Proof of Proposition 4. The Nash Product in problem (III) can be rewritten as follows:

$$N(e, w, \Delta) = [w + e\Delta - c(e) - e\gamma G(D_H) - (1-e)\gamma G(D_L)]^{\alpha}[L + e(H - L) - (w + e\Delta)]^{1-\alpha} \tag{33}$$

[32] Englmaier and Wambach (2010) impose a similar assumption. In line with their model, the condition restricts the strength of the worker's aversion towards advantageous inequity. More specifically, it rules out the possibility that, if the worker's net income exceeds that of the firm, he would be willing to transfer money to the firm in order to reduce income inequity. Similarly, Fehr and Schmidt (1999) impose $\beta < 1$ for the worker's feelings of compassion to remain sufficiently low.

[33] Below we verify that $D_H = D_L$ in the optimal contract. Note that $\gamma G'(D_H) > -1/2$ implies that $1 + 2e\gamma G'(D_H) > 1 - e$, or equivalently, $1 + 2e\gamma G'(D_H) + 2(1-e)\gamma G'(D_L) > (1-e)(1 + 2\gamma G'(D_L)) > 0$. Hence, the latter condition is equivalent to the one derived above (see also the explanations in footnote 32).

Let $C := EU/\pi_F$. Then the first-order conditions with respect to e, w, Δ become:

$$\begin{aligned}\alpha C^{\alpha-1}[\Delta - c'(e)(1 + e\gamma G'(D_H) + (1-e)\gamma G'(D_L) - \gamma(G(D_H) + \gamma G(D_L))] \\ + (1-\alpha)C^{\alpha}[H - L - \Delta] = 0,\end{aligned} \tag{34}$$

$$\alpha C^{\alpha-1}[1 + 2e\gamma G'(D_H) + 2(1-e)\gamma G'(D_L)] - (1-\alpha)C^{\alpha} = 0, \tag{35}$$

$$\alpha C^{\alpha-1}[e + 2e\gamma G'(D_H)] - (1-\alpha)eC^{\alpha} = 0 \tag{36}$$

Rearranging equation (36) and assuming that $e > 0$, we obtain:

$$C = \frac{\alpha}{1-\alpha}(1 + 2\gamma G'(D_H)) \tag{37}$$

Note that the above equation is satisfied only for $\gamma G(D_H) > -1/2$. Hence, we obtain the same condition as under the profit-maximizing contract (see footnote 32). Rearranging equation (35), it must hold that

$$C = \frac{\alpha}{1-\alpha}(1 + 2e\gamma G'(D_H) + 2(1-e)\gamma G'(D_L)). \tag{38}$$

Comparing this result to equation (37) and cancelling common terms, we obtain $G'(D_H) = G'(D_L)$, i.e., $D_H = D_L =: D^N$, as stated in (*ii*). This implies the optimal wage spread in (*iii*); $\Delta^N = (H-L)/2$. If we substitute Δ^N for Δ in condition (34) and rearrange the terms, we obtain:

$$(1 + \gamma G'(D^N))(H - L - c'(e)) = 0 \tag{39}$$

As stated above, if a solution exists, it must hold that $\gamma G(D^N) > -1/2$, and thus, it follows that $H - L = c'(e)$, yielding result (*i*). With EU^N and π_F^N denoting the worker's expected utility and expected firm profit under the optimal contract $\left(e^N, w^N, \Delta^N\right)$, respectively, equation (37) is equivalent to

$$EU^N = \frac{\alpha}{1-\alpha}(1 + 2\gamma G'(D^N))\pi_F^N. \tag{40}$$

Substituting EU^N and π_F^N, as given in equations (4) and (2), the foregoing equation becomes:

$$w + e^N\Delta^N - c(e^N) - \gamma G(D(w)) = \frac{\alpha}{1-\alpha}(1 + 2\gamma G'(D(w)))(L + e^N(H-L) - w - e^N\Delta^N) \tag{41}$$

The optimal wage, w^N, can then be defined as the solution to the above equation, which, obviously, depends on γ and α. Since EU^N is strictly increasing in w while the right-hand side of the above equation is decreasing in w, the solution for w^N is unique, as stated in result (*iv*). To prove the second part of result (*ii*), i.e., how the optimal level of income inequity D^N changes depending on α, note that the optimal contract with Nash bargaining implements Δ^N, e^N for any α. Therefore, the parties' shares and hence D^N are adjusted through the base wage w^N for different values of α. Moreover, recall that D^N is strictly decreasing in w^N by definition. In the proof of 5 (*i*), we verify that w^N is strictly increasing in α. Next, note that we have $D^N = 0$ if and only if $w^N = \left(L + c(e^N)\right)/2$. Since w^N has to also satisfy equation (41), it follows that

$$\frac{L + e^N \Delta^N - c(e^N)}{2} = \alpha(L + e^N(H - L) - c(e^N)), \tag{42}$$

or equivalently, $S^*/2 = \alpha S^*$, implying that $D^N = 0$ if $\alpha = 1/2$. Moreover, by Proposition 2(iii), with $\alpha = 0$, we have $D^N > 0$ (recall that $D^N = D^{**}$ for $\alpha = 0$). From the foregoing, we also know that D^N is strictly decreasing in α. Together, this proves the results stated in the second part of (ii).

Finally, to prove (v), we solve equation (41) for $e^N \Delta^N$ and substitute the result in equation (2):

$$\pi_F^N = L + e^N(H - L) - \frac{(1-\alpha)(c(e^N) + \gamma G(D^N)) + \alpha(1 + 2\gamma G'(D^N))(L + e^N(H - L))}{1 + 2\alpha\gamma G'(D^N)} \tag{43}$$

or equivalently,[34]

$$\pi_F^N = \frac{1-\alpha}{1 + 2\alpha\gamma G'(D^N)}\left[L + e^N(H - L) - c(e^N) - \gamma G(D^N)\right]. \tag{44}$$

Plugging π_F^N in equation (40), we obtain

$$EU^N = \frac{\alpha(1 + 2\gamma G'(D^N))}{1 + 2\alpha\gamma G'(D^N)}\left[L + e^N(H - L) - c(e^N) - \gamma G(D^N)\right]. \tag{45}$$

Adding equations (44) and (45) yields the surplus is as given in (14). ■

Proof of Proposition 5. Recall that w^N is implicitly defined by equation (41). Applying the Implicit-Function Theorem and rearranging terms yields:

$$\frac{\partial w^N}{\partial \alpha} = \frac{(S^* - \gamma G(D)) + 2\gamma G'(D)\pi_F}{1 + 2\gamma G'(D) + 4\alpha\gamma G''(D)\pi_F}, \tag{46}$$

$$\frac{\partial w^N}{\partial \gamma} = \frac{(1-\alpha)G(D) + 2\alpha G'(D)\pi_F}{1 + 2\gamma G'(D) + 4\alpha\gamma G''(D)\pi_F}, \tag{47}$$

where π_F is given in equation (2). As shown in the proof of Proposition 4 above, if a solution to problem (III) exists, it must hold that $\gamma G'(D) > -1/2$. Since $\pi_F \geq 0$ and $G''(D) > 0$, the denominator in both derivatives is strictly positive. Moreover, in both numerators, the first summand is non-negative (note that $S^* - \gamma G(D) < 0$ represents an economically unreasonable case). However, the overall numerator may be negative in both derivatives if $D < 0$.

First, consider the numerator of the right-hand side of equation (46) and assume that it is not positive. Since $\gamma G'(D) > -1/2$, it follows that $-\pi_F < 2\gamma G'(D)\pi_F \leq -(S^* - \gamma G(D))$, or equivalently, $\pi_F > S^* - \gamma G(D)$. This yields a contradiction since expected firm profit cannot exceed the total surplus of the relationship. Consequently, it follows that $\partial w^N/\partial\alpha$ is strictly positive, as stated in result (i). Second, consider the numerator of the right-hand side of equation (47). By Proposition 4(ii), with $\alpha \in (0, 0.5)$, we have $G'(D) > 0$, and the numerator as well

[34] Note $\alpha \in (0,1)$ and $\gamma G(D^{**}) > -1/2$ imply that $1 + 2\alpha\gamma G'(D^{**}) > 0$.

as $\partial w^N/\partial\gamma$ are both strictly positive, as stated in result (*ii*). Yet, with $\alpha \in (0.5, 1)$, we have $D < 0$ and it follows that $G'(D) \in (-0.5, 0)$. Now assume that the numerator is positive, i.e., $(1-\alpha)G(D) + 2\alpha G'(D)\pi_F \geq 0$, or equivalently,

$$\frac{-G(D)}{G'(D)} \geq \frac{2\alpha}{1-\alpha}\pi_F. \tag{48}$$

Due to the convexity of $G(D)$, it holds that $G'(D) \leq \frac{G(D+h)-G(D)}{(D+h)-D}$, where $h \in \mathbb{R}_+$. With $h = -D$, we obtain $G'(D) \leq \frac{-G(D)}{-D}$, or equivalently, $-D \geq \frac{-G(D)}{G'(D)}$. Combining this result with inequality (48) yields $-D \geq \frac{-G(D)}{G'(D)} \geq \frac{2\alpha}{1-\alpha}\pi_F$. Since $\frac{2\alpha}{1-\alpha} > 2$, this implies

$$-D > 2\pi_F. \tag{49}$$

Recall that, with $\alpha = 0.5$, we have $D = 0$ and $\pi_F = S^*/2$. Note that, for $\alpha > 0.5$ but close to 0.5, the foregoing inequality yields a contradiction since D is close to 0 while the right hand-side of condition (49) is close to S^* which is, by assumption, strictly positive. Therefore, with $\alpha \in (0.5, \bar{\varepsilon}]$, for some $\bar{\varepsilon} \in (0, 0.5)$, it has to hold that $\partial w^N/\partial\gamma$ is strictly negative, as stated in (*iii*). Note, however, that, if inequality (49) holds, this does not necessarily imply a positive numerator of the right-hand side of equation (47) and thus it is not necessarily true that $\partial w^N/\partial\gamma > 0$. With $\alpha \in (\bar{\varepsilon}, 1)$, the sign of $\partial w^N/\partial\gamma$ depends on the relative levels of the model parameters α, γ, and S^*. ■

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