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**Article — Published Version**

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Managerial and Decision Economics

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*Suggested Citation:* Kirstein, Roland (2023) : Strategic delegation in Nash bargaining, Managerial and Decision Economics, ISSN 1099-1468, Wiley, Hoboken, NJ, Vol. 45, Iss. 2, pp. 784-794, <https://doi.org/10.1002/mde.4033>

This Version is available at:

<https://hdl.handle.net/10419/293999>

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## RESEARCH ARTICLE

# Strategic delegation in Nash bargaining

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**Abstract**

Bargainers can increase their outcome by delegation. This paper analyzes delegation contracts consisting of two components: First, a percentage of the outcome if the delegate concludes an agreement. Second, a bonus payment if the delegate fails to do so. This paper derives the effects of these components on the principal's payoff and shows that the optimal contract is unique. Optimally, the principal offers a small share and a high reward for failure to reach an agreement. Delegate's bargaining skills play no role in the optimal contract. The condition is derived under which the optimal contract benefits the principal.

**JEL CLASSIFICATION**  
C78, M52

## 1 | INTRODUCTION

This paper analyzes negotiations between two parties when the one side (called the “principal”) considers employing a risk-neutral delegate (or “agent”) to carry out the negotiations on her behalf.<sup>1</sup> The principal makes a take-it or leave-it offer to her delegate in order to compensate him for his opportunity costs of working for her. In such situations, contract theory suggests the usage of linear contracts, which consist of two components. A linear contract makes sense because it addresses two problems simultaneously: The fixed wage induces the agent to accept the contract (“participation”) and the share induces the agent to pursue the principal's goals (“incentive compatibility”). This paper also analyzes contracts consisting of two components.

Several reasons may exist for appointing a delegate, even though this is costly. First of all, the delegate may have better negotiations skills than the principal. Moreover, appointing a delegate may serve as a commitment to a specific shape of the agent's utility function.<sup>2</sup> Another reason could be the interruption of direct communication between the principal and the other party.<sup>3</sup> Absence of direct

communication would enable the principal to commit the delegate to a certain bargaining strategy from which the latter must not deviate.

This paper demonstrates a different effect of strategic delegation: Using a two-part contract allows the principal to influence the Nash bargaining solution systematically.<sup>4</sup> The model suggests the usage of bargaining delegation contracts that consist of two components. The first component stipulates a compensation for the delegate in case he successfully concludes a bargaining agreement by offering him a share of the bargaining outcome. The second component kicks in if the delegate fails to close an agreement. In this case, a fixed payment should be made. If the parties agree upon a positive payment, this would be a reward for failure; if the payment is negative, that would be a sanction for not being successful. The derived results demonstrate that an optimal contract for a delegate representing a principal in a symmetric Nash bargaining situation with bilateral full information<sup>5</sup> is characterized by

- a rather moderate share for the delegate and
- a high bonus payment in case the negotiations fail.

The intuition behind these results is due to the structure of the Nash bargaining solution: A higher bonus payment promised to the delegate if no agreement is closed drives up his threat point, which has an increasing effect on the Nash bargaining result. Lowering the

I am grateful to Joshua Gomersall and Annette Kirstein for their most helpful and constructive remarks that helped me to improve the current version of this paper.

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delegate's share of the bargaining outcome has a similar effect: The lower a bargainer's marginal valuation of the bargaining result, the higher is this party's share according to the Nash bargaining solution.<sup>6</sup>

By offering a delegation contract consisting of these two components, it is possible to replace the own threat point and the own valuation of the agreement result by a threat point and a valuation which are determined by the delegation contract. When trying to exploit these two effects, however, the principal had to obey three conditions when choosing the contract offer:

- the delegate's share must cover his alternative wage;
- an increased threat point must not distract him from concluding an agreement; and
- employing a delegate must be profitable for the principal.

This paper discusses these constraints, shows the conditions under which a non-empty set of mutually acceptable contract parameters exists, and derives the unique optimal contract. An analysis of the optimal delegation contract in Nash bargaining situations does not exist in the literature.

The paper by Bester and Sakovics (2001) pursues a similar research goal, but looks at the non-cooperative bargaining model of Rubinstein (1982). According to the results of their model, a "sell the shop" contract would be optimal: The delegate is promised the whole bargaining result, and pays a fixed amount. My analysis demonstrates that this contract would not be optimal in a Nash bargaining situation, as it would forgo the strategic leverage offered by a lower share for the player who carries out the bargaining. According to my results, the delegate's share should be as low as possible. Moreover, the agent in their model has a zero outside option, whereas my model takes into account that the alternative wage of the delegate may be positive.

Segendorff (1998) and Jones (1989) have analyzed bilateral delegation in bargaining. The latter also introduces a payment scheme based on shares of the outcome, but in his model, the reason for low shares is competition among potential delegates, not, as in my model, the strategic choice of the principal.

A non-cooperative bargaining model is adequate for negotiations in which the players face explicit rules for making offers. For example, the Rubinstein model allows the parties to make alternating offers for an infinite time.<sup>7</sup> Threat points, that is, the parties' payoffs in case bargaining breaks up, play no role in Rubinstein's model, as it consists of an infinite number of rounds.<sup>8</sup> On the other hand, it would be easy to integrate a delegate's decision on how much effort to spend in order to promote his principal's goals into a non-cooperative bargaining model.

The Nash bargaining solution is the more adequate solution concept if the rules according to which two parties carry out their negotiations do not stipulate a clear structure.<sup>9</sup> Moreover, its derivation is usually simpler than that of the subgame perfect equilibrium in a Rubinstein model. Nakamura (2012, p. 252) points out that the Nash bargaining solution approximates the equilibrium outcome of a non-cooperative Rubinstein bargaining game, if the parties have sufficiently high discount factors, as it was shown in the canonical paper by Binmore et al. (1986).

The Nash solution expressly takes into account threat points and, thereby, allows for the analysis of their strategic impact on the bargaining outcome.<sup>10</sup> It would, however, be difficult to integrate an effort choice of the bargainer (the principal or her delegate) into the framework of the original Nash bargaining solution. Hence, this paper neglects the classical moral hazard problem, which allows it to focus on the strategic effect of a delegation contract on Nash bargaining.

A few papers so far have discussed delegation in bargaining. Cai and Cont (2004) discuss the impact of a bargainer's marginal valuation of the bargaining result, but do not use this parameter as a strategic variable. Their model rather addresses the problem of moral hazard on the side of the delegate, which I have excluded from my analysis. Harris (1990) also manipulates the marginal valuation and the threat point of one party in Nash bargaining but does not systematically analyze the effect derived here. Burtraw (1992) focuses on (the strategic use of) risk-aversion in bargaining, as the curvature of the delegate's utility function may also influence his marginal valuation of the outcome.<sup>11</sup>

The canonical work on the manipulation of bargaining threat points is the book by Schelling (1960).<sup>12</sup> Putnam (1988) demonstrates how domestic constitutional constraints can make an international bargainer tougher.<sup>13</sup> Palacio Garcia et al. (2015) analyze the impact of threat points in a non-cooperative bargaining game, namely the "hawk-dove" game. Abreu and Pearce (2015) also focus on a non-cooperative bargaining game, the Nash demand game. Talamàs (2020) considers endogenous threat points in cooperative Nash bargaining created by non-cooperative forming of coalitions.

Recently, embedding Nash bargaining into a non-cooperative game has led to various fruitful insights in the strategic management literature. Kraft (2006) has compared wage bargaining and efficient bargaining (i.e., negotiations about wage and employment) if the Nash bargaining within the firms is followed by a Cournot interaction between the firms; strategic delegation plays no role in this model. In the experiment presented by van Witteloostuijn et al. (2007), managerial bargaining power is taken into account if cartel formation and oligopolistic interaction are preceded by Nash bargaining over delegation contracts within the firms. Nakamura (2012) derives generalized theoretical results for the same model approach.

Fanti and Buccella (2017) have derived normative insights for optimal trade policy when taking into account that the non-cooperative interaction between the firms is preceded by intra-firm Nash bargaining over managerial contracts. Finally, Karagözoğlu et al. (2021) have as well discussed a game consisting of Nash bargaining and non-cooperative interaction. In their model, a tournament takes place which delivers the threat points for the following bargaining stage.

## 2 | BARGAINING WITHOUT DELEGATION

### 2.1 | Setup

This section analyzes negotiations between two risk-neutral players, denoted P and T.<sup>14</sup> They may bargain over splitting up a specific

amount of money, denoted  $\Sigma$  (the size of the “bargaining pie,” or the “amount at stake”). If no agreement is closed, then player P receives a disagreement payoff of  $\pi \geq 0$ , whereas T's disagreement payoff is  $\tau \geq 0$ .

For the sake of simplicity, assume P and T to have equal bargaining skills. The pair  $(S, d)$  describes the bargaining problem, where  $S$  is the set of feasible payoff combinations that the players can agree upon, and  $d$  is the vector of disagreement payoffs (or: “threat points”)

$$d = (\pi, \tau). \quad (1)$$

Let  $U_i$  denote player  $i$ 's payoff. The pie size  $\Sigma$  limits the set of feasible  $U_P$ - $U_T$ -combinations the players can achieve jointly by closing an agreement. Hence, the following equation constrains the feasible payoffs:  $U_P = \Sigma - U_T$ . In a diagram with  $U_P$  on the vertical axis and  $U_T$  on the horizontal axis, this equation describes the “Pareto frontier.” The set of feasible payoff combinations  $S$  is limited upwards by the Pareto frontier

$$S = \{(U_P, U_T) | U_P \leq \Sigma - U_T\}. \quad (2)$$

Figure 1 displays the bargaining problem described above. The figure shows the payoff combinations for players P and T. The downwards sloped diagonal line  $U_P = \Sigma - U_T$  is the Pareto frontier. The black dot symbolizes the players' disagreement payoffs.

## 2.2 | Symmetric Nash bargaining solution

Because P and T are assumed to have equal bargaining skills, the symmetric Nash bargaining solution can be applied. According to Nash (1950), this solution concept rests on four axioms.

- **Individual rationality:** The players do not accept a bargaining solution which makes them worse off than their disagreement payoff.

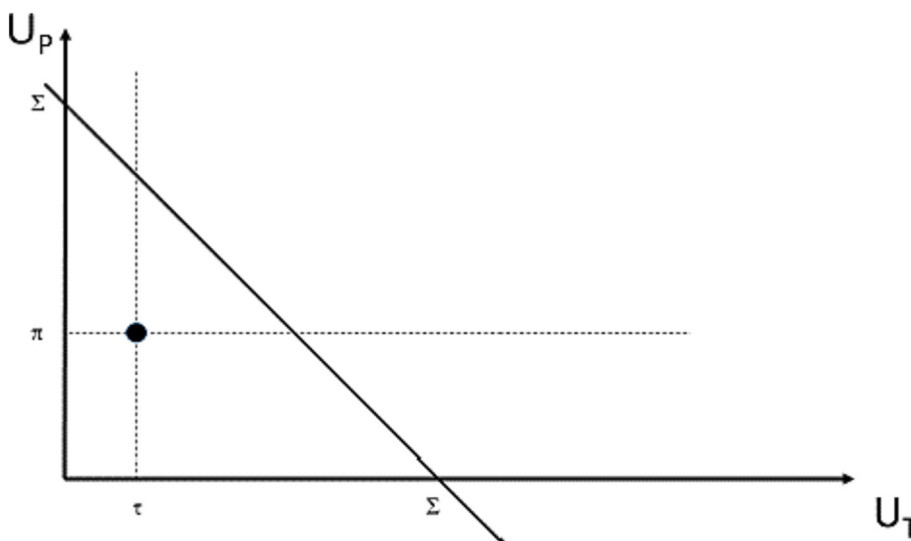


FIGURE 1 The bargaining problem without delegation.

- **Pareto-efficiency:** The parties split up the full bargaining pie among themselves.<sup>15</sup>
- **Invariance of the utility functions:** The solution remains unaffected if the individual utility functions of the players are made subject to a positive affine transformation.<sup>16</sup>
- **Irrelevance:** The solution is unaffected if options that are not part of the solution (i.e., which are “irrelevant”) are erased from the feasible set.

Nash (1950) has proven the following: When two parties collectively choose a solution for their bargaining problem and obey these four axioms, then the solution will maximize the “Nash product.” The Nash product is obtained by multiplying the players' respective net gains from closing an agreement. An agreement splits up the bargaining pie  $\Sigma$  between P and T. Any possible agreement is fully characterized by the share P receives. Let  $\varphi$  denote P's share. Player T, thus, receives the remainder of the bargaining pie, that is,  $\Sigma - \varphi$ . Should the joint disagreement payoffs exceed the bargaining pie ( $\pi + \tau > \Sigma$ ), then there would be no scope for an agreement between the parties. Hence, a necessary condition for an agreement is

$$\pi + \tau \leq \Sigma, \quad (3)$$

which will be assumed throughout the subsequent analysis. As player P is assumed to receive  $\pi$  in case of non-agreement, whereas T would get  $\tau$ , P's net gain from an agreement is  $(\varphi - \pi)$  whereas T's net gain from an agreement amounts to  $(\Sigma - \varphi - \tau)$ . Hence, the Nash product for this bargaining problem is

$$(\varphi - \pi)(\Sigma - \varphi - \tau). \quad (4)$$

The predicted solution is the value of  $\varphi$  that maximizes this Nash product. Let  $\varphi^*$  denote this solution.

**Lemma 1.** i) If P and T negotiate directly, then the symmetric Nash bargaining solution for their bargaining

problem  $(S, d)$  with  $S = \{(U_P, U_T) | U_P \leq \Sigma - U_T\}$  and  $d = (\pi, \tau)$ , assuming that  $\Sigma \geq \pi + \tau$  holds, is given by

$$\varphi^* = 0.5(\Sigma + \pi - \tau). \quad (5)$$

ii) With this agreement, player P's payoff amounts to  $U_P(\varphi^*) = 0.5(\Sigma + \pi - \tau)$ , whereas T gets  $U_T(\varphi^*) = 0.5(\Sigma - \pi + \tau)$ .

**Proof:** i) The first-order condition for an optimum of (4) is  $-(\varphi - \pi) + (\Sigma - \varphi - \tau) = 0$ , which is equivalent to  $2\varphi = \pi + \Sigma - \tau$ . The second derivative of (4) with respect to  $\varphi$  is  $-2 < 0$ , implying that the second-order condition for a maximum is satisfied. ii) In case of an agreement, P receives her share  $\varphi^*$ , whereas T obtains the remainder  $\pi - \varphi^*$ , which equals  $0.5(\Sigma - \pi + \tau)$ .

It is obvious that, as long as the condition for an agreement  $\Sigma \geq \pi + \tau$  holds, the outcome for P is increasing in her disagreement payoff  $\pi$  (and decreasing in T's disagreement payoff  $\tau$ ). Consequently, T's agreement payoff is decreasing in  $\pi$  and increasing in  $\tau$ . Nash (1950) has already pointed out this effect of the disagreement payoffs on the Nash bargaining solution.

This effect gives room for strategic manipulation. If, for instance, P could make an investment that increases her disagreement payoff (or "threat point")  $\pi$  by one unit, this would increase her bargaining result by half a unit and, therefore, decrease T's outcome, as long as this strategic move does not lead to a violation of the condition  $\Sigma \geq \pi + \tau$ . Such a strategic move, however, is likely to be costly, and perhaps these costs are higher than the additional bargaining result for P.

The analysis in the next section makes use of the threat point effect: P could appoint a delegate, A, who bargains on her behalf. P could promise this delegate a payment that is due if A fails to conclude an agreement with T. If A accepts P's contract offer, then this promised payment is the threat point, instead of P's original threat point, in the Nash product. If the promised payment exceeds P's original threat point without violating the condition for an agreement, this would increase the bargaining result. Other than an investment into increasing the own threat point, however, this promised payment does not actually have to be paid if the delegate closes an agreement with T.

Beyond trying to exploit the threat point effect by offering a delegation contract, P could use the delegation contract to invoke another effect. The next section introduces a second instrument with which P can also strategically manipulate the bargaining problem between A and T: the percentage of the bargaining result that A receives in case of success.

### 3 | BARGAINING WITH DELEGATION

#### 3.1 | Setup

This section analyzes a game among three risk-neutral players, denoted P (the "principal"), A (the "agent"), and T (the "third party").<sup>17</sup>

Players P and T may bargain over splitting up a specific amount of money, denoted  $\Sigma$  (the size of the bargaining pie or the amount at stake). If no agreement is closed, then player P receives a disagreement payoff of  $\pi \geq 0$ , whereas T's disagreement payoff is  $\tau \geq 0$ , just as in the previous section.

Initially, P has to decide whether to carry out the negotiations with T by herself. Alternatively, P could try to employ player A as her delegate by offering a contract to him. The contract  $(\alpha, \beta)$  considered here consists of two components. The first component,  $\alpha$ , is taken from the interval between 0 and 1 and denotes A's percentage of the bargaining result if he negotiates with T on P's behalf and closes an agreement. The second component,  $\beta \in \mathbb{R}$ , represents a lump-sum payment that is due if A fails to close an agreement with T. If  $\beta < 0$  then the contract would stipulate that A had to pay a fine to P in the absence of an agreement; with  $\beta > 0$ , A would receive a bonus.

If A rejects P's contract offer, or if P does not make an offer to A in the first place, then P has to carry out the negotiations with T by herself. In this case, A would receive an alternative income, denoted  $u \geq 0$ , which he could earn elsewhere if not employed by P. If, on the other hand, A accepts P's contract offer, then he negotiates with T on behalf of P and forgoes the alternative income  $u$ . For the sake of simplicity, I assume P and T to have equal bargaining skills, but the subsequent model analysis takes into account the possibility that A has better bargaining skills than P and T.

Figure 2 displays the sequence of events as described above and the resulting payoffs that the three parties obtain. In the following Section 3.2, I will discuss the bargaining stage with delegation, that is, the negotiations between A and T if P has initially offered and A then has accepted a delegation contract, using the asymmetric Nash bargaining solution, denoted  $\psi$ . In the next step (Section 3.3), I will derive the condition under which A would accept a contract offer made by P. The third step of the analysis (Section 3.4) is the derivation of the unique delegation contract  $(\alpha^*, \beta^*)$  that is optimal for P.

In Section 3.5, I will use the bargaining result derived in Section 2.2 for the direct negotiations between P and T, to evaluate the condition under which it is beneficial for P to offer the optimal delegation contract to A.

#### 3.2 | Asymmetric Nash bargaining solution under a delegation contract

In this section, I assume that P has made a contract offer  $(\alpha, \beta)$  to A, and A has accepted this offer. In this case, A acts as P's delegate to carry out the negotiations with T. The contract stipulates for A to receive a percentage, denoted  $\alpha$ , of the bargaining result. Moreover, the delegation contract stipulates a lump-sum payment  $\beta$  that has to be paid if, and only if, A and T do not close an agreement.

The bargaining problem between A and T is denoted  $(S', d')$ , where  $S'$  is the set of feasible payoffs the two bargainers may obtain, and  $d'$  is the vector of disagreement payoffs. The subsequent analysis demonstrates how the contract components  $(\alpha, \beta)$  systematically influence the bargaining problem  $(S', d')$ .

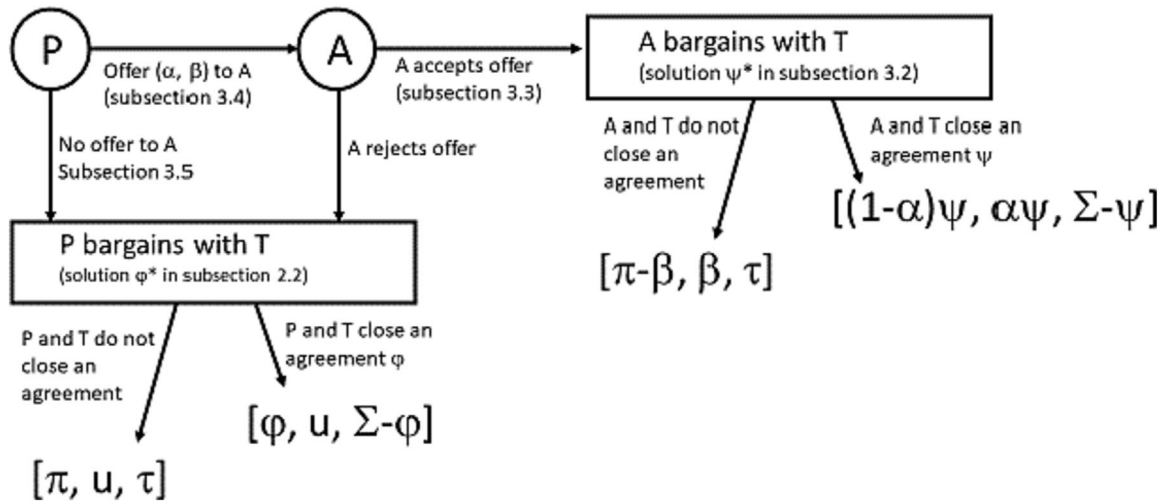


FIGURE 2 Sequence of events.

In case of a disagreement, T receives  $\tau$  (just as in the case of direct negotiations with P), whereas A's disagreement payoff amounts to  $\beta$ . The contract between P and A may stipulate that  $\beta$  is positive, equal to zero, or negative. Hence, the vector of disagreement payoffs of A and T is  $d' = (\beta, \tau)$ .

Now I will derive  $S'$ , the set of feasible payoffs  $(U_A, U_T)$  under the delegation contract.  $S'$  is limited by the "Pareto-frontier," that is, the payoff combinations that are Pareto-efficient. Let  $\psi$  denote the part of the bargaining pie  $\Sigma$  that A brings home. A's individual payoff is only a share  $\alpha$  of  $\psi$ , whereas P receives  $(1-\alpha)\psi$ . T is left with the remainder  $\Sigma-\psi$ . A payoff combination is Pareto-efficient if it is not possible to make one party better off without damaging the other party. If both bargaining parties are risk-neutral, then the Pareto-frontier is linear. Identifying two points is, thus, sufficient to characterize the Pareto-frontier.

Among the feasible and Pareto-efficient payoff combinations that can easily be identified are those that give one side the whole bargaining pie and zero to the other side. Hence, it would be Pareto-efficient for the parties to agree upon a bargaining result  $\psi = 0$ , which would give A zero, whereas T gets  $\Sigma$ . Hence, the payoff combination  $U_A = 0$  for A and  $U_T = \Sigma$  for T is an element of the Pareto-frontier.

It is also Pareto-efficient if A brings home the full bargaining pie, that is, if  $\psi = \Sigma$ . A's own payoff then amounts to  $U_A = \alpha\Sigma$ , whereas  $U_T = 0$ . This payoff combination is also on the Pareto-frontier. In Figure 3, which displays  $U_A$  on the vertical and  $U_T$  on the horizontal axis, the diagonal that connects these two payoff combinations, namely  $(U_A = 0, U_T = \Sigma)$  and  $(U_A = \alpha\Sigma, U_T = 0)$ , is the Pareto-frontier. Therefore, the equation of the Pareto-frontier in the  $U_A-U_T$  diagram is given by  $U_A = \alpha(\Sigma-U_T)$ , and the set of feasible payoffs can be written as

$$S' = \{(U_A, U_T) | U_A \leq \alpha(\Sigma - U_T)\}. \tag{6}$$

Scope for an agreement exists in a bargaining problem if, and only if, the disagreement payoff vector is located on or below the Pareto

frontier. Otherwise, there is no scope for an agreement between A and T. Thus, one necessary condition for the existence of a bargaining solution is  $\beta \leq \alpha\Sigma$ . Otherwise, A's disagreement payoff would be above the Pareto frontier, and any feasible agreement makes at least one party worse off, compared to that party's threat point. Such an agreement would violate, therefore, the axiom of individual rationality.

As it is shown in Figure 3, the horizontal line  $U_A = \beta$  intersects with the Pareto frontier at  $U_T = \Sigma-\beta/\alpha$ . Hence, if  $\tau > \Sigma-\beta/\alpha$ , then the vector of disagreement payoffs would be above the Pareto frontier. Therefore,  $\tau \leq \Sigma-\beta/\alpha$ , which can equivalently written as

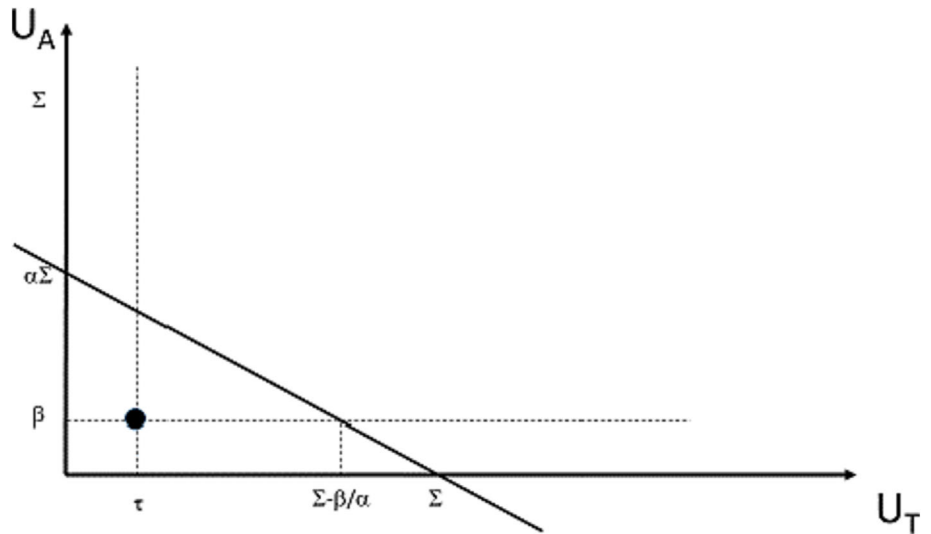
$$\beta \leq \alpha(\Sigma - \tau) \tag{7}$$

is another condition for the existence of scope for an agreement. The condition  $\beta \leq \alpha\Sigma$  implies that the right hand side of  $\tau \leq \Sigma-\beta/\alpha$  is positive, as it is displayed in Figure 3. Moreover, condition (7) is stricter than  $\beta \leq \alpha\Sigma$ . Thus, condition (7) is necessary and sufficient for the existence of scope for an agreement. In Figure 3, arbitrary values of  $\alpha\Sigma$ ,  $\beta$ , and  $\tau$  are displayed which satisfy condition (7).

The delegate A may be a more skillful bargainer than both T and P. The model considers this by exponents  $\delta$  and  $(1-\delta)$  in the Nash product. The parameter  $\delta$  may assume values between 0.5 and 1:  $1/2 \leq \delta < 1$ . With  $\delta = 1/2$ , the two parties are assumed to have equal bargaining skills. If  $\delta$  is greater than 1/2, this models the case that A is more skilled than his opponent T. The case  $\delta = 1$  is trivial because A would always capture the whole bargaining pie. Because A and T may have unequal bargaining skills, the asymmetric Nash bargaining solution has to be applied. The solution of this maximization problem is not fully determined but is a function of the bargaining power parameter  $\delta$ . Recall that  $\psi$  denotes the bargaining result (to be shared among P and A). The following Lemma 2 derives the asymmetric Nash bargaining solution, denoted  $\psi^*(\delta)$ , for the relevant cases of this bargaining problem.

**Lemma 2.** i) Assume that A has accepted a contract offer  $(\alpha, \beta)$  made by P which has obeyed the condition

**FIGURE 3** Bargaining problem between A and T (with delegation contract).



$\beta \leq \alpha(\Sigma - \tau)$  and faces the bargaining problem ( $S'$ ,  $d'$ ), in which he may have better bargaining skills (denoted  $\delta$ ) than T, hence  $1/2 \leq \delta < 1$ . For  $\alpha > 0$ , the asymmetric Nash bargaining solution between T and A is

$$\psi^*(\delta) = \delta(\Sigma - \tau) + (1 - \delta)\beta/\alpha. \quad (8)$$

ii) As long as  $\beta \leq \alpha(\Sigma - \tau)$ , if  $\alpha > 0$ ,  $\beta > 0$ , and  $\delta < 1$ , then  $\psi^*(\delta)$  is increasing in  $\beta$  and  $\delta$ , and it is decreasing in  $\alpha$ .

iii) If A and T agree upon  $\psi^*$ , then P receives  $(1 - \alpha)\psi^*(\delta)$  as her payoff, whereas A gets  $\alpha\psi^*(\delta) = \alpha\delta(\Sigma - \tau) + (1 - \delta)\beta$ , and T ends up with  $\Sigma - \psi^*(\delta)$ .

**Proof:** i) The solution  $\psi^*(\delta)$  is supposed to maximize the Nash product  $(\alpha\psi - \beta)^\delta (\Sigma - \psi - \tau)^{1-\delta}$ . The first derivative of the Nash product with respect to  $\psi$  is

$$\delta\alpha(\alpha\psi - \beta)^{\delta-1}(\Sigma - \psi - \tau)^{1-\delta} - (1 - \delta)(\alpha\psi - \beta)^\delta(\Sigma - \psi - \tau)^{-\delta}. \quad (9)$$

Setting (9) equal to zero gives the first-order condition for an internal optimum. Multiplication with  $(\alpha\psi - \beta)^{1-\delta}(\Sigma - \psi - \tau)^\delta$  leads to  $\delta\alpha(\Sigma - \psi - \tau) - (1 - \delta)(\alpha\psi - \beta) = 0$ , which is equivalent to  $\delta\alpha(\Sigma - \psi - \tau) = (1 - \delta)(\alpha\psi - \beta)$ . Adding  $\delta\alpha\psi$  to both sides of this equation gives  $\delta\alpha(\Sigma - \tau) = \alpha\psi - (1 - \delta)\beta$ , which is equivalent to (8). The second derivative of the Nash product with respect to  $\psi$  is

$$\begin{aligned} & \delta\alpha^2(\delta - 1)(\alpha\psi - \beta)^{\delta-2}(\Sigma - \psi - \tau)^{1-\delta} \\ & - \delta\alpha(1 - \delta)(\alpha\psi - \beta)^{\delta-1}(\Sigma - \psi - \tau)^{-\delta} \\ & - \delta\alpha(1 - \delta)(\alpha\psi - \beta)^{\delta-1}(\Sigma - \psi - \tau)^{-\delta} \\ & - \delta(1 - \delta)(\alpha\psi - \beta)^\delta(\Sigma - \psi - \tau)^{-\delta-1}. \end{aligned} \quad (10)$$

According to the axiom of individual rationality, both parties' net gains from an agreement are non-negative. The axiom of Pareto-optimality implies that at least one party earns a positive net gain from closing an agreement. With  $1/2 \leq \delta < 1$  and  $\alpha > 0$ , expression (10) is strictly negative, which implies that the Nash product is concave in  $\psi$ .

Thus,  $\psi^*(\delta)$  satisfies the second order condition for an internal maximum and, indeed, maximizes the Nash product. ii)  $\partial\psi^*/\partial\beta = (1 - \delta)/\alpha > 0$ .  $\partial\psi^*/\partial\alpha = -(1 - \delta)\beta/\alpha^2 < 0$ . Finally,  $\partial\psi^*/\partial\delta = \Sigma - \tau - \beta/\alpha$ , which is positive if, and only if,  $\beta \leq \alpha(\Sigma - \tau)$ . Finally, the proof of iii) is trivial.  $\square$

As long as  $\beta \leq \alpha(\Sigma - \tau)$ ,  $\alpha > 0$ ,  $\beta > 0$ , and  $1/2 \leq \delta < 1$ , the asymmetric Nash bargaining result  $\psi^*(\delta)$  increases if P

- employs a delegate with better bargaining skills  $\delta$ ,
- closes a delegation contract with a higher payment  $\beta$  for failure,
- closes a delegation contract promising a lower share  $\alpha$  of  $\psi^*(\delta)$  for A.

The first two of these claims are quite obvious: *Ceteris paribus*, it pays to appoint a delegate with better bargaining skills. Sending a delegate whose threat point is higher would also increase the bargaining result, as long as a scope for an agreement exists. The third result is less obvious. The intuition behind the third result is that a negotiator bargains tougher if he obtains only a small percentage of the bargaining result. In other words: If the percentage is higher, the delegate becomes more eager to close the deal, which turns him into a softer negotiator.

### 3.3 | Condition for accepting P's contract offer

This section demonstrates the condition under which A will accept a contract offer made by P. If her contract offer violates condition (7), that is, if  $\beta > \alpha(\Sigma - \tau)$ , then A and T would not close an agreement, and A would receive his disagreement payoff  $\beta$ . P has to obey condition (7) in order to induce A to close an agreement with T. But there is an additional condition that has to be obeyed: Negotiations between A and T will only take place if A accepts the contract offer initially submitted by P. Lemma 3 derives the condition under which A accepts P's offer.

**Lemma 3.** If P makes a contract offer to A that obeys the conditions  $\beta \leq \alpha(\Sigma - \tau)$  and  $\alpha > 0$ , then A will accept this offer if

$$\beta \geq [u - \alpha\delta(\Sigma - \tau)] / (1 - \delta). \tag{11}$$

**Proof:** If the contract offer obeys  $\beta \leq \alpha(\Sigma - \tau)$  with  $\alpha > 0$ , then A, after having accepted the contract, will expect to bring home a bargaining result  $\psi^*(\delta)$ , see Lemma 2. This is attractive for A if his absolute share of this result  $\alpha\psi^* = \alpha\delta(\Sigma - \tau) + (1 - \delta)\beta$  is at least as high as his outside option  $u$ . The condition  $u \leq \alpha\delta(\Sigma - \tau) + (1 - \delta)\beta$  is equivalent to inequality (6).

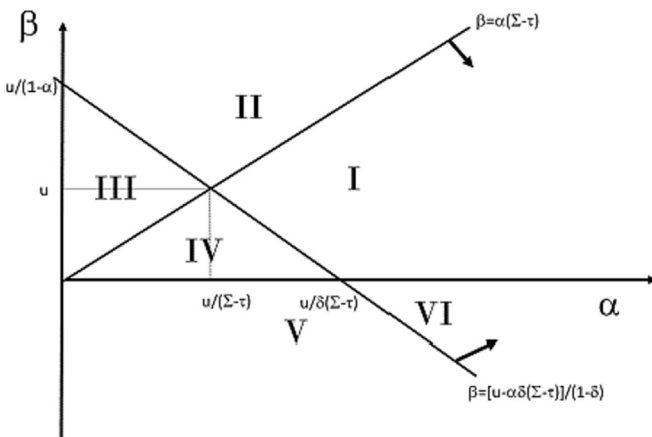
Figure 4 displays the set of contract components  $(\alpha, \beta)$  from which P can choose her offer to A. Contract combinations that obey condition (7) would lead to an agreement between A and T should A accept the contract. These combinations are located on and below the upwards sloped diagonal line in Figure 4, the equation of which is  $\beta = \alpha(\Sigma - \tau)$ . The downwards sloped diagonal is characterized by the equation  $\beta = [u - \alpha\delta(\Sigma - \tau)] / (1 - \delta)$ . On and above this line, there are contract combinations that obey condition (11) and, thereby, induce A to accept a contract offer, expecting to conclude an agreement with T later.

The contract components in areas I and VI satisfy both conditions (7) and (11). These  $(\alpha, \beta)$  combinations induce A to accept the contract and then to close an agreement with T. If P offers a combination from this area, she obtains  $(1 - \alpha)\psi^*(\delta)$  as her payoff, whereas A gets  $\alpha\psi^*(\delta)$ , and T is left with  $\Sigma - \psi^*(\delta)$ , where  $\psi^*(\delta) = \delta(\Sigma - \tau) + (1 - \delta)\beta/\alpha$ , according to Lemma 2.

Should P offer a contract taken from area II, and A accepts it, he would later fail to close an agreement. In that case, P would receive her non-agreement payoff  $\pi$  and had to pay  $\beta$  to A. A would receive  $\beta$ , whereas T would end up with  $\tau$ . Obviously, A would accept such an offer only if  $\beta \geq u$  and reject it otherwise. A will also reject contract offers taken from the areas III, IV, and V, so P would have to carry out the negotiations with T by herself after having picked an offer from one of these areas.

The following Lemma 4 identifies some useful properties of the two diagonals in Figure 4.

**Lemma 4.** i) The intersection of the two diagonals  $\beta = \alpha(\Sigma - \tau)$  and  $\beta = [u - \alpha\delta(\Sigma - \tau)] / (1 - \delta)$  in Figure 4 is located at  $\alpha = u / (\Sigma - \tau)$  and  $\beta = u$ .



**FIGURE 4** Possible delegation contracts and related outcomes.

ii) The intercept of the diagonal  $\beta = [u - \alpha\delta(\Sigma - \tau)] / (1 - \delta)$  with the horizontal axis is located at  $\alpha = u / \delta(\Sigma - \tau)$ .

**Proof:** i)  $\alpha(\Sigma - \tau)(1 - \delta) = u - \alpha\delta(\Sigma - \tau) < = > \alpha(\Sigma - \tau)$   
 $= u < = > \alpha = u / (\Sigma - \tau)$ ; use this in  $\beta = \alpha(\Sigma - \tau)$  to derive  $\beta = u$ . ii) Set  $\beta(1 - \delta) = 0$  and solve  $u = \alpha\delta(\Sigma - \tau)$  for  $\alpha$ .

### 3.4 | The optimal contract offer (if P wants to make an offer)

This section analyzes which contract offer is optimal if P wishes to make A an offer. In the next section, I will derive the condition under which P actually wants to make the optimal offer.

If P chooses her contract offer from the areas III, IV, or V, then A would reject the offer and earn his alternative wage  $u$ . Then, P must carry out the negotiations with T on her own, and would earn  $\varphi^* = 0.5(\Sigma - \tau + \pi)$ , as derived by Lemma 1. Obviously, this would not improve P's outcome compared to the situation in which she does not offer a contract to a potential delegate.

If P offers a contract combination from area II, this would fail to induce A to close an agreement with T, if A accepts the contract. Area II is characterized by  $\beta \geq u$ , see Lemma 4; moreover, I have made the assumption  $u > 0$ . Hence, A would receive at least  $u$ , which indeed suffices to make him accept the contract. The resulting payoff of P's amounts to  $\pi - \beta$ . With  $\beta \geq u > 0$ , this payoff will never exceed  $\varphi^*$ . Hence, making a contract offer from area II is never an improvement for P, compared to the situation without delegation contract.

In area VI,  $\beta$  is negative, and  $\alpha > u / \delta(\Sigma - \tau) > 0$  (see Lemma 4). Hence,  $\beta$  is now a sanction the delegate had to pay in case he fails to close an agreement with T. In area VI, A would nevertheless accept the contract offer and close the agreement with T, thereby avoiding the sanction. The bargaining result, according to the asymmetric Nash bargaining solution, would then amount to  $\psi^*(\delta) = \delta(\Sigma - \tau) + (1 - \delta)\beta/\alpha$ .

For any level of  $\alpha > 0$ , the bargaining result as well as P's share of it,  $(1 - \alpha)\psi^*(\delta)$  could be increased by proposing a contract with a higher  $\beta$ . For each contract offer taken from area VI, contract combinations in area I exist that make P better off and keep A on the same payoff level. Hence, P never has an incentive to offer a contract from area VI.

Moreover, a negative value of  $\beta$  would forgo the strategic effect of the bargainer's threat point on the bargaining result. As long as P plans to bargain with T on her own behalf, her own threat point  $\pi \geq 0$  is effective for the Nash bargaining result. However, if she appoints a delegate A, then the contractually imposed threat point  $\beta$  becomes effective in the negotiations with T:  $\beta$  replaces  $\pi$  in the Nash product and, thereby, influences the bargaining solution. For this to create a strategic advantage,  $\beta$  has to be greater than  $\pi$  (moreover,  $\beta$  must not violate condition (7), the condition for an agreement between A and T). Contract offers taken from area VI will, thus, fail to create a strategic advantage for P, as they would stipulate a negative  $\beta$ .

Therefore, only area I must be examined further. If P chooses her contract offer from this area, A would accept the offer and close an agreement  $\psi^*(\delta)$  with T. Then, P receives  $(1 - \alpha)\psi^*(\delta)$ . The next result demonstrates which contract combination in area I maximizes the



outcome for P; in particular, the proposition claims that a unique optimal contract exists. The following section derives the condition under which this unique optimal contract provides a payoff for P that exceeds the one she receives when bargaining directly with T.

**Proposition 1.** The unique optimal contract offer of P is  $\alpha^* = u/(\Sigma - \tau)$  and  $\beta^* = u$ .

**Proof:** If P wants to make a contract offer that is accepted by A and induces A to close an agreement  $\psi^*$  with T, she has to obey conditions (7) and (11). The bargaining outcome then is  $\psi^*(\delta) = \delta(\Sigma - \tau) + (1 - \delta)\beta/\alpha$ . The maximum bargaining outcome (which leaves nothing but his outside option  $\tau$  for T) would be  $\Sigma - \tau$ . The bargaining result  $\psi^*(\delta)$  equals  $(\Sigma - \tau)$  if, and only if  $\alpha$  and  $\beta$  are set such that  $(\Sigma - \tau) = \beta/\alpha$ , with  $\alpha > 0$ . Hence, if  $(\Sigma - \tau) = \beta/\alpha$ , then this contract offer does not only obey condition (7), but also maximizes the bargaining outcome to be shared among A and P, if A accepts. If the contract offer also satisfies condition (11), it will be accepted by A, and then P's payoff would amount to  $(1 - \alpha)\psi^*$  with  $\psi^* = \delta(\Sigma - \tau) + (1 - \delta)(\Sigma - \tau) = (\Sigma - \tau)$ . The first derivative of P's payoff  $(1 - \alpha)(\Sigma - \tau)$  with respect to  $\alpha$  is  $-\alpha(\Sigma - \tau)$ , which is negative for  $\alpha > 0$  and  $\Sigma > \tau$ . Hence, when offering a contract combination on the upwards sloped diagonal in Figure 4 that obeys condition (11), P aims at setting  $\alpha$  as small as possible. Therefore, the unique optimal contract is the intersection of the diagonal lines in Figure 4,  $\alpha = u/(\Sigma - \tau)$  and  $\beta = u$ , as derived in Lemma 4.

If P offers the unique optimal contract  $\alpha^* = u/(\Sigma - \tau)$  and  $\beta^* = u$  to A, this induces the delegate to accept the contract offer, negotiate with T, and close the agreement  $\psi^* = \Sigma - \tau$ . After A and T have agreed upon  $\psi^* = \Sigma - \tau$ , P will receive an individual payoff of  $U_P(\psi^*) = \Sigma - \tau - u$ , A will get  $U_A(\psi^*) = u$ , and T is left with  $U_T(\psi^*) = \tau$ . As the delegation enables A and P to capture the whole bargaining rent (net of T's threat point  $\tau$ ), this contract is optimal, regardless of whether other contractual forms exist that lead to the optimal outcome as well.

### 3.5 | The condition under which P wants to make the optimal contract offer

As the last step of the analysis, I derive the condition under which P prefers to make the optimal contract offer derived above, instead of bargaining on her own behalf. Initially, P has to decide whether to carry out the negotiations with T by herself, or to try to employ player A as her delegate by making a contract offer to him.

A delegation contract  $(\alpha, \beta)$  consists of two components. The first component,  $\alpha$ , is taken from the interval between 0 and 1 and denotes the relative share of the bargaining result that player A brings home for P if he negotiates on her behalf with T and closes an agreement. The second component,  $\beta \in \mathbb{R}$ , represents a lump-sum payment that is due if A fails to close an agreement with T. If  $\beta < 0$  then the contract would stipulate that A had to pay a fine to P in the absence of an agreement. With  $\beta > 0$ , A would receive a bonus. If A rejects P's contract offer, or if P does not make an offer to A in the first place, then P will have to carry out the negotiations with T by herself. In this case,

A would receive an alternative income, denoted  $u \geq 0$ , which he could earn elsewhere if not employed by P. If, on the other hand, A accepts P's contract offer, then he negotiates with T on behalf of P and forgoes the alternative income  $u$ . In section 2, it has been shown that P receives a payoff of  $0.5(\Sigma + \pi - \tau)$  if she negotiates directly with T (see Lemma 1).

**Proposition 2.** P strictly prefers to offer A the optimal contract combination  $(\alpha^*, \beta^*)$  with  $\alpha^* = u/(\Sigma - \tau)$  and  $\beta^* = u$  if, and only if

$$u < (\Sigma - \tau - \pi)/2. \quad (12)$$

**Proof:** If P makes the optimal contract offer, for which  $\alpha > 0$  holds, then her payoff will amount to  $\Sigma - \tau - u$ , according to Proposition 1. If, on the other hand, she abstains from making a contract offer, she will earn  $0.5(\Sigma - \tau + \pi)$ , see Lemma 1. The former payoff exceeds the latter if, and only if,  $2(\Sigma - \tau - u) > (\Sigma - \tau + \pi) < = > \Sigma - \tau - \pi > 2u$ .  $\square$

Note that the right-hand side of inequality (12) is identical to T's payoff in case P and T bargain directly. T's absolute share of the bargaining pie in the direct negotiations with P is the maximum that P can capture (beyond  $\pi^*$ ) by a strategic move. Hence, Proposition 2 allows for the following interpretation: It makes sense for P to use A as a delegate to bargain on her behalf if the opportunity cost of her employment falls short of the maximum additional gain that can be captured by employing him.

The following corollary, the proof of which is trivial, summarizes the insight that the bargaining power of A, expressed by the parameter  $\delta$ , plays no role for the main results presented in Propositions 1 and 2.

**Corollary.** The unique optimal delegation contract  $(\alpha^*, \beta^*)$  as well as the condition (12) under which P prefers to make the optimal contract offer to A are independent of A's bargaining power  $\delta$ , if  $1/2 \leq \delta < 1$ .

The corollary indicates that P does not consider employing A because of A's superior bargaining skills, but only because of the strategic opportunity that the delegation contract offers. If A has better bargaining skills than P or T, this is irrelevant for P's decision whether to offer a delegation contract at all, which contract combination to offer, and for the bargaining result.

## 4 | CONCLUSIONS AND DISCUSSION

This paper has analyzed a contract consisting of a percentage for the delegate and a fixed payment if he fails to conclude an agreement. Under the assumption that the delegate could earn a positive wage elsewhere, I have shown that a combination of a small percentage and

a high payment for non-success may improve the principal's outcome in Nash bargaining.

The delegation contract analyzed here gives a bargaining party the chance to take part in the negotiations with a third party while concealing her own marginal valuation of the agreement outcome and the own disagreement payoff. Instead, the delegate negotiates with a contractually induced marginal valuation and disagreement payoff. Hence, employing a delegate offers the opportunity to strategically manipulate the Nash product and, thereby, the Nash bargaining solution.

Carefully selected contract components can increase the negotiator's threat point, and decrease her marginal valuation of the bargaining result. Both may have an increasing effect on the bargaining solution. However, even under the contract there still must exist scope for an agreement. Hence, the delegate's threat point must not be too tempting. If the principal takes into account these two constraints, a unique optimal contract offer exists. If the opportunity cost of employing the delegate fall short of the additional bargaining rent  $P$  can capture (i.e.,  $T$ 's payoff if  $P$  and  $T$  negotiate directly), then it makes sense for  $P$  to make this offer.

The model shows that the optimal contract is independent of whether  $A$ 's bargaining skills are better than those of  $P$  or  $T$ . Moreover, the model results demonstrate that  $A$ 's share of the bargaining result should be as low as possible (as long as  $A$  is still inclined to close an agreement).

The derived results may shed some light on a puzzle discussed in Bazerman and Neale (1993) as well as in Levitt and Dubner (2005, p. 73).<sup>18</sup> Real-estate agents usually receive a commission of just 6%. According to the authors, it would not really pay off for the agent to engage in tough negotiations with a potential buyer. If the real-estate agent (REA) bargains tough and drives up the price of a house from, say, \$420,000 to \$430,000, this would only benefit his client, as the REA would receive only \$600 of the additional \$10,000. It makes little sense for the REA to risk the whole deal for such a small additional profit. This is even more true if the REA's opportunity cost of carrying out the extra round of bargaining exceed the \$600, It would be better for the real-estate agent to save such cost and avoid pushing for a better outcome, even though this would certainly be in the client's interest. Hence, the REA has an incentive to agree upon a lower price (or to convince his client to agree to this lower price, should the client have reserved a veto right), in order to close the deal and secure at least the lower commission.

It is certainly an economic puzzle that sellers agree to contracts that disincentivize their REA. It would be incentive compatible to apply a "sell-the-shop" contract, under which a (risk-neutral) REA became residual claimant against having to pay a fixed fee to the client. Under such a contract, the REA would be motivated to push for the extra \$10,000 if the additional expected revenues exceed the necessary cost. A similar puzzle arises in the case of sales representatives who also charge only a low percentage of their sales. Just as well, it is surprising that lawyers' contingent fees are usually in the area of 30%, a contract structure that fails to make the lawyer the residual claimant.

However, according to the result derived in this paper, it would be a strategic mistake for a residual claimant (be it the principal or the delegate) to take part in negotiations, be it the principal or be it a delegate under a "sell-the-shop" contract. If the negotiations are adequately modeled by the Nash bargaining solution, then it creates a strategic advantage to send a delegate whose valuation of a bargaining outcome consists of only a small share. Moreover, it would be beneficial to close a contract with the delegate that stipulates a reward for failure, in order to increase the own side's threat point in Nash bargaining.

As derived in this paper, however, the delegate's share must not be too low and the reward must not be too high. Both is required to incentivize the delegate to close an agreement with the third party. In the light of these results, the empirically observed delegation contracts appear less puzzling. Then, only one economic puzzle remains: Usually, such delegation contracts do not prescribe a reward for the failure to close an agreement, by which they forgo an opportunity for a strategic advantage.

## ACKNOWLEDGEMENTS

Open Access funding enabled and organized by Projekt DEAL.

## DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study. There is no conflict of interest, no funding, no ethics approval, no patient consent, no material reproduced from other sources, not clinical trial whatsoever.

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## ENDNOTES

- Subsequently, and without loss of generality, the principal is assumed to be female, whereas her delegate is male.
- See Burtraw (1992) for an application with regard to uncertain bargaining results.
- In Bazerman et al. (1992), the agent is the third player through which the bargaining parties exclusively communicate. In their model, the agent receives a commission (of 6%) in case of a deal, and zero if bargaining fails.
- See Nash (1950). The application of this simple solution concept requires the delegation contract to be observable for the other party; on unobservable contracts (serving as commitment devices) see Katz (1991).
- Haake and Recker (2018) discuss the application of the Nash bargaining solution under incomplete information and derive a tradeoff between fairness and efficiency. A non-cooperative mechanism to elicit reservation prices, if these are the respective parties' private information, is presented by Brams et al. (2015).
- This effect was discussed (however, in a very specific context) in Kirstein et al. (2010). The present manuscript generalizes this insight and combines it with the strategic manipulation of the threat point in the context of delegation.
- Lammers (2010) analyzes the impact of fairness on the part of the delegate on ultimatum bargaining with a third party.

- <sup>8</sup> See, however, Binmore et al. (1989) who distinguish between “imasse” and “breakdown” payoffs. While the former play no role in an infinite game, the latter may have an impact on the bargaining outcome.
- <sup>9</sup> Vetschera (2019) provides empirical support for the hypothesis according to which the Zeuthen-Hicks bargaining solution (a non-cooperative bargaining protocol) leads to outcomes that are close to the Nash bargaining solution.
- <sup>10</sup> The practical relevance of best alternatives (or: threat points) is discussed in Roth (1985).
- <sup>11</sup> Rausser and Simon (2016) have, however, challenged the traditional view that lower risk-aversion makes a bargainer negotiate tougher for the Nash solution and for the Kalai-Smorodinsky solution.
- <sup>12</sup> Kirstein and Rickman (2004) as well as Kirstein (2000) present settlement models that exploit this effect.
- <sup>13</sup> Dewatripont (1988) has analyzed such a commitment in a more general framework.
- <sup>14</sup> Subsequently, player P is referred to as female (“she”), whereas T is male (“he”).
- <sup>15</sup> Acharya and Ortner (2022) use a search model to demonstrate how bargaining parties approach the Pareto-frontier. Vetschera (2019) presents an empirical analysis of how negotiators in the Zeuthen-Hicks bargaining model approach the Pareto-frontier and the Nash bargaining solution.
- <sup>16</sup> To obey this axiom, it is sufficient (albeit not necessary) to assume risk-neutral players.
- <sup>17</sup> Again, player P is referred to as female (“she”), whereas A and T are male (“he”).
- <sup>18</sup> See also Levitt and Syverson (2008).

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**How to cite this article:** Kirstein, R. (2024). Strategic delegation in Nash bargaining. *Managerial and Decision Economics*, 45(2), 784–794. <https://doi.org/10.1002/mde.4033>