Optimal Opacity in International Negotiations

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Abstract

We study the role of transparency in international negotiations. In a simple ultimatum bargaining framework with incomplete information, the responder might optimally choose to delegate decision making even if the responder cannot make the delegate tougher in expectation. It is sufficient to be able to generate opacity about the delegated valuation of an agreement. The optimal opacity choice implements efficiency and gives both negotiation parties a positive rent.

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1 Introduction

Delegation can yield commitment in negotiations. As Schelling (1960, p.29) pointed out, a "bargaining agent" may allow the delegating principal to commit to a specific position or demand. A generic example is the delegation of decision rights to a delegate who attributes less value to a positive negotiation outcome. Such preferences make the delegate tougher in ultimatum bargaining. This may induce the offer maker to offer a more attractive deal. In their survey, Sengul, Gimeno and Dial (2012) highlight the strategic nature of delegation through delegate selection, choice of the delegate’s decision rights, and choice of induced incentives.

We consider a different dimension of a delegate’s preferences: opacity. The delegate who responds to an ultimatum offer might be less known to the offer maker. Think of a leader of a country or of a firm who will have to respond to an ultimatum offer. If the leader decides, any offer is accepted that is preferable to his/her reservation payoff. If the leader’s type is well-known, then he/she will be offered not much more than this reservation payoff. The bulk of the bargaining surplus goes to the offer maker in this case. What, if the leader can send a delegate to make the acceptance decision? Suppose this delegate cannot be given a higher reservation payoff in expectation – the delegate cannot be made ‘tougher’. However, suppose the leader can send a negotiator whose actual reservation payoff is opaque – randomly distributed around the leader’s reservation payoff. Can the leader benefit from choosing a delegate with opaque preferences? And if the leader can fine-tune the nature of opacity, what would be the “optimal opacity” of the delegate that maximizes the leader’s payoff? We characterize the equilibrium solution of this problem and analyse its efficiency properties.

We find that the equilibrium choice of opacity may preserve efficiency. This might be surprising, as opacity of the delegate’s preferences might create a challenge for efficiency of ultimatum bargaining: It confronts the proposer with a problem of incomplete information about the responder type. As is well known, such incomplete information may lead to inefficient bargaining outcomes (Myerson and Satterthwaite, 1983; Chatterjee and Samuelson 1983).

From an institutional point of view, opacity can have multiple causes. In international negotiations incomplete information emerges from the political
costs, which the representative faces when signing an agreement. The representative’s political costs may depend on factors such as career concerns (Fingleton and Raith 2005) and professional and personal ties to the decision maker’s multiple supporters.\(^1\) These individual political costs of the decision maker can rarely be precisely known by the offer-making country.\(^2\) A country may choose a representative who is well known to the offer maker from previous international negotiations. It may publish position papers and disclose the boundaries for its negotiators, thus creating more transparency for the other side. Alternatively, it may select a largely unknown representative. Following the latter strategy reduces transparency and increases uncertainty from the proposer’s point of view. Another means to choose more or less opacity is institutional choice on group decision making. Think about a large group that has to collectively accept or reject an ultimatum offer. Suppose each member of the group has his or her own reservation utility. Let these be drawn from a symmetric random distribution. If the group accepts or rejects an ultimatum offer by majority voting, then the median voter decides. For a large group, the median voter’s reservation price is in a very narrow range around the average reservation price. If the group randomly appoints one of its members to make the decision, then the decision is based on a reservation price that has the same mean, but a much larger variance. These examples illustrate: by the choice of the decision maker or the choice of decision procedures, a responding country can manipulate the offer-maker’s uncertainty about what is the least attractive acceptable offer.

The analysis is linked to a large literature studying strategic delegation. Jones (1989) and Burtraw (1992), for instance, employ a Nash bargaining approach, where the two parties select tough negotiators in a first stage to represent them in the negotiations in the second stage. Ellingsen and Miettinen (2008) study bilateral bargaining and consider firm commitments on being tough and commitments which can be revoked with some probability.

\(^1\) For instance, top-level bureaucrats from the European Commission represent the EU in the TTIP negotiations and must answer to the Council of Ministers and to the European Parliament (Ripoll Servent 2014).

\(^2\) For an application of this type of information asymmetry to climate negotiations, see Konrad and Thum (2014, 2018). Because we want to abstract from strategic delegation to a specific type of negotiator, we assume that the political cost of the negotiator is also stochastic from the parent party’s perspective. Due to delegation, the agreement concluded by the representative is binding for the parent party.
Ellingen and Miettinen (2014) consider bilateral bargaining if commitments decay stochastically. Segendorff (1998), Buchholz, Haupt and Peters (2005) and Harstad (2010) explore similar principles in the context of international public goods and environmental negotiations. For a survey on strategic delegation in negotiations see also Caparrós (2016). Gaimlard and Hammond (2011) illustrate the principle in the context of bicameral legislation, where a chamber may have the opportunity to delegate negotiations to a committee. They model negotiations as a take-it-or-leave-it offer, where the proposer right is randomized. This randomization creates a trade-off in the strategic delegation to the committee. A tough committee with more extreme preferences than the chamber’s own preferences forces the other chamber to make more favorable offers but is harmful when it gets the proposer right. In other contexts, it might be difficult to instill the delegate with tough preferences, but feasible to cause uncertainty about the delegate’s true preferences. This is the context we study.

A second line of research studies delegation when the delegate is better informed than the delegator, but has different genuine objectives. Optimal delegation then responds to the trade-off between a more informed decision and a systematic distortion from the principal’s interests. The question is when and how a task or decision should be delegated given this trade-off. A seminal paper in this literature is Alonso and Matouschek (2008). The trade-off between the delegate’s superior private information and the delegate’s diverging preferences might also emerge if the task of the agent is to respond as a delegate to an ultimatum offer of a third player. In this case the choice whether to delegate also has an impact for what offer the superior or his delegate will have to decide on. The information asymmetries are typically given in such a set-up and not the object of choice. In contrast, in our framework opacity is the delegator’s main choice variable.

Third, our analysis is linked to the literature on Bayesian persuasion. In the Bayesian persuasion games in Kamienko and Gentzkow (2011) a player can transform a decision-maker’s prior belief about the distribution of the true states of the world by collecting and committing to truthful revelation of informative signals. This sampling procedure has to obey the rules of Bayesian updating. In our analysis the responder can design and choose the probability distribution from which the delegate’s genuine value of accepting the ultimatum offer is drawn. The commonality of our ap-
approach with Bayesian persuasion is belief manipulation, and the property that this manipulation cannot alter certain aspects of the true distribution. In the Bayesian persuasion setup, the manipulation is subject to the rules of Bayesian updating. In our case the distribution from which the true type is drawn is constrained to a set of distribution functions for which the delegate is not tougher in expectation than the principal.

Little attention has been given to the possible option to modify the degree of opacity. Where transparency is discussed, it typically refers to other types of information problems. For instance, the term 'transparency' is occasionally used in connection with the bargaining process itself rather than the preferences of the representative or his/her constituency.\(^3\) Sometimes transparency is considered when it refers to the observability of the offer-making party.\(^4\) In our context, incomplete information is about the delegate’s preferences who receives and decides on the offer. Opacity is chosen, and the purpose of this choice is to generate and protect an information rent.

We find that the optimal choice of opacity induces a bargaining equilibrium that is efficient, despite the incomplete information it might involve. Moreover, it leaves some rent to both the ultimatum-offer maker and to the responder player. The analysis has many prominent applications. One area is international negotiations. These include negotiations on climate agreements, on tax harmonization in the fight against harmful tax competition, negotiations on peace treaties, and negotiations on trade agreements. A country might choose its delegate. This might be someone whose preferences are well-known to the counterparty negotiators. But it can also be someone who does not have a track record and whose intentions are difficult

\(^3\)For instance, Perry and Samuelson (1994) analyze open- versus closed-door negotiations. Under closed-door bargaining, the constituency (principal) can only accept or reject the final agreement that was negotiated by a representative (agent). With open-door bargaining, the constituency can also terminate negotiations at an intermediate stage when the agent makes or receives offers.

\(^4\)In Stasavage (2004) and Fingleton and Raith (2005), with closed-door bargaining, the constituency is informed about the outcome only; under open-door bargaining, the constituency can also observe both the proposal and the identity of the proposer. To distinguish from this literature, we consider "opacity" which refers to uncertainty about the preferences of the responder in an ultimatum bargaining game. We analyze how opacity of the personal benefits or cost of deal-making of the chosen negotiator affects the outcome.
to read. A country might also choose what kind of institutions to endow with decision rights, and what kind of decision procedures to implement. This choice might make the preferences that emerge from this decision institution more opaque or more transparent. Choice of transparency was also discussed more explicitly in the negotiation of the Transatlantic Trade and Investment Partnership (TTIP). Shortly after the first round of negotiations in summer 2013, environmentalists, anti-globalization activists, consumer protection groups and even members of the European Parliament called for more transparency in trade negotiations. They criticized the EU for its secrecy regarding its negotiation strategies, priorities, stop lines and intermediate results of the bargaining process. The European Commission – represented by Trade Commissioner Cecilia Malmström – reacted by increasing transparency (see Conceição-Heldt 2016). This move towards more transparency – aimed at appeasing the opponents of enhanced free trade – also reduced the uncertainty of the US about the likely stop lines of EU negotiators. If the negotiations had not stalled for political reasons, the increased transparency, which was generated by the reduced leeway of the EU representatives at the negotiation table, could have affected the outcome of trade negotiations. In particular, it could shift rents and affect negotiation success. Our analysis potentially applies to many other bargaining

5The Commission made some EU negotiation documents publicly available. In October 2014, the Council of Ministers disclosed the Commission’s negotiating directives. In subsequent months, the Commission even made some of the documents describing the EU’s negotiating positions publicly available. For a more detailed account of this differentiated approach to transparency, see Conceição-Heldt 2016.

6The economics literature covers a broad range of aspects regarding free trade agreements in general and of negotiations over these agreements in particular. However, the literature has been more or less silent on negotiation failures and on the role of transparency in these negotiations. Bagwell, Staiger and Yurukoglu (2015) study the recently declassified negotiation data on the Torquay Round of GATT negotiations in 1950 and 1951. As the Torquay Round mostly addressed continuously adjustable tariff rates rather than discrete matters (such as the bilateral adoption of product standards), the aspect of negotiation failure is absent almost by definition. A recent strand of the literature analyzes the settlement of trade disputes that emerge after a free-trade agreement has been signed (Beshkar 2016, Maggi and Staiger 2018). Due to the complexity of regulatory issues, free-trade agreements are necessarily incomplete. Shocks that occur after a treaty is signed may make it optimal to deviate from the free-trade agreement, and dispute settlement bodies may receive only imperfect signals of the true shocks. This type of incomplete information may lead to trade disputes in equilibrium.
contexts.\footnote{Other examples beyond international negotiations, where some degree of ambiguity with respect to the negotiator’s type or position may be desirable, include hostage crises and ransom negotiations in cases of kidnapping. The total turnover in the criminal market for kidnappings is estimated to be at least £1 billion per annum (Esme McAvoy and David Randall 2010). Professional negotiators try to find the minimum ransom that kidnappers will accept rather than paying whatever the family or the employer can raise. For professional negotiators, it is crucial that bargaining take place under asymmetric information for the kidnappers. In her analysis of the governance in the K&R insurance market, Shortland (2016) stresses that kidnappers must be left in the dark about the entity in charge of paying the ransom (e.g., family, firm, insurer, government) and its financial capabilities. Hence, it is not the tough negotiator whose fallback position differs from the fallback position of the victim’s family but the ambiguity about the type of negotiator that matters here.}

\section{A simple example}

We consider the standard setting in international negotiations where two players (countries, or country groups) potentially enter into a mutually beneficial agreement. We abstract from all within-country or within-group coordination problems, as recently emerged in the EU when finalizing the CETA agreement with Canada. Hence, we view a country group such as the EU as a unitary player.

Consider two players $A$ and $B$ who negotiate about an agreement. Player $A$ benefits by $a = 1$ if the agreement is signed, player $B$’s gross benefit is zero. These values are common knowledge. Player $B$ makes an ultimatum offer to $A$. If $A$ and $B$ negotiate directly with each other, then $B$ demands a payment equal to $y = 1$ for signing the contract. This makes $A$ indifferent about accepting or rejecting. It gives $B$ a payoff of $y = 1$ and $A$ a payoff of $1 - y = 0$. This case of direct negotiations under complete information comprises the benchmark case for our analysis.

We depart from this benchmark and assume that $A$ delegates the acceptance decision to a decision mechanism, which we call ’the delegate’, and which might, for instance, be a politician who represents the country in the negotiations. The delegate has a payoff of zero if no agreement is signed. If an agreement is signed, then the payoff of the delegate is $v - y$. This payoff potentially deviates from the country payoff $1 - y$. As follows from the literature on strategic delegation, if $A$ can choose the delegate type freely
and the type is common knowledge, then $A$ chooses a "tough" delegate: one for whom $v = 0$. In this case the equilibrium ultimatum offer is $y = 0$, and $A$ receives the full rent. "Toughness" is not our concern, however. We consider a constrained delegation problem: player $A$ cannot make the delegated decision one that is "tougher" in expectation. Country $A$ can delegate and induce a delegated decision with a threshold $v$ that is a draw from a random distribution with cumulative distribution function $F(v)$. The set $\mathcal{F}$ of distributions $F$ from which the delegate's type distribution is chosen is constrained to distributions with 

$$E_F(v) \equiv \int_{v=0}^{v=z} vdF(v) \geq 1.$$  

(1)

So the standard benefit of making the delegate a tougher negotiator cannot materialize, at least not in expectation.

Can it still be strictly beneficial for $A$ to choose a non-degenerate $F$ from the set $\mathcal{F}$? We illustrate the potential benefits of opacity for a set of two-point distributions $F$ for which the delegated value can be of only two types, characterized by $(v_L, v_H) \in [0, z]^2$ with the respective probabilities $p_H = 1 - p_L = \frac{1}{2}$. Then (1) requires $E(v) = p_H v_H + (1 - p_H)v_L = 1$. If $v_L < v_H$, then $v_H = 2 - v_L$, in the range of $v_H \in [1, z]$. We find that, for two-point distributions with equal probabilities on the two points, 

$$v_L^* = \max \left\{ \frac{2}{3}, 2 - z \right\}$$

$$v_H^* = 2 - v_L$$

maximizes the payoff of $A$ under these constraints.

To see why, consider the choice of $B$. Only two amounts of $y$ are economically reasonable: $y = v_L$ or $y = v_H$. Any demand higher than $v_H$ is rejected with certainty. Any demand between $v_L$ and $v_H$ is accepted with the same probability as $y = v_H$, so $B$'s payoff from $y = v_H$ dominates any of the demands from the open interval $(v_L, v_H)$. A demand $y = v_L$ is accepted with higher probability than $y = v_H$, so the higher probability might compensate for the lower payment in case of acceptance. And for demands smaller than $v_L$ again the dominance argument applies: $y = v_L$ is accepted with the same probability as any $y < v_L$, but yields a higher payment to $B$. Supposing that $z$ is large enough, such that $\max \left\{ \frac{2}{3}, 2 - z \right\} = \frac{2}{3}$, a delegated value that is drawn from this distribution gives the offer maker a
payoff of \( \frac{1}{2}v_H = \frac{1}{2}(2 - v_L) \) if the offer is \( y = v_H \), and a payoff of \( v_L \) if the offer is \( y = v_L \).

The minimum \( v_L \) for which the offer-maker finds the lower offer \( y = v_L \) still at least as attractive as the high offer is when \( \frac{1}{2}(2 - v_L) = v_L \), or \( v_L = \frac{2}{3} \). This offer gives \( A \) a payoff of \( 1 - y = \frac{1}{3} \) with probability 1. Hence, by choosing a delegate whose willingness to accept is opaque and from a two-point distribution with \( p_H = p_L = \frac{1}{2} \), player \( A \) can push his equilibrium payoff up from zero to \( \frac{1}{3} \).

3 The general problem

Consider the more general ultimatum-bargaining problem in which \( A \) can choose the distribution of possible delegated valuations from a much larger set of distribution functions. Player \( B \) makes an ultimatum offer. This offer is accepted or not. Acceptance is determined by the random decision process (by the 'delegate') that \( A \) implements. More precisely, in stage 1, Player \( A \) chooses what we call a random distribution of delegated values \( v \). This random distribution is characterized by its cumulative distribution function \( F(v) \). The true value of \( v \) for this choice is a random draw from \( F(v) \) and unknown to both \( A \) and \( B \). Player \( A \) can select any \( F(v) \) from a set \( \mathcal{F} \) of feasible distributions. We restrict the set \( \mathcal{F} \): Each element \( F(v) \in \mathcal{F} \) is continuous and differentiable except for possibly a finite number of mass points, which we denote by \( \rho(v) \). The support of \( F \) is an interval which is a subset of the interval \([0, z]\), where \( z \) is a positive number larger than 1 and exogenously given. Further we impose the restriction that

\[
E_F(v) \equiv \int_{v=0}^{v=z} vdF(v) \geq 1. \tag{2}
\]

Recall that \( a = 1 \) is \( A \)’s valuation and is common knowledge. (2) requires that the delegate’s willingness to pay is not smaller than that of \( A \) in expectation. Condition (2) distinguishes the problem from the choice of a delegate who simply has a lower valuation than player \( A \). It allows us to focus on the option to make the type of the delegate opaque but not tougher.

Once \( F \) has been chosen, \( F \) is observed by \( B \) and the game enters into stage 2. Player \( B \) is the proposer. The player chooses a non-negative real amount \( y \in [0, z] \) which \( B \) demands as a payment from \( A \). Then, a simple
threshold rule applies. The payment demanded is accepted if and only if the amount demanded does not exceed the delegate’s valuation: \( y \leq v \). No further decisions have to be made.

The proposer’s payoff is \( \pi_B = y \) if the demand of \( y \) is accepted and \( \pi_B = 0 \) otherwise. Player A’s payoff is \( \pi_A = 1 - y \) if B’s demand is \( y \) and is accepted and \( \pi_A = 0 \) otherwise.

We can first study the optimal choice of \( B \) in stage 2 for a given choice of \( F(v) \). In this subgame player \( B \) chooses \( y \) to maximize

\[
E\pi_B = \text{prob}(y \leq v) \cdot y. \tag{3}
\]

The set of values \( y \) that maximize (3) is not empty and might be multi-valued for a given \( F(v) \). We make a tie-breaking assumption/definition that is in line with a weak preference for efficiency: if \( B \) is indifferent between several values of \( y \), \( B \) chooses the \( y \) that has the higher payoff for \( A \):

**Efficient tie-breaking:** For a given \( F(v) \), if several \( y \) yield the same maximized value of (3) then \( B \) chooses the smallest \( y \) from this set. We denote this unique choice of \( y \) by \( \theta(F) \).

We next turn to the optimal choice of \( F \in \mathcal{F} \) in stage 1. For a given \( F \), the choice \( \theta(F) \) determines the expected payoff of \( A \) as

\[
\pi_A(F) = (1 - \theta(F))(1 - [F(\theta(F)) - \rho(\theta(F))]). \tag{4}
\]

Here, \( F(\theta(F)) - \rho(\theta(F)) \) is the probability that, for given \( F \), the true value of \( v \) is strictly smaller than \( \theta(F) \), which is the probability that the delegate will reject \( \theta(F) \). Moreover, \( (1 - \theta(F)) \) is \( A \)'s payoff if \( B \) demands \( \theta(F) \) and the delegate accepts this demand. Player \( A \)'s problem is to choose \( F \) to maximize (4) subject to \( F \in \mathcal{F} \), anticipating stage-2 subgame equilibrium behavior.

We first characterize a family \( \mathcal{G} \) of cumulative distribution functions that is of particular relevance. As will turn out, the distribution function that is chosen in the equilibrium is an element of this family, and the family plays also a crucial role in the proof of our main result. The family \( \mathcal{G} \) is the set of cumulative distribution functions \( F_x(v) \) defined on the interval \([0, z]\) and
distinguished by the parameter $x \in [0, 1]$, such that

\begin{align*}
F_x(v) & = 0 \text{ for } v < x \\
F_x(v) & = 1 - \frac{x}{v} \text{ for } v \in [x, z) \text{ with } x < v < z \text{ and} \\
F_x(v) & = 1 \text{ for } v = z.
\end{align*}

Each $F_x(v) \in \mathcal{G}$ has the properties of a cumulative distribution function of a random variable $v$ with support $[x, z]$. The function has $F_x(v) = 0$ for $v \leq x$ and is a strictly concave, strictly increasing, and continuously differentiable function for $v \in (x, z)$. The function $F_x$ has one single mass point which is at $v = z$ and of size $\frac{x}{z}$. The functions in $\mathcal{G}$ are ordered such that, for two functions $F_x$ and $F_{x'}$ it holds that $F_x \geq F_{x'}$ for $x < x'$ and $F_x > F_{x'}$ for $y \in (x, z)$. A random variable $v$ that has the cumulative distribution function $F_x(v)$ has the expected value

\begin{equation}
E_{F_x}(v) = \int_x^z v \frac{x}{v^2} dv + (1 - (1 - \frac{x}{z})) z,
\end{equation}

where $\frac{x}{v^2} = F_x'(v)$ in the interior interval $(x, z)$. This can be written equivalently as

\begin{equation}
E_{F_x}(v) = (\ln z) x - (\ln x) x + x.
\end{equation}

Figure 1 plots representatives of the family $\mathcal{G}$ for $z = 2$. The thicker function is the one for which $E_{F_x}(v) = 1$, i.e. the one for which the expected value of the delegated valuation is just equal to the true valuation of $A$. We label this function by $F_{v^*}$. The functions above $F_{v^*}$ have $E_{F_x}(v) < 1$, the ones below have $E_{F_x}(v) > 1$. The function $F_{v^*}$ will be an important element of $\mathcal{G}$ when we characterize optimal opacity later. Functions in $\mathcal{G}$ have important properties:

**Proposition 1** (1) $\mathcal{G} \cap \mathcal{F}$ is non-empty. (2) For any point in $(0, 1] \times [0, 1]$ there is an element $F_x \in \mathcal{G}$ that passes through this point. (3) If player $A$ chooses $F_x \in \mathcal{G}$, then the set of demand choices for which $B$ maximizes $B$’s expected payoff is the full set $[x, z]$: each of these demands yields $B$ a payoff of

\begin{equation}
(1 - [F_x(y) - \rho(x)])y = x.
\end{equation}
Figure 1: The family $G$ of cumulative distribution functions $F_x(v)$ such that $B$ is indifferent with respect to any demand $y \in [x, z]$ for a given $F_x(v)$.

**Proof.** Property (1): We need to show that there is at least one $x \in [0, 1]$ for which (2) holds. Note that $F_x \in G$ has at most one mass point (at $v = z$). For $x = 1$ the expected value is

$$E_{F_x}(v) = \int_1^z v^x \frac{v}{v^2} dv + 1 > 1.$$  

For property (2) fix any coordinate $(v, p) \in (0, 1) \times [0, 1]$ from the unit square. We need to show that for any such coordinate there is an $x \in [0, 1]$ such that $F_x(v) = p$. Note that $F_x(v) = 1 - \frac{v}{v}$ is a continuous and monotonically declining function of $x$; it takes value 1 for $x = 0$ and value 0 for $x = v \in (0, 1]$. This implies that, for any $(v, p) \in (0, 1] \times [0, 1]$ there exists (at least) one $x$ for which $F_x(v) = p$. Finally turn to property (3). The product $(1 - [F_x(y) - \rho_x(y)]) \cdot y$ is the payoff $\pi_B(y)$ of player $B$ for given $F_x$ for $B$’s choice of $y$. By (8) the specific shape of $F_x(y)$ makes this payoff $\pi_B$ just invariant and equal to $x$ for the function $F_x$ for all $y \in [x, z]$ and equal to $y < x$ for all $y \in [0, x]$.

Proposition 1 shows that there are members of the family $G$ that are also feasible choices for $A$. Moreover, the members of the family $G$ are “tight”
within the unit square: For each coordinate \((v, p)\) in the unit square there is at least one function from the family \(G\) that passes through this point. Note that much like indifference curves they cannot intersect. In the interior of the unit square this representative of \(G\) is actually unique. But for \(p = 0\) and \(p = 1\) there are multiple representatives from that pass through \((v, 0)\) and \((v, 1)\). These properties will be useful when we consider general functions \(F \in F\) and argue why for each of these there is always a member of the family \(G\) that is a Pareto dominant choice for player \(A\).

The assumption of efficient tie-breaking by \(B\) will be important. Player \(A\)'s expected payoff from \(F_x\) is 
\[
(1 - (F_x(y) - \rho_x(y)))(1 - y). 
\]
It depends on \(B\)'s choice of \(y\). For a given \(F_x\), player \(B\) is indifferent about the choice of \(y \in [x, z]\), but \(A\) strictly prefers \(y = x\). The assumption about efficient tie-breaking makes \(B\) choose \(y = x\) in this case. Efficient tie-breaking makes the stage-2 equilibrium unique and makes the payoff from choosing \(F_x\) in stage 1 equal to \(\pi_A = 1 - x\) for player \(A\). This leads us to a first result on optimal opacity, but only on a restricted set \(G \cap F\) of cumulative distribution functions:

**Proposition 2** If player \(A\) is constrained to choose \(F_x \in G \cap F\) and efficient tie-breaking applies, then \(A\) chooses the \(F_x\) with \(E_{F_x}(v) = 1\). Denote \(v^*\) the \(x\) that solves this condition. Then the resulting equilibrium payoffs are \(\pi_A = 1 - v^*\) and \(\pi_B = v^*\).

**Proof.** For given \(F_x \in G \cap F\), player \(B\) is indifferent about \(y \in [x, z]\) and \(B\) prefers \(y \in [x, z]\) to any \(y < x\). Among \(y \in [x, z]\) player \(A\) strictly prefers \(y = x\). It follows from efficient tie-breaking that \(B\) chooses \(y = x\). Hence, \(A\)'s equilibrium payoff from choosing \(F_x\) is \(\pi_A = 1 - x\). Compare the payoff of player \(A\) for two cumulative distribution functions \(F_x \in G \cap F\) and \(F_x' \in G \cap F\). Player \(A\)'s payoff is \(x\) and \(x'\), respectively. Player \(A\) will therefore choose the smallest feasible \(x\), which, by definition, is \(x = v^*\). The payoffs \(\pi_A = 1 - v^*\) and \(\pi_B = v^*\) follow directly from these choices. □

Intuitively, any given cumulative distribution function in \(G \cap F\) makes \(B\) just indifferent about \(B\)'s choice of \(y\). For a given \(F_x\) the efficient tie-breaking assumption leads to the smallest demand \(y = x\) from the support of \(F_x\) and this yields sure acceptance by the delegate. If \(A\) can choose a distribution function from this family with a lower \(x\), this is advantageous for \(A\): it yields a lower demand and sure acceptance of this demand by the
delegate. So this is why \( A \) would like to choose the \( F_x \) with the smallest \( x \). However, the smaller \( x \) the smaller is \( E_{F_x}(v) \). Therefore, an ever further decrease in \( x \) finally runs into the constraint that \( E_{F_x}(v) \geq 1 \) and makes this constraint binding.

We are now ready to state our main result:

**Proposition 3** Under efficient tie-breaking any subgame perfect equilibrium choice of \( F(v) \in \mathcal{F} \) implements an equilibrium demand \( y = v^* \), where \( v^* \) is the solution of

\[
\ln z \cdot y - \ln x \cdot y + y = 1. \tag{9}
\]

The payoffs in the equilibrium are

\[
\pi_A = 1 - v^* \quad \text{and} \quad \pi_B = v^*. \tag{10}
\]

A cumulative distribution function that implements this outcome is \( F_{v^*} \in \mathcal{G} \cap \mathcal{F} \).

**Proof.** We prove the main claim of Proposition 3 by contradiction in three steps. We first hypothesize that \( \hat{F} \) is not an optimal choice for \( A \), such that an \( \hat{F} \in \mathcal{F} \) with \( \hat{F} \notin \mathcal{G} \) exists that gives \( A \) higher payoff than \( 1 - v^* \). We state a few properties of such a presumably optimal choice. Second, we show that this choice \( \hat{F} \notin \mathcal{G} \) is (weakly) dominated by the choice of some \( \hat{F}_x \in \mathcal{G} \cap \mathcal{F} \). Third, we apply Proposition 1 to conclude that either \( \hat{F}_x = F_{v^*} \) already, or that \( \hat{F}_x \) is dominated by \( F_{v^*} \) for player \( A \). This then allows us to conclude that an \( \hat{F} \in \mathcal{F} \) that is superior to \( F_{v^*} \) does not exist.

**Step 1: Postulating optimal \( \hat{F} \).** Let \( \hat{F} \in \mathcal{F} \) be a function such that \( \hat{F} \) gives \( A \) a payoff that exceeds \( 1 - v^* \). By definition of \( \mathcal{F} \) this function \( \hat{F} \) has only a finite number of mass points. Denote the mass points of \( \hat{F}(v) \) by \( \hat{\rho}(v) \). Moreover, as \( \hat{F} \in \mathcal{F} \) it holds that \( E_{\hat{F}}(v) \geq 1 \). For \( \hat{F} \), player \( B \) maximizes \( (1 - [\hat{F}(y) - \hat{\rho}(y)]) \cdot y \). We denote \( B \)'s maximized payoff by \( \hat{\pi}_B \).

Let \( \hat{\Theta} \) be the set of \( y \) that yield this maximum payoff \( \hat{\pi}_B \) for \( \hat{F} \). The set \( \hat{\Theta} \) is non-empty. For a given \( y \in \hat{\Theta} \) the payoff of \( A \) is \( (1 - [\hat{F}(y) - \hat{\rho}(y)]) \cdot (1 - y) \). Among all \( y \in \hat{\Theta} \), the choice \( \theta(\hat{F}) = \hat{y} \) maximizes this payoff for player \( A \). The respective payoff is

\[
(1 - [\hat{F}(\hat{y}) - \hat{\rho}(\hat{y})]) \cdot (1 - \hat{y}) \equiv \hat{\pi}_A.
\]

By efficient tie-breaking, \( B \) chooses the demand \( \hat{y} \) in the continuation game in stage 2 if \( A \) chooses \( \hat{F} \) in stage 1. Furthermore, we can rule out that
\( \hat{y} > 1 \), because such a choice \( \hat{F} \) with \( \hat{y} > 1 \) yields payoff \( \hat{\pi}_A = (1 - (\hat{F}(\hat{y}) - \hat{\rho}(\hat{y}))) \cdot (1 - \hat{y}) \leq 0 \) and is dominated by \( F_{v^*} \) that yields positive payoff \( 1 - v^* \).

Step 2: Showing that \( \hat{F} \) is dominated by some \( F_{\hat{x}} \in \mathcal{G} \cap \mathcal{F} \). For given \( \hat{F} \), the choice \( \hat{y} \) induces a probability equal to \( \hat{F}(\hat{y}) - \hat{\rho}(\hat{y}) \). Consider the family of cumulative distribution functions \( \mathcal{G} \). As has been shown in (2) of Proposition 1, there is a function \( F_{\hat{x}} \in \mathcal{G} \) for which

\[
\hat{F}(\hat{y}) - \hat{\rho}(\hat{y}) = F_{\hat{x}}(\hat{y}) - \rho_{\hat{x}}(\hat{y}) = F_{\hat{x}}(\hat{y}),
\]

where the second equality holds as \( \rho_{\hat{x}}(\hat{y}) = 0 \) by \( \hat{y} \leq 1 < z \) for \( F_{\hat{x}} \in \mathcal{G} \). This implies

\[
\hat{\pi}_B = \left( 1 - \left[ \hat{F}(\hat{y}) - \hat{\rho}(\hat{y}) \right] \right) \hat{y} = (1 - F_{\hat{x}}(\hat{y})) \hat{y}, \tag{11}
\]

\[
\hat{\pi}_A = \left( 1 - \left[ \hat{F}(\hat{y}) - \hat{\rho}(\hat{y}) \right] \right) (1 - \hat{y}) = (1 - F_{\hat{x}}(\hat{y})) (1 - \hat{y}).
\]

Suppose that \( A \) chooses this \( F_{\hat{x}} \in \mathcal{G} \) instead of \( \hat{F} \). This yields the same payoff \( \hat{\pi}_B \) as for \( \hat{F} \) for \( B \). For given \( F_{\hat{x}} \), every other \( y \in [\hat{x}, z] \) also yields \( B \) the expected payoff \( \hat{\pi}_B \). Player \( B \) chooses \( \theta(F_{\hat{x}}) = \hat{x} \) by efficient tie-breaking. Therefore, the payoff for \( A \) for \( F_{\hat{x}} \) is

\[
(1 - F_{\hat{x}}(\hat{x})) (1 - \hat{x}) = (1 - \hat{x}) > (1 - F_{\hat{x}}(\hat{y})) \hat{y}
\]

for all \( \hat{y} \neq \hat{x} \). This shows that \( A \) prefers the choice \( F_{\hat{x}} \) to the choice of \( \hat{F} \), unless \( \hat{y} = \hat{x} \). So we found that the \( F_{\hat{x}} \) that is a member of \( \mathcal{G} \) and passes through \((\hat{y}, \hat{F}(\hat{y}))\) either implements the same demand as \( \hat{F}(\hat{y}) \) or dominates \( \hat{F}(\hat{y}) \).

It remains to show that this \( F_{\hat{x}} \) is also feasible, i.e., \( E_{F_{\hat{x}}} \geq 1 \). Consider the following chain of (in-)equalities:

\[
\left( 1 - \left[ \hat{F}(y) - \hat{\rho}(y) \right] \right) y \leq \left( 1 - \left[ \hat{F}(\hat{y}) - \hat{\rho}(\hat{y}) \right] \right) \hat{y} = (1 - F_{\hat{x}}(\hat{y})) \hat{y}. \tag{12}
\]

The inequality on the left follows directly from the optimality of the choice \( \hat{y} \) for \( B \) under \( \hat{F} \). The equality that follows holds by the definition of \( F_{\hat{x}} \). Moreover,

\[
(1 - F_{\hat{x}}(\hat{y})) \hat{y} = (1 - F_{\hat{x}}(y)) y \tag{13}
\]

for all \( y \in [\hat{x}, z] \) by property (3) of \( F_{\hat{x}} \in \mathcal{G} \) in Proposition 1. Hence, from a comparison of the term on the far left of (12) and on the right of (13), using further that \( F_{\hat{x}}(y) = 0 \) for all \( y \in [0, \hat{x}] \) we conclude

\[
\hat{F}(y) \geq \hat{F}(y) - \hat{\rho}(\hat{y}) \geq F_{\hat{x}}(y) \tag{14}
\]
for all \( y \in [0, z] \). Furthermore, \( \hat{F}(z) = \hat{F}_x(z) = 1 \). It follows that \( F_x \) (weakly) dominates \( \hat{F} \) in the sense of first-order stochastic dominance. Hence,

\[
E_{\hat{F}}(v) \leq E_{F_x}(v).
\]

As \( \hat{F} \in \mathcal{F} \), it follows that \( F_x \in \mathcal{F} \).

**Step 3:** Showing that \( F_x \) is dominated by \( F_{v^*} \), unless \( \hat{x} = v^* \). Proposition 2 already showed that the choice of \( F_{v^*} \) maximizes A’s payoff within the class of \( F_x \in \mathcal{G} \cap \mathcal{F} \).

Finally, the payoffs \( \pi_A \) an \( \pi_B \) as stated in the proposition follow from

\[
\pi_A = (1 - F_{v^*}(v^*))((1 - v^*) = 1 - v^* \text{ and } \pi_B = (1 - F_{v^*}(v^*))v^* = v^*.
\]

Figure 2 illustrates these comparisons. Take an arbitrary, but feasible \( \hat{F} \) as described by the red curve in the figure. Any given \( \hat{F} \) induces a choice \( \hat{y} \) that maximizes B’s payoff, as described by the red rectangle. Now we search for a \( F_x \) in the family \( \mathcal{G} \) that passes through \( (\hat{y}, \hat{F}(\hat{y})) \). By Proposition 1 such an \( F_x \in \mathcal{G} \) exists. In the figure, this is the blue function that is tangent to the red function in \( (\hat{y}, \hat{F}(\hat{y})) \). If A chooses this \( F_x \in \mathcal{G} \), and furthermore, if B chose \( \hat{y} \) given the choice \( F_x \), this led to the same equilibrium payoffs as the choice of \( \hat{F} \). But for \( F_x \) any choice \( y \in [\hat{x}, z] \) gives B the same payoff as \( \hat{y} \). Moreover, player A is not indifferent as regards all these choices \( y \in [\hat{x}, z] \) and, under \( F_x \) strictly prefers \( y = \hat{x} \). Due to efficient tie-breaking, B chooses \( y = \hat{x} \) under \( F_x \). But then, the choice \( F_x \) gives A a higher equilibrium payoff than the payoff from the subgame given \( \hat{F} \). This shows that \( \hat{F} \) is weakly dominated by \( F_x \). This is not yet the end of the proof, as we do not know yet whether this dominating \( F_x \) is feasible, i.e., that \( E_{\hat{F}}(v) \geq 1 \).

Feasibility can be shown using a stochastic dominance argument: A has a higher equilibrium payoff from \( F_x \) than from \( \hat{F} \). A further improvement for A is feasible by a choice of \( F_{v^*} \) rather than \( F_x \), unless \( \hat{x} = \hat{y} \).

Proposition 3 characterizes player A’s choice of opaqueness that maximizes this player’s equilibrium payoff among all feasible distribution functions. The feasible set is mostly characterized by a minimum of the admissible expected value of the delegated valuation for the choice of the distribution function. If the player A could reduce this expected value below A’s own true valuation, the player could make the delegate ‘tougher’ than A is, and due to the standard logic of delegation in bargaining, this made A better-off. However, given the restriction on the maximum of expected toughness, player A chooses a distribution of valuations that makes this
Figure 2: For a given feasible function $\hat{F}$ the function $F_\hat{x}$ yields the same equilibrium payoff for $B$ for $y = \hat{y}$ and a higher equilibrium payoff for $A$ if, in addition, $y = \hat{x}$.
restriction binding and among these chooses the one that generates the lowest demand. Still, the right choice of opacity makes the player better-off compared to choosing no delegate or a delegate with a fully transparent valuation.

4 Comparative statics and robustness

The highest feasible type The comparative statics regarding the highest feasible type \( z \) is straightforward. An increase in the maximum type \( z \) gives more leeway to player \( A \) and leads to a reduction in the lower bound \( v^* \). To show this formally, recall that \( v^* \) is implicitly defined by \( E_{F_A}(v) = 1 \) or \( (\ln z) v^* - (\ln v^*) v^* + v^* = 1 \) [see eq. (7)]. Implicit differentiation yields

\[
\frac{dv^*}{dz} = -\frac{v^*}{z \ln(z) - \ln(v^*)} < 0.
\] (16)

Hence, an increase in \( z \) leads to a lower \( v^* \). Even though \( z \) is never selected in equilibrium, an increase in the upper bound allows player \( A \) to extract more rents by reducing \( v^* \). In Figure 3, the outcome is illustrated for an increase from \( z = 2 \) to \( z = 3 \).

Properties of \( A \) and \( B \) To make player \( B \) most powerful in the absence of a delegate, we assumed that player \( A \)'s willingness to pay is perfectly known (and normalized to 1). Nothing in the proof of proposition 3 made use of the distributional properties of what is common information about \( A \). Instead of a degenerate distribution, \( A \)'s willingness to pay might be \( A \)'s private information and a draw from a separate distribution function.

If \( A \) must send a delegate and choose some \( F(v) \) for this delegate, and if \( A \)'s true valuation is larger than \( v^* \), then the function \( F(v) \) remains optimal. A difference emerges if \( A \) has a choice whether or not to choose a delegate. In this case, this choice might be informative and this information might become relevant in case \( A \) choses not to appoint a delegate.

The model analysis can also be extended in several other directions without affecting our main message. Suppose, for instance, that player \( B \) faces the cost \( b \) \((0 < b < 1)\) of signing an agreement. This cost introduces a lower bound for player \( B \)'s demand. The offer-maker’s payoff now becomes \( \pi_B = y - b \) if the demand of \( y \) is accepted and \( \pi_B = 0 \) otherwise. The
principal’s payoff is the same as in the basic model: \( \pi_A = 1 - y \) if the demand \( y \) is accepted and \( \pi_A = 0 \) otherwise. Offer-maker \( B \) now maximizes the expected payoff \( E\pi_B = \text{prob}(y \leq v) \cdot (y - b) \). In the subgame perfect equilibrium, player \( A \) chooses an opacity of the delegate’s preferences that follows the distribution

\[
F_{v^{**}}(v) = 1 - \frac{v^{**} - b}{v - b} \quad \text{for} \quad v \in [v^{**}, z) \quad \text{and} \quad F(z) = 1.
\] (17)

The constraint that implicitly determines \( v^{**} \) becomes

\[
E_{F_{v^{**}}} (v) = \int_{v^{**}}^{z} \frac{v^{**} - b}{(v - b)^2} dv + (1 - (1 - \frac{v^{**} - b}{z - b}))z = 1.
\] (18)

The proof is analogous to Propositions 1-3 and is only briefly sketched here. First, equation (18) has a unique solution for \( v^{**} \in (b, 1) \). This equation can be rewritten as

\[
\ln (z - b) (v^{**} - b) - \ln (v^{**} - b) (v^{**} - b) + v^{**} = 1.
\] (19)

The left-hand side is strictly increasing in \( v^{**} \) as \( \frac{\partial}{\partial v^{**}} = \ln(z - b) - \ln(v^{**} - b) > 0 \). At \( v^{**} = b \) the left-hand side amounts to \( b < 1 \) and at \( v^{**} = 1 \) to
\[(1-b)\cdot [\ln (z - b) - \ln (1 - b)] + 1 > 1.\] Hence, there must be a unique solution \(v^{**} \in (b, 1)\). Note that the critical value \(v^{**}\) increases in \(b\). Second, player \(B\) is indifferent about the choice of \(y \in [v^{**}, z]\) as the expected payoff amounts to \(\pi_B(y) = v^{**} - b\) for any demand \(y\). Third, player \(A\) cannot be better off than with distribution \(F_{v^{**}}\) given the constraint \(E_F(v) \geq 1\). The proof is by contradiction. Suppose again that another distribution \(\hat{F}\) with support \([\hat{y}, z]\), which induces a choice \(\theta(\hat{F}) = \hat{y}\), generates a strictly higher payoff for \(A\). Let us define the left-hand limit of \(F(v)\) as \(\lim_{v \uparrow v_0} F(v) = \Phi(v)\).

Then optimality for player \(B\) requires \(\hat{y} - b \geq (1 - \Phi(v))(v - b)\) for all \(v > \hat{y}\). For distribution \(F_{v^{**}}\), it must hold that \(v^{**} - b = (1 - \Phi_{v^{**}}(v))(v - b)\) for all \(v > v^{**}\). Subtracting the latter from the former condition yields \((1 - \Phi(v))(v - b) - (1 - \Phi_{v^{**}}(v))(v - b) \leq \hat{y} - v^{**}\). If player \(A\) wants to improve on the payoff compared to \(1 - v^{**}\), the transfer to \(B\) must be lower with \(\hat{F}\): \(\hat{y} < v^{**}\). Again, we obtain \(\Phi_{v^{**}}(v) < \Phi(v)\), which implies that distribution \(\hat{F}\) violates the constraint on the type of the delegate \((E_{\hat{F}}(v) < E_{F_{v^{**}}}(v) = 1)\).

## 5 Conclusion

In ultimatum bargaining with incomplete information, the responder may benefit from some opacity about the delegate’s valuation of an agreement. Opacity prevents the responder from being exploited by the offer-making party. Optimally designed opacity can even generate an efficient solution. A welfare improving agreement is concluded with certainty. While the existing literature has focused on the delegation to tough negotiators to secure some rents for the responding party, we have shown that the protection of rents can also be achieved through the opacity of the delegate’s preferences.

From a practical point of view, the beneficial effects of opacity point to a trade-off when countries select the delegates to international negotiations. While experienced negotiators may know the tricks of the deal, they are also more transparent in terms of their policy stance. Sending dark horses to the negotiation table makes it more difficult for the other side to pin the country down to its reservation utility. An interesting question is under which conditions opacity can be used in addition to strategic delegation to tough negotiators.

There is no question that international negotiations are much more complex than the ultimatum game analyzed here. Most international negotia-
tions are multifaceted and allow for issue linkages. Negotiators learn over time the other side’s policy stances and preferences. And delegates often face the problem of responding to multiple principals. On the national basis, the outcome of international negotiations is evaluated by the executive and legislative branches of the government – and often even by the subnational governments. With country groups, several national governments are involved as well as supranational institutions such as the EU. There are still many open research questions to be analysed regarding transparency and opacity in complex real-world negotiations.

**References**


