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Research Paper

The contractual dispute resolution game: Real-effort experiments on contract negotiation and arbitration

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ABSTRACT

In many contractual arrangements where product or service delivery occurs sometime after contracts have been concluded, conditions may change, leading to disputes that need to be resolved often by a third party (arbitrator/mediator). In this paper we introduce the Contractual Dispute Resolution Game (CDRG), which allows us to study dispute resolution through arbitration. Unlike prior research studying arbitration at impasse using zero-sum bargaining games, we analyze a situation where parties can create additional value. We introduce a novel real-effort task, the Car Assembly Real-effort Task (CART), and show in two studies how automated arbitration rules (Study 1) and human arbitrators (Study 2) affect dispute resolution and surplus creation. In Study 1, we find that high-accuracy arbitration enhances efficiency. In Study 2, we find that arbitrators who are incentivized based on the total surplus of the negotiation do also promote greater efficiency. The CDRG provides a valuable tool for examining the effects of arbitration and mediation in settings where contracts are incomplete and can be impacted by shocks.

"When will mankind be convinced and agree to settle their difficulties by arbitration?"

Benjamin Franklin

1. Introduction

Interfirm contracts allow companies to create value through the future exchange of products and services in the absence of well-organized markets. However, most contracts are incomplete because it is impossible or extremely costly to specify what to do in every possible contingency (see e.g., Shavell, 2009 for a review). Disputes are thus likely to occur in the face of an unforeseen event that benefits one of the parties at the expense of the other. This is the case because renegotiations are likely to fail due to information asymmetries between parties (Klein et al., 1978; Williamson, 1979) and different views on what should be the reference point for the

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new contract (Babcock et al., 1996; Babcock and Loewenstein, 1997; Hart and Moore, 2008; Fehr et al., 2011).[1] Legal disputes are typically costly, and lengthy and can, given their public nature, damage the reputation and threaten the survival of litigating firms (Ben-Shahar and White, 2006; Gurcaylilar-Yenidogan, 2014). In response to these concerns, alternative dispute resolution (ADR) mechanisms have become increasingly popular. ADR includes mediation and arbitration methods that allow firms to reach settlements and resolve disputes in private, avoiding some of the drawbacks of litigation in court.[2] Arbitration, unlike mediation (Carnevale and Pruitt, 1992), forces the resolution of a conflict by imposing an arrangement implemented by the relevant parties.

In this paper we study arbitration in contractual disputes, which is increasingly supported by governments and judicial systems around the world because it is faster, cheaper, and less invasive than litigation (Fuller, 1993; Lipsky and Seeber, 1998; Stone, 2007; Zuckerman, 2007; Stipanowich, 2010; Colvin, 2017). For example, in the United States, the American Arbitration Association (AAA) has intervened in more than 6 million cases since its founding in 1926, ranging from labor and business disputes to government and international disputes. In 2020, the AAA provided alternative dispute resolution for 9538 business-to-business cases involving approximately $18 billion in claims, in a broad range of industries.[3]

Unlike previous arbitration research which was based on comparing popular arbitration rules in bargaining games (see Dickinson, 2020 for a review), we focus on broader properties of contractual dispute resolution mechanisms related to incentives and information, following the extensive mechanism design literature in economics (Laffont and Martimort, 2002; Bolton and Dewatripont, 2005). We thus study the informational and motivational properties of arbitration instead of its institutional features. We show how these properties affect the efficiency, the fairness and the level of risk associated with a transaction.

To this end, we design a novel contractual dispute resolution game (CDRG, henceforth) that we deployed in a series of laboratory experiments. To our knowledge, this is the first experimental design that includes an arbitration phase in the resolution of contractual disputes between firms. By contrast, previous research has focused on the study of negotiation and disagreements in bargaining games (see Roth, 1995; Güth and Kocher, 2014) rather than on contractual disputes that occur when one of the parties is unwilling to carry out a previously signed contract.

In our setup, two parties (a 'buyer' and a 'seller', henceforth) negotiate a contract over the delivery of a quantity of products at a given price. This contract can be renegotiated at a later stage when new relevant information is available to the seller regarding the cost of production. This dynamic game with asymmetric information is such that parties will not necessarily agree on a counteroffer price, thus triggering a dispute (see Hypothesis 1). In case of a dispute, an arbitration mechanism will set the final price level.[4]

The CDRG features a situation in which parties hold asymmetric information regarding the seller's cost of production so that any cost information collected by the arbitrator can help reduce the information gap between parties.[5] Our approach, which studies how arbitration affects surplus creation, contrasts with previous research that has focused on procedural aspects of arbitration leaving aside its crucial informational role (Park, 2010).[6]

We conduct two separate studies, each focusing on different characteristics of the arbitration process. In both studies, we had to vary more than one variable, so we did not aim to compare the two studies directly. Study 1 consists of repeated one-shot games and employs automated arbitration, while Study 2 uses repeated games and human arbitrators. In the following paragraphs, we explain the purpose and characteristics of each study in detail.

In Study 1, we compare the efficiency of arbitration mechanisms with various accuracy levels. In particular, we consider that the arbitration mechanism can verify the updated cost of production of the seller with a low (20 %) or high (100 %) probability. We predict that the accuracy of the arbitrator will facilitate transactions between parties, thus fostering efficiency. This is the case because the accurate arbitrator will help reduce the asymmetry of information between parties. It follows that the contract price will more likely be adjusted to new information, thus protecting the seller against the risk of an increase in costs. This reduction in the risk associated with transactions will facilitate the signing of contracts in the first stage of the game, thus promoting gains from exchange. We thus expect high-accuracy arbitration to promote efficiency.

This positive effect of arbitration is novel to the literature on bargaining and dispute resolution. In the seminal model of Ashenfelter et al. (1992), the uncertainty associated with the decision of the arbitrator improves efficiency because it reduces dispute rates in conventional arbitration. This occurs because uncertainty increases the cost of arbitration for risk-averse parties, leading them to settle early and avoid arbitration. Their setup differs from ours because arbitrators cannot collect any relevant information about the case. We show that this fact-finding mission of the arbitrator, which is practically relevant (Park, 2010), facilitates risk-sharing between parties, thus making transactions between risk-averse parties easier.

In Study 2, we focus on the impact of incentives on the decision of human arbitrators. In the case of interfirm disputes, we are not

[1] An alternative solution to contracts to mitigate the underinvestment problem is vertical or lateral integration (Grossman and Hart, 1986; Hart and Moore, 1990).

[2] See for example Edwards (1986), Jeffries (1992), Goss (1995), Shavell (1995), Blackman and McNeill (1998) for reviews of the advantages and disadvantages of alternative dispute resolution mechanisms compared to court litigation.

[3] https://www.adr.org/ last accessed on December 27th 2024.

[4] Because the arbitration mechanism is not constrained to pick a price equal to the original price or the counteroffer price, this can be seen as a conventional arbitration mechanism.

[5] An earlier example of an experimental design with asymmetric information in the bargaining literature is the ultimatum game study by Mitzkewitz and Nagel (1993).

[6] Fact-finding mediators have been studied and shown to reduce dispute rates in laboratory experiments (Dickinson and Hunnicutt, 2005, 2010). Unlike arbitrators, mediators' recommendations are not binding and can be ignored when resolving a dispute.

aware of any empirical or theoretical study assessing the effect of aligning the incentives of the arbitrator with parties' profits.[7] This can partly be explained by the fact that previous research has focused on the case in which arbitration is automated (e.g., Ashenfelter et al., 1992; Pecorino and Van Boening, 2001; Dickinson, 2004, 2005; Deck et al., 2007a,b), thus discarding the study of the underlying motives of arbitrators' decisions.[8] Our goal is to test whether rewarding arbitrators a share of the value of the transaction will facilitate agreements between buyers and sellers, thus improving efficiency compared to arbitrators who are rewarded a fixed fee.

A crucial feature of the CDRG is that, unlike in previous dispute resolution experiments, it includes both a transaction and a production phase. As a result, the arbitration outcome is followed by a production stage in which the seller can decide to comply with the contractual agreement or not. Sellers might not comply with the contract even though they incur a steep monetary fee for not doing so. Indeed, experimental evidence has shown that people might engage in costly punishments if they perceive a situation to be unfair (e.g., Pillutla and Murnighan, 1996; Fehr and Gächter, 2000; Henrich et al., 2006; Molenmaker et al., 2014; Weber et al., 2018; Claessens et al., 2024). This behavior is also in line with the idea of "shading" proposed by Hart and Moore (2008).[9] For example, if sellers feel disadvantaged by a change in the terms of the contract, they may reduce the quality of the product, which can be difficult to verify, thus hurting the buyer. Our experimental setup is thus one in which we can study the commitment of the seller to the arbitration outcome, which is critical for a proper assessment of the efficiency of various arbitration mechanisms (see e.g., Notz and Starke, 1978). We make the prediction that arbitrators whose incentives are aligned will thrive to foster sellers' commitment to the contract by picking prices that are favorable to the seller. This will lower the likelihood that contracts fail to be completed while increasing the likelihood that sellers will produce beyond the contractual quantity. Increasing a seller's commitment to the contract will benefit the arbitrator who receives aligned incentives because it increases the value of a transaction.

2. Related literature

2.1. Contractual disputes between firms

Research on contractual disputes between firms has focused on the type of agreements, formal or relational (Luo, 2002; Poppo and Zenger, 2002; Lui and Ngo, 2004; Goo et al., 2009; Puranam and Vanneste, 2009; Ryall and Sampson, 2009; Weber and Mayer, 2011; Lumineau et al., 2015; Zhou and Xu, 2012; Abdi and Aulakh, 2017) and on the procedures used to manage conflicts (Malhotra and Lumineau, 2011; Lumineau and Oxley, 2012; Chen et al., 2018). This literature has studied the main reasons for conflict, pointing out the lack of interdependence between firms, the divergence in objectives and the lack of communication as the most relevant factors (Mohr and Spekman, 1994; Habib, 1987). Interorganizational conflicts have a strong effect on trust (Robinson, 1996; Kim et al., 2004, 2006; Tomlinson et al., 2004; Dirks et al., 2009), commitment (Ganesan et al., 2010; Kim et al., 2011), and intentions to seek new partners (Ganesan et al., 2010; Malhotra and Lumineau, 2011). Unlike our work, this literature does not study informational and incentive effects of arbitration. In addition, this literature uses archival data while we employ the experimental method to exogenously manipulate the defining features of the arbitration mechanism and provide a precise measure of the efficiency, fairness and risk associated with each mechanism.

2.2. Bargaining and arbitration experiments

At the experimental level, the closest works to ours belong to the extensive and multidisciplinary literature on bargaining games (e.g., Siegel and Fouraker, 1960; Bazerman et al., 1985; Carnevale and Pruitt, 1992; Roth, 1993; Roth, 1995; De Dreu and Carnevale, 2005; Smith, 2007; Güth and Kocher, 2014). The experimental research on bargaining covers a wide range of topics related to various procedural features such as deadlines (e.g., Roth et al., 1988; Moore, 2004; Güth et al., 2005), delays between offers (e.g., Ghosh, 1996), time pressure (e.g., Stuhlmacher et al., 1998; De Dreu, 2003; Karagözoğlu and Kocher, 2019) as well as mediation (see e.g., Grigsby and Bigoness, 1982; Carnevale and Pruitt, 1992; Dickinson, 2020 for reviews).

More recently, the experimental literature on bargaining has studied the impact of renegotiation (Katok and Tan, 2024) in cases where a disruption may occur after the buyer and seller have agreed on a contract price, leading to an increase in the seller's costs. In particular, they show that renegotiation can reduce the negative impact of disruptions in short-term relationships. Renegotiation has no effect in long-term relationships because reputational concerns already motivate sellers to manage disruptions efficiently. Our study focuses on arbitration rather than renegotiation, but future work should consider a direct comparison of these two mechanisms. The bargaining literature has also studied arbitration (see Dickinson, 2020 for a review). Using theory and experiments, this literature has shown that the presence of an arbitrator can reduce the frequency of disagreements (e.g., Farber and Katz, 1979; Farber, 1980; Ashenfelter et al., 1992). In addition, several papers have shown that arbitration can reduce the frequency of disagreements by reducing transacting parties' optimism, overconfidence and self-serving biases (Bazerman and Neale, 1982; Neale and Bazerman,

[7] Within a firm, arbitrators' incentives may be aligned with the interests of the disputants when a manager acts, for example, as an ombudsperson in an employment conflict (Rowe, 1987; Goss, 1995; Tadelis and Williamson, 2012).

[8] Bazerman and Neale (1982), Neale and Bazerman (1983) and Birkeland (2013) use human arbitrators in their experimental design. However, these studies focused on negotiators' decisions leaving aside the analysis of arbitrators' decisions. More importantly, no study has yet assessed the effect of arbitrators' incentives on their decisions.

[9] Hart and Moore (2008) define "shading" as the decision of one firm to withhold part of its non-judicially enforced performance if it is short-changed. Therefore, "shading" generates a deadweight loss.

1985; Babcock et al., 1996; Babcock and Loewenstein, 1997; Dickinson and Hunnicutt, 2005; Dickinson, 2009; De Dreu et al., 2007) while fostering perspective-taking (Neale and Bazerman, 1983; Babcock et al., 1997; Galinsky and Mussweiler, 2001). Finally, the literature has studied the relative effectiveness of various arbitration rules such as the conventional offer arbitration (COA), under which the arbitrator can impose any settlement, and the final-offer arbitration mechanism (FOA) which constrains the arbitrator to impose one of the last offers of the parties. The FOA was developed as a response to the tendency of arbitrators to split the difference between parties' final offers under COA, which might induce parties to make extreme offers and prevent a compromise (Dickinson, 2020). Ashenfelter et al. (1992) found that FOA induces higher disagreement rates than COA in an experimental setting with an automated arbitrator. This was a surprising result as FOA had become increasingly popular (see Notz and Starke, 1978; Neale and Bazerman, 1983) based on the general belief that it might eliminate disputes (e.g., Feuille, 1975; Donn, 1977). Furthermore, Olszewski (2011) shows that COA dominates FOA when the arbitrator's ability to gather private signals is high, whereas the opposite holds true when the arbitrator's ability is low. Although our setup focuses on COA rather than FOA, future research could use our Study 1 design to test whether COA dominates FOA (FOA dominates COA) when the arbitrator can verify the updated cost of production for the seller with a high (low) probability. More recently, various innovating procedures combining FOA and COA have been proposed but with limited effect on voluntary settlement rates compared to COA (Ashenfelter et al., 1992; Dickinson, 2004, 2005).[10] Interestingly, Pecorino and Van Boening (2001) show that allowing negotiations to continue after final offers were submitted to the arbitrator could lower disagreement between parties under FOA. In the same vein, Deck et al. (2007a,b) show that amended FOA, according to which the arbitration outcome is determined by the offer of the losing party, could lower disagreement rates compared to the standard FOA mechanism.

Although the bargaining literature is extensive, more research is needed on the efficiency of conflict resolution mechanisms (Dickinson, 2020). The available research on bargaining and arbitration differs from ours because it focuses on negotiation and disagreements rather than on contractual disputes that occur when one of the parties is unwilling to carry out a previously signed contract. Furthermore, none of the existing studies focus on the informational accuracy of arbitration and on the incentives given to arbitrators.

3. The contractual dispute resolution game (CDRG)

To derive our hypotheses, we design a novel contract dispute resolution game (CDRG) which we study using game-theoretic tools. Game theory has been found to be especially useful in identifying the efficiency of FOA and COA (see e.g., Farber, 1980) and other innovative arbitration mechanisms such as double-offer arbitration (Zeng et al., 1996) or amended FOA (Zeng, 2003). Our empirical strategy is to deploy the CDRG in a series of laboratory experiments to test our game-theoretic predictions. As put forth by De Dreu and Carnevale (2005, p. 62) this approach may alleviate some of the generality concerns of lab experiments because: “With theory-based research, the results may be generalized because the theoretical processes occur in the laboratory as well as in natural settings.”

3.1. The CDRG

In CDRG two parties (a ‘buyer’ and a ‘seller’, henceforth) negotiate a contract over the delivery of a quantity of products at a given price. This contract can be renegotiated at a later stage when new relevant information is available. At that stage, sellers learn their actual cost of production which can differ from the estimated cost when signing the contract, thus possibly triggering conflicts. We describe the four stages of the game below.

In Stage 1, the buyer offers a contract to a seller for the production of a quantity (q) of products and a unitary price (p_1). We also denote by q^+ the maximum quantity a seller can produce, which captures capacity constraints. The value of the product for the buyer is equal to v and this value is known to both parties. The seller decides whether to accept or reject the contract. At the time the contract is signed, the unitary cost of production for the seller is equal to c_1. If no contract is signed, no transaction is completed and the game ends.

In Stage 2, after a contract has been signed in the first stage, the unitary cost of production for the seller can be impacted by a positive ($b > 0$) or a negative shock ($b < 0$), thus increasing or decreasing the unitary cost of production effectively incurred by the seller to $c_1 + b$ or $c_1 - b$. Shocks are equally likely. The effective cost of production of the seller at this stage (c_2) is not known by the buyer. At that time, the seller can send a counteroffer to the buyer by proposing an alternative price p_2. If the counteroffer is accepted by the buyer (or if $p_2 \le p_1$) the final unitary price of the contract (p_f) is set equal to p_2 and the game moves directly to the production phase (Stage 4). If the counteroffer is rejected, the game first moves to the arbitration stage (Stage 3) before going to Stage 4.

In Stage 3, an automated arbitrator verifies the value of c_2 in which case the unitary price of the original contract is adjusted to reflect the new cost conditions so that the final price is: $p_f = p_1 + (c_2 - c_1)$. There is a fixed cost of arbitration (φ) that is incurred by both parties.

In Stage 4, the seller produces according to the standing contract. If sellers fail to comply with the contract, they incur a penalty $\psi > 0$. Sellers can produce more than stipulated in the contract.

The structure of CDRG is represented graphically in Fig. 1.

In the absence of arbitration fees ($\varphi = 0$), the earnings of the buyer and the seller are given by $\left(v - p_f\right)q$ and $\left(p_f - c_2\right)q$,

[10] The mechanisms studied in Dickinson (2005) is double-offer arbitration according to which the parties submit two final offers to the arbitrator.

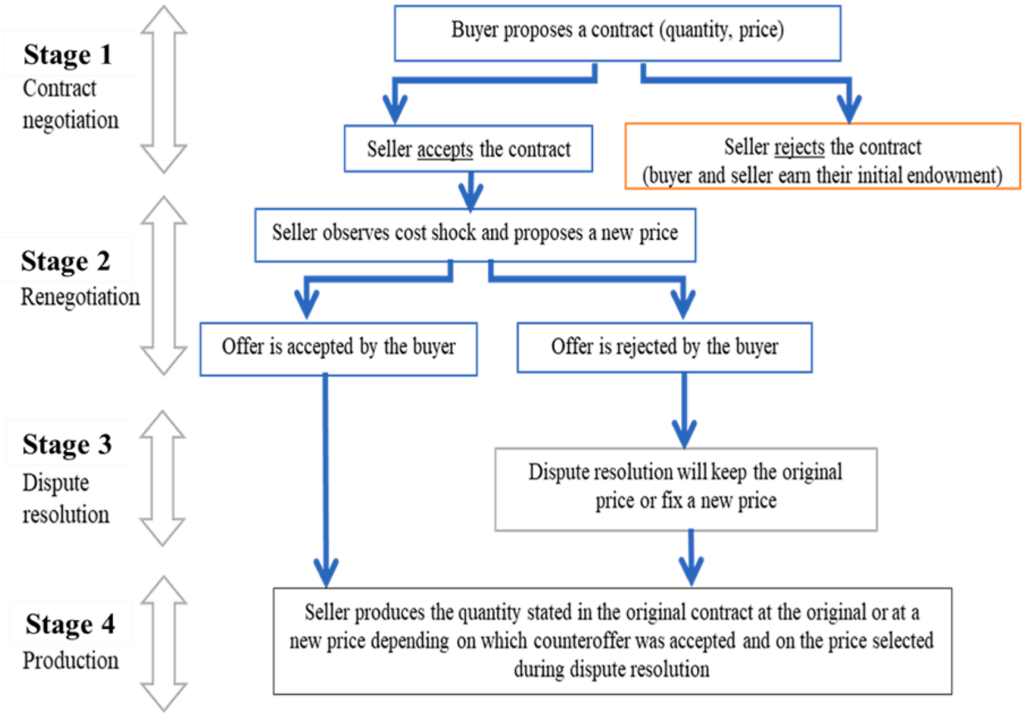

Fig. 1. The structure of CDRG (and timeline of the experiments).

respectively. The sum of both parties' earnings are equal to $(v - c_2)q$. The expected value of the transaction for both parties is equal to $(v - c_1)q$ which is always assumed to be strictly positive ($v > c_1$).

3.2. Theoretical properties of CDRG

For illustrative purposes and to provide a clear benchmark, we focus on pure-strategy subgame perfect equilibria following from money maximization, while acknowledging that mixed strategy Nash equilibria exist, along with equilibria in which players have social preferences and suffer from lying costs. For example, if sellers suffer from a cost of lying, truthful equilibria could be achieved even if dispute arbitration fees (φ) are high, and the accuracy of the arbitration is low. In that case, we would expect limited differences across treatments.

To study potential treatment differences, we consider that both parties are maximizing their expected earnings.[11] Using backward induction, we know that a profit-maximizing seller will comply with the contract in Stage 4. In Stage 3, the arbitration outcome is automatically implemented.

In Stage 2, the seller decides on the counteroffer. Let us first consider the possibility of a truthless equilibrium in which the choice of p_2 by the seller reveals nothing about the value of c_2 to the buyer. This implies that p_2 is set independently of c_2. This type of equilibrium exists if the buyer always rejects p_2. However, if the seller's offer is always rejected, a costly conflict would ensue. This cannot be an equilibrium because the seller would rather set a price $p_2 = p_1$ that would lead to the same expected earnings while saving the arbitration fees.

We thus focus on truthful equilibria in which the choice of p_2 by the seller reveals the true value of c_2. For such an equilibrium to exist it cannot be that the buyer always accepts the counteroffer and arbitration never occurs. This is the case because the seller would then deviate from the truthful equilibrium by always asking for the highest counteroffer price. A truthful equilibrium in which the buyer always rejects the counteroffer is not relevant either because sellers would have no incentive to pick a counteroffer price that reveals their cost of production.

Ultimately, a truthful equilibrium is one in which the buyer accepts the counteroffer when it reveals a low unitary cost and rejects it when it reveals a high unitary cost.[12] More specifically, when the unitary cost of production increases, the seller will set p_2 high enough to force arbitration ($p_2 > p_1 + b + \frac{\varphi}{q}$). In the case in which the unitary cost of production decreases, the seller will set p_2 so as to avoid

[11] This corresponds to the case of self-interested parties who are risk neutral.

[12] The opposite cannot be an equilibrium because the seller would have an incentive to deviate by always offering the higher counteroffer price (which is the one that the buyer accepts in equilibrium) regardless of c_2.

arbitration, given that the buyer knows that the final price would be $p_f = p_1 - b$ in case of arbitration. That is, the seller will set $p_2 = p_1 - b + \frac{\varphi}{q}$ so that the buyer has no incentive to deviate and trigger arbitration.[13] Sellers will not have an incentive to deviate by setting the higher counteroffer price when the cost of production decreases. This is the case because this offer would be rejected by the buyer thus generating a profit per unit for the seller equal to $p_1 - c_1 - b - \frac{\varphi}{q}$ which is no greater than what they can achieve in equilibrium. It follows that, in a truthful equilibrium, the final price is $p_f = p_1 + b$ if the unitary cost increases in Stage 2, and $p_f = p_1 - b + \frac{\varphi}{q}$ if it decreases.

Following backward induction, we solve the game in Stage 1. Buyers and sellers know that the final price will depend on c_2. Buyers will thus set a price and a quantity in Stage 1 so as to maximize their expected earnings $\left[v - \frac{1}{2}(p_1 + b) - \frac{1}{2}\left(p_1 - b + \frac{\varphi}{q}\right)\right]q - \frac{1}{2}\varphi$ ensuring that sellers' expected earnings are not negative so they accept the contract: $\left[\frac{1}{2}(p_1 + b) + \frac{1}{2}\left(p_1 - b + \frac{\varphi}{q}\right) - c_1\right]q - \frac{1}{2}\varphi \geq 0$. In Stage 1, the equilibrium contract set by the buyer and accepted by the seller is thus as follows: $p_1^* = c_1$ and $q^* = q^+$. In Stage 2, when the unitary cost of production decreases, the equilibrium counteroffer of the seller is $p_2^* = c_1 - b + \frac{\varphi}{q^+}$ which is accepted by the buyer without arbitration. When the unitary cost of production increases, the equilibrium counteroffer of the seller is any price greater than $c_1 + b + \frac{\varphi}{q^+}$ which is rejected by the buyer, thus triggering arbitration. In equilibrium, we thus have that: $p_f^* = c_1 + b$ if the unitary cost increases in Stage 2, and $p_f^* = c_1 - b + \frac{\varphi}{q^+}$ if it decreases.

In equilibrium, all the surplus of the transaction is obtained by the buyer. However, this prediction relies on the absence of fairness concerns which have been shown to be prevalent in bargaining games (Roth, 1993; Roth, 1995; De Dreu and Carnevale, 2005; Smith, 2007; Güth and Kocher, 2014). In ultimatum games, the proposer of the contract leaves on average around 40 % of the surplus to the other party. We would thus naturally expect that the price of the contract in Stage 1 would be strictly greater than c_1. Importantly, we predict that disputes will occur, which is a necessary step in the use of the CDRG as a tool to study contractual dispute resolution. We summarize our main predictions in Hypothesis 1, which are based on the truthful equilibrium.

4. Hypotheses

In this section we use the CDRG presented in the previous section to derive the hypotheses we will test in our real-effort experiment. The first hypothesis is derived directly from the theoretical properties of the CDRG.

Hypothesis 1. (CDRG)

i) *Parties will agree on a contract that stipulates a price that is at least as high as the expected cost of production and a quantity that equals the maximum capacity of the seller.*
ii) *Sellers will make counteroffers that are above (below) the original price when the unitary cost increases (decreases).*
iii) *Disputes will occur when the cost of production increases but not when it decreases.*
iv) *Final prices will be higher when the cost of production increases than when it decreases.*
v) *The buyer will obtain a larger share of the surplus of the transaction than the seller.*

4.1. On the role of information in arbitration

We have thus far assumed that the conflict resolution mechanism was perfectly accurate. However, the accuracy of the information available to the arbitrator is a key dimension of the efficiency of contractual dispute resolutions. Indeed, by accessing more precise information, the arbitrator will be able to implement a contract in which the cost of production reflects its updated value. In the absence of such information, the seller would incur the additional risk of a surge in production costs that would slash profits.

In our model, we can study the accuracy of arbitration by introducing a parameter (π) which denotes the probability that an arbitrator will successfully verify the cost of effort if solicited. The solution of the CDRG presented above assumed $\pi = 1$ (perfect accuracy). Solving the CDRG with $\pi < 1$ is similar to the case of $\pi = 1$ with the exception that counteroffer prices of sellers in Stage 2 when the unitary cost of production increases is such that $p_2 > p_1 + \pi b + \frac{\varphi}{q}$, and $p_2 = p_1 - \pi b + \frac{\varphi}{q}$ if it decreases. Importantly, the final price will respond less to the new cost conditions when π is low because: $E\left[p_f^*\right] = \pi(c_1 + b) + (1 - \pi)c_1$ if the unitary cost increases in Stage 2, and $E\left[p_f^*\right] = c_1 - \pi b + \frac{\varphi}{q^+}$ if it decreases. The difference in final prices between the case in which the unitary cost increases and the case in which it decreases will thus shrink as π decreases (Hypothesis 2*iii*). This implies that the variance of the seller's profits will increase when π is low (Hypothesis 2*iv*).[14] By contrast, the variance of the buyer's profits will decrease when π is low as the final price

[13] In our experimental setup, we have $b = \varphi$ so we can predict that the counteroffer price will be lower than the original price if the cost of production decreases (see Hypothesis 1*ii*).

[14] More specifically, the variance of the earnings (per unit of production) of the seller is given by $V[\Pi_S] = \frac{1}{2}\left[\pi b^2 + \left(c_1 - \pi b + \frac{\varphi}{q^+}\right)^2\right]$ which decreases in π given a wide range of parameters, including the ones ($b = \varphi = 10$) used in our experimental setup.

tends to react less to new cost conditions.[15] Thus, if we drop the risk neutrality assumption, we should expect that the risk-averse seller will require a higher price in Stage 1 when π is low to account for the increased variance in earnings (Hypothesis 2*ii*). This added risk premium on the seller side tends to reduce the profitability of the transaction as some of the gains from exchange must be dedicated to the compensation of the seller for the risk incurred. In the extreme case in which π is close to zero, the final price is approximately equal to the price in Stage 1 regardless of cost conditions. In that case, the whole risk associated with the transaction would be incurred by the seller. When π is large, a truthtelling equilibrium exists that allows parties to share the risk associated with the transaction more effectively than when π is low. As a result, a high value of π will facilitate transactions and increase the gains from exchange associated with the transaction.[16]

In sum, we expect parties to be less likely to reach an agreement when π is low (Hypothesis 2*i*), thus decreasing overall revenues (Hypothesis 2*v*). Interestingly, we do not expect the accuracy of the arbitration mechanism (π) to impact the frequency of disputes. It follows that access to more accurate information will promote transaction gains while possibly maintaining dispute resolution costs at a high level. We summarize these predictions in Hypothesis 2.

Hypothesis 2. (Accuracy of the arbitrator)

i) *Parties will be less likely to agree on a contract when π is low.*
ii) *Parties will sign contracts involving higher prices when π is low.*
iii) *The decrease (increase) in final prices compared to original prices when the unitary cost decreases (increases) will be less pronounced when π is low.*
iv) *Sellers' profits will be more volatile when π is low.*
v) *Overall revenues will be lower when π is low.*

4.2. On the role of incentives and fairness in arbitration

In our model, the arbitrator is an automated device that, when possible, adjusts the price of the contract to the updated cost information. This led us to keep aside the study of the behavior of arbitrators in resolving disputes. Even though algorithms are expected to play an increasing role in the legal system (Kleinberg et al., 2018), arbitrators are still overwhelmingly human and will thus need to be incentivized for their task.

Compared to automated arbitration that systematically updates the price of the contract based on available cost information, human arbitrators might not always do so. Furthermore, human arbitrators might be guided by fairness and efficiency concerns such as equalizing the allocation of the gains from exchange across parties (e.g., Ouchi, 1980; Bazerman, 1985; Sitkin and Roth, 1993; Bigley and Pearce, 1998; Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Husted and Folger, 2004; Engelmann and Strobel, 2004). In field settings where arbitrators compete, they may also equalize earnings to avoid being perceived as biased and to remain selectable for future disputes (see Ashenfelter and Bloom, 1984; Ashenfelter, 1987). In our framework, we set aside arbitrators' competition and reputational concerns so that any observed attempt to equalize earnings can be more directly attributed to fairness concerns. We expect these fairness motives to be observed in both the fixed-fee treatment and the aligned-incentives treatment. This argument leads to our Hypothesis 3*i*.

In our setup, the seller might fail to deliver the contractual quantity after the arbitration stage. Indeed, although sellers face a penalty for not delivering the agreed-upon quantity, such behavior might be observed if sellers felt they had not been fairly treated during the arbitration stage. This type of costly retaliation has been observed in numerous experiments in which one can punish other players at a personal cost (e.g., Fehr and Gächter, 2000; Henrich et al., 2006; Gächter et al., 2008; Hart and Moore, 2008; Molenmaker et al., 2014).[17] Furthermore, the arbitrator can also try to foster positive reciprocity so that the seller goes beyond the stated contract and delivers additional products in the production stage (e.g., Esser and Komorita, 1975; Berg et al., 1995; McCabe, Rassenti and Smith, 1996; Fehr et al., 1997; Fehr et al., 1998; Fehr and Gächter, 1998; Diekmann, 2004, Gächter et al., 2025). This will increase the gains from exchange associated with the transaction, thus benefiting arbitrators whose incentives are aligned with the value of the transaction. In our setup, this would be the case if arbitrators are paid a share s of the total value, $(v - c_2)q$. A crucial difference between arbitrators who are paid a fixed fee and those whose incentives are aligned with the transaction value is that the latter will try to avoid costly retaliation and foster positive reciprocity from the seller (Hypothesis 3*ii*). To foster positive reciprocity and to avoid negative reciprocity, an arbitrator with aligned incentives will implement final prices which are generally more favorable to the seller compared to a fixed-fee arbitrator (Hypothesis 3*iii*). In our setup, this can be introduced by considering that the arbitrator will choose

[15] The variance of the earnings (per unit of production) of the buyer will increase in the variance of the final price, which increases in π whenever $b(1 + 2\pi) - 2\frac{\varphi}{q^+} \geq 0$. Given the parameters of our experimental setup, this holds for any π for $q^+ \geq 2$. This condition is satisfied in our experiment where the contractual quantity is at least greater than 2 in 99.32 % of the cases.

[16] We do not attempt to characterize the efficient risk-sharing equilibrium as this is not central to our main point. This strategy would depend on a number of parameters including the risk attitudes of the buyer and the seller.

[17] Alternatively, Anbarcı et al. (2018) show that sellers might rationally disobey a recommendation from the arbitrator that would produce a very asymmetric payoff distribution giving 10 % or less to one of the parties. However, given our experimental design, arbitrators' decisions are unlikely to induce highly unequal distributions. Indeed, only 6.96 % of the arbitration decisions assigned 10 % or less to one of the parties.

the final price as follows: $p_{f,\gamma} = p_1 + (c_2 - c_1) + \gamma$, where $\gamma > 0$ captures the favorable treatment of the seller by the arbitrator. It follows that counteroffers in Stage 2 will also increase by γ.

More specifically, arbitrators might trigger positive reciprocity and avoid negative reciprocity by choosing a final price that is at least as high as the original price of the contract. Indeed, the original price might serve as a reference point for the seller under (above) which negative (positive) reciprocity might be triggered (Akerlof, 1982; Falk et al., 2006; Hart and Moore, 2008; Fehr et al., 2009, 2011). Thus, in a case in which the cost of production decreases, the arbitrator might be reluctant to lower the price, thus setting $\gamma \geq c_1 - c_2$ (Hypothesis 3*iv*). This behavior of the arbitrator will also lead to an increase in the seller's share of the surplus that will lead to a more equal sharing of profits between parties. This mechanism is likely to be more prevalent when the human arbitrator's incentives are aligned because, in that case, arbitrators would increase their revenues by fostering positive reciprocity while avoiding negative reciprocity (Hypothesis 3*v*). Because transactions will be more likely to be completed and retaliation attempts will be less likely, overall revenues will be higher under aligned incentives (Hypothesis 3*vi*).

Hypothesis 3. (Incentives and fairness)

i) *Human arbitrators will be driven by fairness concerns, thus not automatically adjusting final prices according to costs.*
ii) *Sellers will be more likely to produce beyond the contractual quantity and will be less likely to fail to complete the contract when arbitrators' incentives are aligned.*
iii) *Human arbitrators will set prices that are more favorable to the seller when incentives are aligned.*
iv) *Human arbitrators will be less likely to set prices that are below the original prices when incentives are aligned.*
v) *The seller's share of the surplus of the transaction will increase when arbitrators' incentives are aligned.*
vi) *Overall revenues will be higher when arbitrators' incentives are aligned.*

To test these hypotheses, we design a new experimental paradigm based on the CDRG. This laboratory experiment will allow to study in detail the sequence of decisions highlighted above.

5. The car assembly real-effort task (CART)

Our novel real-effort task (available at https://osf.io/tgp35/) simulates a buyer-seller relationship in which a buyer offers a contract to a seller for producing a fictitious good (a 'car'). This setup aims at capturing the main features of a transactional relationship between a buyer and a seller of cars. The production of the fictitious cars involves a real-effort task (see Corgnet et al., 2015; Gächter et al., 2016) where the seller assembles car parts into their correct positions (see Fig. 2). The seller selects each part by clicking on it (see top panel in Fig. 2) and place them with a double-click (see bottom panel) following a specific pattern (see top-left picture). Incorrectly placed parts can be removed by double-clicking on them, after which a new identical piece is provided to complete the car. Each time a seller correctly ensembles all the parts, one unit is produced, initiating the next car. This task allows for the implementation of a monetary cost per car produced, as well as a unit cost for each puzzle piece used and a cost for each piece that is incorrectly placed and subsequently removed.

In our setup, sellers had 60 s to produce the number of units stated in the contract, thus establishing a limit to the maximum quantity that could be produced (q^+). The value of each car produced was 100 ECUs and the production cost for each car was fixed and known by the seller before starting the task. Depending on the random cost shock, the unitary cost of the car could be 30, 40, 50, 60, or 70 (all with equal chances). No additional costs were set for using or removing pieces.

Our intention was to use a framing that is inspired by a natural setting, as is typically done in social psychology experiments in the conflict literature (De Dreu and Carnevale, 2005). The experiment was incentivized following the induced-valuation techniques which define economic experiments (e.g., Smith, 1976; Ariely and Norton, 2007; Croson et al., 2007). The seller thus incurred an actual monetary cost for putting up a car using a puzzle task while the buyer obtained a monetary value for each car being produced.

6. Overview of the studies and common procedural details

We conducted a total of four treatments which are divided into two studies. Study 1, which consists of the first two treatments, allowed us to test the first two hypotheses related to the presence of opportunistic behavior in our dispute resolution game and to the relevance of information accuracy in dispute resolution. In Study 2, we extended our dispute resolution experiment with two additional treatments to test Hypothesis 3. Unlike Study 1, the buyer and the seller engaged in a repeated relationship. Depending on the treatment, the incentives of the dispute resolution mechanism were either aligned to transacting parties' profits or not. In the aligned-incentives treatment, the arbitrator was paid a share of the gains from exchange materialized by the two parties whereas in the fixed-fee treatment the arbitrator earned a fixed fee for each dispute.

The experiments for both studies were conducted at the CeDEx lab (University of Nottingham) and were approved by the relevant research ethics committee. Detailed instructions are available at OSF: https://osf.io/tgp35/. Custom Visual Basic software programmed by the authors was used for the experiments, which lasted for 1.5 h. Average payments were 12.97 British Pounds ($16.21) in Study 1 and 13.52 British Pounds ($16.90) in Study 2. A total of 300 students participated in the experiments (Study 1: $N = 160$, 60.63 % female, Age $M = 24.46$ SD $= 4.60$; Study 2: $N = 140$, 55.07 % female, Age $M = 24.46$ SD $= 4.54$), recruited via ORSEE (Greiner, 2015).

We used university students instead of a population of managers because our aim was to test an abstract theory and uncover general

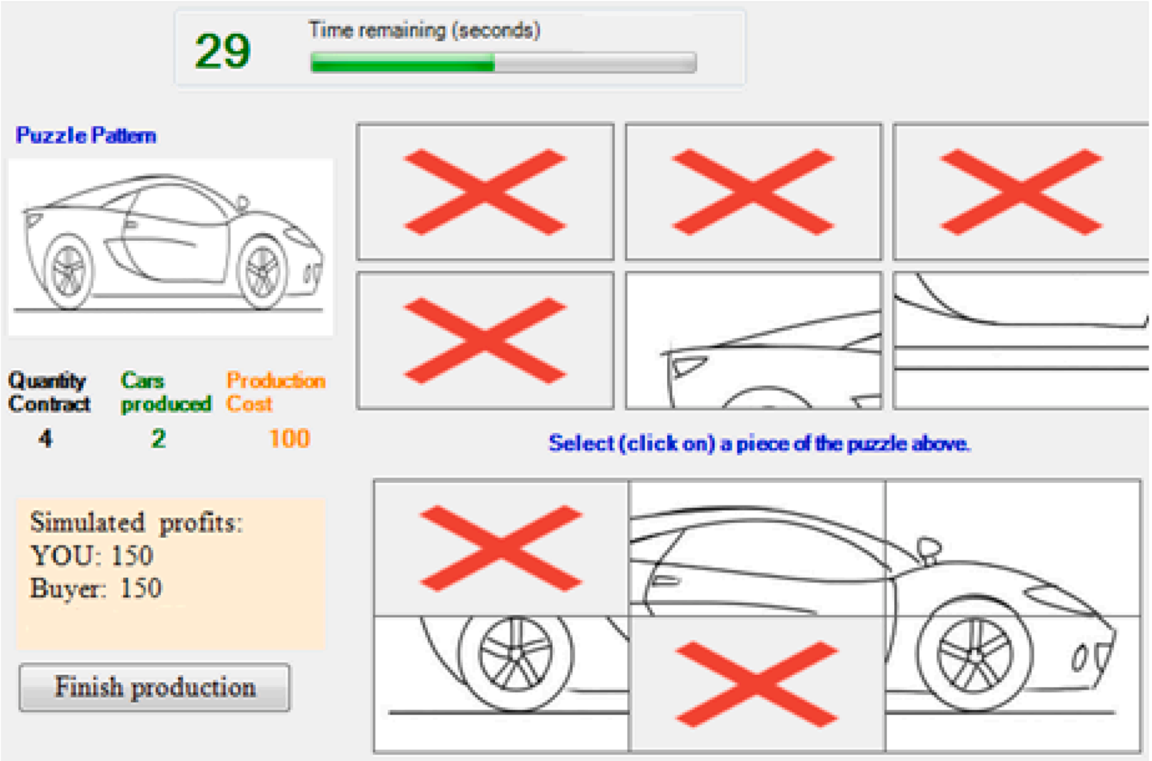

Fig. 2. The car assembly real-effort task (CART).

rules of behavior (see Gächter, 2010; Biketine et al., 2018) rather than study specific managerial practices. Recent experimental works have shown little differences in behavior between actual managers and university students in experimental setups similar to ours (see Harmon et al., 2015; Fréchette, 2015, 2016 for reviews). But it is interesting to note that managers may react to contextual cues differently than university students (Cooper et al., 1999). This might be the case because recognizing a familiar situation might prompt managers to apply strategies that have been successful in their daily work (Rand et al., 2014). Because we are not interested in understanding actual managerial routines and context-dependent strategies, but, guided by relevant theory, in uncovering general patterns of behavior, we opted for conducting experiments with university students.

7. Study 1: the role of information accuracy for dispute resolution

The first study allows us to test the basic implications of our dispute resolution paradigm regarding the existence of opportunistic behavior and disputes (see Hypothesis 1). This first study is thus key to validate our experimental setup. In this study, we conduct two treatments in a between-subject design that vary the accuracy of the information available to the dispute resolution mechanism so as to be able to test Hypothesis 2.

7.1. Method

7.1.1. Participants

Participants were randomly assigned to one of two treatments so that we had a total of 40 pairs of buyers and sellers for each treatment in each of the 15 periods of the experiment. This gave us a total of 600 data points per treatment. Ex ante power calculations were based on related studies (see e.g., Brown et al., 2004) with the aim of achieving a statistical power of 80 % to detect a 10 % difference in mean production levels across treatments using a 5 % significance level. Ex post calculations indicate a power of 85.45 %.

7.1.2. Design

Participants were assigned the role of a buyer or a seller at the beginning of the experiment and maintained their role throughout the experiment. The experiment consisted of 15 periods, preceded by 2 practice periods. At the beginning of each period, a buyer was randomly assigned to a seller in the session. Each session had between 20 and 30 participants. No information was communicated to the parties about plays in previous periods. Participants received an endowment of 100 experimental currency units (ECUs, henceforth) at the beginning of each period, with an exchange rate of 1 British Pound ($1.25 at the time of the study) for 300 ECUs.

Each period consisted of four phases which are referred to as: contract negotiation, renegotiation, dispute resolution, and production. These four phases are summarized in Fig. 1.

In the contract negotiation phase (Phase 1), the buyer could propose a contract to the seller by stating an invoice price for a given quantity of goods (‘cars’) to be produced by the seller. The value of the car for the buyer was 100 ECUs whereas the sellers incurred a cost per car produced that was either equal to 30, 40, 50, 60, or 70 with equal chances. However, this cost was known only after the contract of Phase 1 had been signed. The buyer could continue making offers during this contract negotiation phase until the seller accepted the deal. If no offers were accepted by the end of the 2-min contract negotiation phase, then no transaction was completed for that period. In that case, both parties kept their 100 ECUs endowment.

If an offer was accepted, then the cost of production was privately revealed to the seller who could then make a counteroffer invoice price for the quantity that (s)he agreed upon in Phase 1. The buyer would then decide whether to accept or reject the seller’s counteroffer without being able to observe the actual cost of production. If the seller made a counteroffer price which was lower than the original contracting price, the offer was automatically accepted.[18] In case the counteroffer was accepted, the game moved directly to the production phase (Phase 4). In case of rejection, the game moved to the dispute resolution phase (Phase 3).

Dispute resolution was automated to abstract away from human idiosyncrasies in the evaluation of each case. We conducted two treatments, one in which the dispute resolution mechanism always observed the true cost of production of the seller (the accurate treatment) and one in which the true cost of production was only observed in 20 % of the cases (the inaccurate treatment). In case the cost of production was observed, the automated dispute resolution mechanism adjusted the invoice price negotiated in Phase 1 so as to reflect the actual cost. The new invoice price would thus equal the contract price in Phase 1 plus the difference between the actual cost of production and the expected cost of production (50 ECUs) times the number of items to be produced. In case the cost of production was not observed, the automated dispute resolution mechanism maintained the Phase 1 contract.[19] The price determined by the arbitration mechanism was final and irrevocable, in the spirit of an arbitration procedure. In all the cases, initiating a dispute resolution entailed a fixed cost of 10 ECUs to both buyer and seller.

In the production phase, the seller had to produce the quantity stated in the contract. If the seller produced less than the quantity stated in the relevant contract, then a penalty of 80 ECUs was paid for each missing unit. The seller could produce more units than stated in the contract. Production took place using CART.

At the end of the production phase, both parties could see their earnings for the period. If the dispute resolution mechanism had observed the seller’s cost, then it was also shown to the buyer. Participants could also see their own history of contracts, final prices, units produced, and earnings.

At the beginning of each experimental session and before reading the instructions, participants were asked to solve puzzles (assembling cars using CART) for a 1-min period. The task was identical to the production task used in the main experiment. For each unit produced, participants earned 5 pence (6.25 cents). This task helped us in two ways. First, we obtained a direct measure of sellers’ ability on the task. Second, it allowed both participants to gauge the difficulty of completing the task, thus helping them to negotiate a contract that stated a feasible number of units. This learning was especially important for participants that were assigned the role of buyers because it was their only opportunity to complete the task.

7.1.3. Variables

Task ability is defined as the number of puzzles solved in the 1-min ability task for the participant assigned to the role of seller ($M = 3.58$, SD = 2.02). This can be used as an estimate of a seller’s maximum capacity level in our model (q^+).

% Contracts signed is the percentage of times a seller accepted the offer proposed by a buyer.

Price is defined as the value of the invoice divided by the number of units requested as agreed upon in the original contract.

Final price is the price that applies in the production phase after counteroffers might have been extended and disputes might have taken place, divided by the number of units requested as agreed upon in the original contract.

% Disputes is the percentage of times a counteroffer requires the intervention of the dispute resolution mechanism.

Buyer’s profits are calculated as follows: Initial endowment (100) + (100 - *Final price*) × Quantity produced + Production penalties paid by the seller - Dispute resolution fees.

Seller’s profits are calculated as follows: Initial endowment (100) + (Invoice price - Final cost) × Quantity produced - Production penalties paid to the buyer - Dispute resolution fees.

Overall revenues are calculated as the number of units produced multiplied by the value of the product for the buyer (100). Because prices and production penalties represent internal transfers between buyers and sellers, they do not affect group profits. Unlike profits, revenues do not incorporate production costs, thus facilitating comparisons across periods and treatments. Overall revenues are always positive because costs are always less than 100.

Buyer’s surplus share of the transaction value is the ratio of the profit of the buyer over the sum of the buyer’s and seller’s profits. The *seller’s surplus share* is one minus the *buyer’s surplus share*.

[18] Letting buyers decide whether to accept the improved offer could be theoretically interesting. However, our design choice was guided by ecological validity concerns (Orne, 2017), and the observation that in an actual transaction the buyer who is offered an improvement in the terms of the contract will typically not be able to reject it.

[19] We chose this simple rule because it uses the original contracting price—agreed upon by the buyer and seller—as a reference point, consistent with previous research suggesting that contractual terms often serve as natural reference points (Hart and Moore, 2008; Fehr et al., 2011). We acknowledge that other rules could have been used, such as equalizing the sharing of surplus across parties. Investigating these alternatives motivated us to introduce human arbitrators in Study 2.

7.2. Results

Table 1 shows the main characteristics of the contracts and counteroffers. We start by testing Hypothesis 1 pooling the data for the accurate and inaccurate treatments. We reporting statistical tests to compare variables between treatments. In Appendix S1, we confirm our results by conducting regression analyses controlling for task ability. We also confirm our findings in the case in which we use the last five periods of the experiment instead of all periods. Given the dynamic structure of our design, we also report panel data regressions which account for the fact that we observe repeated decisions for each buyer and seller.

In line with Hypothesis 1*i*, parties agree on a contract in most instances (80.92 % overall) with an average price ($M = 68.09$, SD = 12.80) which is higher than the expected cost of production (50) ($t(970) = 44.02, p < 0.001$; Cohen's $d = 1.413$). As predicted, the contract quantity in the first period ($M = 4.29$, SD = 1.17) reaches and even surpasses sellers' task ability ($M = 3.66$, SD = 2.11) ($t(62) = 2.40, p = 0.0192$; Cohen's $d = 0.433$). The median value of the contract quantity in the first period (4.00) is equal to median sellers' ability levels. Overall, contract quantity surpasses average sellers' ability measured at the start of the experiment by 31.69 % ($t(970) = 15.28, p < 0.001$; Cohen's $d = 0.676$) which is consistent with the magnitude of learning effects commonly observed in real-effort tasks (e.g., Charness and Campbell, 1988; Corgnet et al., 2015; Gächter et al., 2016).

In line with Hypothesis 1*ii*, counteroffer prices are above the original price ($M = 77.40$, SD = 32.22) when the cost of production increases ($t(389) = 5.69, p < 0.001$; Cohen's $d = 0.387$). Counteroffer prices are below the original price ($M = 52.71$, SD = 37.29) when the cost of production decreases ($t(399) = 7.82, p < 0.001$; Cohen's $d = 0.577$) (see also Table S1.1 in Appendix S1). In our setup, we expect the seller to propose a counteroffer price equal to $p_2 = p_1 - b + \frac{\varphi}{q}$ that will almost fully match the decrease in the cost of production (b) because $\frac{\varphi}{q} = 2.12$. Indeed, counteroffer prices decreased contract prices by an average amount (16.03) that was similar to the average decrease in costs (14.93) ($t(399) = 0.53, p = 0.593$) (see Table 1). Unlike in the design of Mitzkewitz and Nagel (1993), the informed party, here the seller, had limited room to maintain high prices when facing positive news about the total value of the transaction.

In line with Hypothesis 1*iii*, disputes are more likely when the cost of production increases ($M = 70.51$ %, SD = 45.66 %) than when it decreases ($M = 30.25$ %, SD = 45.99 %) ($Z = 11.31, p < 0.001$; Cohen's $d = 0.879$) (see also Table S1.2 in Appendix S1). We note that, unlike Hypothesis 1*iii*, disputes also occur in the case in which the cost of production decreases. This might be due to the fact that,

Table 1
Study 1. Contract and counteroffer descriptive statistics.

Average <Median> (Std Dev) [n/N]		Stage 1 Contracts				Stages 2 & 3			
Accuracy of arbitrator	Unitary cost	% contracts signed	Price	Quantity {first period}	Task ability	Counteroffer price^{+}	% disputes	Final price	Buyer's share of surplus
Low (π = 20 %)	Decreases	78.67 % (37.45 %) [472/600]	69.27 <70.00> (12.14)	4.72 {4.17} <5.00> {4.00} (1.16) {1.23}	3.67 <4.00> (2.18)	54.13 <70.00> (36.94)	29.80 % (45.85 %) [59/198]	68.15 <71.12> (17.29)	58.39 % <55.56 %> (15.53 %)
	Increases					77.32 <83.33> (32.53)	73.37 % (44.32 %) [135/184]	70.29 <72.00> (18.52)	59.69 % <55.68 %> (16.25 %)
	All costs	–				65.55 <75.00> (35.86)	49.58 % (50.05 %) [341/472]	69.50 <72.00> (16.68)	58.55 % <55.56 %> (15.12 %)
High (π = 100 %)	Decreases	83.17 % (41.00 %) [499/600]	66.96 <67.00> (13.31)	4.91 {4.39} <5.00> {4.00} (1.21) {1.12}	3.65 <4.00> (2.05)	51.60 <66.67> (37.28)	30.69 % (46.24 %) [62/202]	63.72 <66.67> (15.94)	60.93 % <60.00 %> (13.90 %)
	Increases					77.55 <83.33> (31.83)	67.96 % (46.78 %) [140/206]	77.85 <80.00> (15.29)	56.12 % <51.93 %> (16.84 %)
	All costs	–				64.41 <75.00> (37.23)	48.10 % (50.00 %) [240/499]	70.36 <72.00> (16.75)	58.71 % <55.56 %> (15.48 %)

Buyer's share of surplus is reported for the case in a contract is signed.

Table 2
Study 2. Types of counteroffer according to unitary cost descriptive statistics.

Average <Median> (Std Dev) [n/N]	Arbitrator's final price[a]				
Treatment	Unitary cost	Cost adjustment	Counteroffer final price	Egalitarian price	Negative price change
Fixed-fee arbitrator	Decreases	28.57 % (46.00 %) [8/28]	10.71 % (31.50 %) [3/28]	14.29 % (35.63 %) [4/28]	28.57 % (46.00 %) [8/28]
	Increases	80.88 % (39.62 %) [55/68]	20.59 % (40.74 %) [14/68]	19.12 % (39.62 %) [13/68]	14.70 % (35.68 %) [4/28]
	All costs	51.22 % (50.19 %) [63/123]	19.51 % (39.79 %) [24/123]	19.51 % (39.79 %) [24/123]	17.07 % (37.78 %) [21/123]
Aligned-incentives arbitrator	Decreases	6.45 % (24.97 %) [2/31]	25.81 % (44.48 %) [8/31]	3.23 % (28.09 %) [1/31]	6.45 % (24.97 %) [2/31]
	Increases	82.86 % (37.96 %) [58/70]	30.00 % (46.16 %) [21/70]	18.57 % (39.17 %) [13/70]	7.14 % (25.94 %) [5/70]
	All costs	49.59 % (50.21 %) [60/121]	30.58 % (46.27 %) [37/121]	19.01 % (39.40 %) [23/121]	6.61 % (24.95 %) [8/121]

[a] We consider the case in which arbitrators made a decision, which is when there was a dispute and they observed the final cost of production.

in addition to the truthful equilibrium used to derive the hypotheses, a truthless equilibrium exists in which disputes occur regardless of the final cost of production. Overall disputes occurred in 48.82 % of the cases, which is consistent with a theoretical prediction of 50 % ($Z = 0.74$, $p = 0.4605$; Cohen's $d = 0.024$).

In line with Hypothesis 1*iv*, final prices are higher when the cost of production increases ($M = 74.28$, SD $= 17.29$) than when it decreases ($M = 65.91$, SD $= 16.75$) ($t(788) = 6.913$, $p < 0.001$; Cohen's $d = 0.492$) (see also Table S1.3 in Appendix S1).

In line with Hypothesis 1*v*, the buyer share of the surplus ($M = 58.38$ %, SD $= 16.88$ %) is higher than the seller's share ($t(970) = 15.47$, $p < 0.001$; Cohen's $d = 0.496$).

In line with Hypothesis 2*i*, we observe that buyers and sellers were more likely to sign a contract in the accurate treatment (83.78 % of the times) than in the inaccurate treatment (78.67 %) ($Z = 11.31$, $p < 0.001$; Cohen's $d = 0.115$) (see also Table S1.4 in Appendix S1).

In line with Hypothesis 2*ii*, contracts stated lower prices per unit in the accurate treatment ($M = 66.96$, SD $= 13.31$) than in the inaccurate treatment ($M = 69.27$, SD $= 12.14$; $t(969) = 2.82$, $p = 0.0049$, Cohen's $d = 0.181$) (see also Table S1.5 in Appendix S1). After the contract was signed, sellers learned about the cost of production and had the option to propose a counteroffer price. The majority of the sellers (80.43 %) indeed submitted a counteroffer. The counteroffer price was similar across treatments ($t(969) = 0.0004$, $p = 0.9997$).

In line with Hypothesis 2*iii*, the increase in price between the final and original contracts, due to an increase in costs, was more pronounced in the accurate ($M = 10.51$, SD $= 0.61$) compared to the inaccurate treatment ($M = 1.77$, SD $= 1.17$) ($t(388) = 6.85$, $p < 0.001$, Cohen's $d = 0.695$) (see also Table S1.6 in Appendix S1). Similarly, the decrease in price due to a decrease in costs was more pronounced in the accurate ($M = -3.86$, SD $= 10.12$) compared to the inaccurate treatment ($M = -1.77$, SD $= 10.95$) ($t(398) = 1.98$, $p = 0.0482$, Cohen's $d = 0.198$).

In line with Hypothesis 2*iv*, the standard deviation of sellers' profits across the 15 periods was higher in the inaccurate treatment (93.46) than in the accurate one (83.94) ($F(471{,}498) = 1.24$, $p = 0.0182$). No differences were observed in the standard deviation of buyers' profits between the inaccurate treatment (85.47) and the accurate one (88.78) ($F(471{,}498) = 1.08$, $p = 0.4035$).

Finally, overall revenues were higher in the accurate treatment ($M = 397.83$, SD $= 211.47$) than in the inaccurate one ($M = 361.50$, SD $= 218.28$) in line with Hypothesis 2*v* ($t(1198) = 2.93$, $p = 0.0035$; Cohen's $d = 0.169$) (see also Table S1.7 in Appendix S1).

7.3. Discussion

Study 1 validated our experimental paradigm while also showing the importance of information accuracy in dispute resolution. Study 1 assumes the benchmark case of a dispute resolution mechanism which automatically adjusts contracts whenever new cost information is available. We need to extend our setup to allow for human arbitration in order to test Hypothesis 3. In essence, the study of incentives is the study of human behavior, and we need to leave the human arbitrator a great degree of freedom in choosing how to resolve a dispute. This is what we do in the design of Study 2.

8. Study 2: dispute resolution with human arbitrators

In Study 2, we extend the setup of Study 1 so that the dispute resolution phase was completed by a human arbitrator. Extending

Study 1 further, we use a partner matching protocol in which a buyer and a seller are matched together at the beginning of the experiment and for the entire duration of the session. Such repeated relationships are commonplace in interfirm transactions (Malhotra and Lumineau, 2011; Lumineau and Oxley, 2012). Using a between-subject design, we conduct two treatments to test the impact of aligning the arbitrator's incentives with the transacting parties. In the fixed-fee treatment, human arbitrators are paid a fixed fee for each case they handle whereas in the aligned-incentives treatment the human arbitrator receive a share of the total earnings of the transacting parties.

8.1. Method

8.1.1. Participants

Participants were randomly assigned to one of two treatments so that we had a total of 10 arbitrators and 30 pairs of buyers and sellers for each treatment in each of the 15 periods of the experiment. This gave us a total of 450 data points per treatment. As for Study 1, ex ante power calculations were based on related studies (see e.g., Brown et al., 2004) with the aim of achieving a statistical power of 80 % to detect a 10 % difference in mean production levels across treatments using a 5 % significance level. Ex post calculations indicate a power of 93.59 %.[20]

8.1.2. Design

To test Hypothesis 3, we modified the design of Study 1 so that the dispute resolution phase was not automated but implemented by a human arbitrator. Arbitrators were chosen randomly at the beginning of the experiment along with buyers and sellers. In each session, we had one arbitrator for three pairs of buyers and sellers. However, a given arbitrator did not necessarily handle the disputes of the same buyers and sellers. In the fixed-fee treatment, arbitrators received 20 ECUs per case they had to handle in addition to an endowment of 100 ECUs each period. In this treatment, arbitrators were assigned to a case at random with the only restriction that they could not handle more than three cases per period. In the aligned-incentives treatment, human arbitrators were also rewarded 20 % of the sum of the earnings of both transacting parties. As in the fixed-fee treatment, arbitrators could not handle more than three cases per period, but they always handled the cases of the same three pairs. This fixed-matching procedure was employed to enhance the ecological validity of our design, reflecting the fact that aligned incentives are typically observed in the context of repeated relationships between parties, such as in disputes involving multiple divisions within the same firm.

Regarding information precision, we considered a dispute resolution mechanism which was moderately accurate with a 70 % chance for the arbitrator to observe the cost of the seller. This was identical for both treatments. In case the cost of the seller was not observed, the arbitrator, as in Study 1, could only implement the original contract.

8.1.3. Variables

Price change is defined as the difference between the final price and the original price.

Cost adjustment is a dummy variable that takes value 1 if *price change* is positive (negative) when the cost of production increases (decreases).

Negative price change is a dummy variable that takes value 1 if an arbitrator sets a price lower than the original contract price.

Counteroffer final price is a dummy variable that takes value 1 if the final price is equal to the counteroffer price.

Egalitarian price is a dummy variable that takes value 1 if the final price is such that the share of the surplus of the buyer equals that of the seller.

8.2. Results

Table 2 shows the main characteristics of the contracts and counteroffers.

In line with Hypothesis 3*i*, we show in Table 3 that, unlike the case of automated arbitration in which final prices adjusted to costs in 100 % of the cases, human arbitrators adjusted the final price to cost information in only 62.44 % of the cases ($Z = 10.60$, $p < 0.001$; Cohen's $d = 1.17$). Furthermore, we do not observe differences between the fixed-fee and aligned-incentives treatments ($Z = 0.90$, $p = 0.3689$; Cohen's $d = 0.128$). As a result, arbitrators updated prices according to costs with the same frequency in the two treatments.

In line with Hypothesis 3*ii*, we find that sellers were more likely to produce above the stated contract quantity ($M = 12.40$ %, SD = 33.09 %) when arbitrators had aligned incentives compared to when they were only paid fixed fees ($M = 4.06$ %, SD = 12.82 %; $Z = 2.37$, $p = 0.0179$; Cohen's $d = 0.306$). However, sellers were only slightly less likely to produce less than contractual quantity ($M = 12.40$ %, SD = 33.09 %) when arbitrators had aligned incentives compared to when they were only paid fixed fees ($M = 14.63$ %, SD = 35.49 %; $Z = 0.51$, $p = 0.6101$; Cohen's $d = 0.065$) (see also Tables S2.1 and S2.2 in Appendix S2). This might not be that surprising given that failing to comply with the contract entailed a large per unit penalty. In addition, this penalty was transferred to the buyer so that punishing the latter was very costly and had a limited impact on the buyer. For each unit the seller failed to produce, the buyer received 80 which is still less than the value of the unit (100).

In line with Hypothesis 3*iii*, arbitrators set final prices which were higher under aligned incentives ($M = 74.28$, SD = 29.71) compared to fixed fees ($M = 69.49$, SD = 18.23; $t(780) = 2.71$, $p = 0.0069$; Cohen's $d = 0.194$) (see also Table S2.3 in Appendix S2).

[20] Accounting for the time dependence of our data, which results from our partner matching protocol, calculations indicate a power of 75.64 %.

Table 3
Study 2. Contract and counteroffer descriptive statistics.

Average <Median> (Std Dev) [n/N]		Stage 1 Contracts				Stages 2 & 3			
Accuracy of arbitrator	Unitary cost	% contracts signed	Price	Quantity {first period}	Task ability	Counteroffer price +	Disputes	Final price	Buyer's share of surplus
Fixed-fee arbitrator	Decreases	85.56 % (35.19 %) [385/450]	63.86 <66.67> (17.55)	4.88 {4.53} <5.00> {5.00} (1.18) {1.35}	2.96 <2.00> (2.32)	54.77 <68.00> (33.41)	23.87 % (42.77 %) [37/155]	67.25 <70.00> (15.76)	57.45 % <55.56 %> (14.26 %)
	Increases					71.24 <80.00> (31.43)	67.81 % (46.88 %) [99/146]	73.61 <75.00> (20.28)	57.62 % <53.33 %> (18.20 %)
	All costs	–				63.86 <66.67> (17.55)	45.18 % (49.83 %) [174/ 385]	69.49 <71.67> (18.23)	57.99 % <54.76 %> (16.39 %)
Aligned-incentives arbitrator	Decreases	88.22 % (32.27 %) [397/450]	66.20 <70.00> (32.38)	5.11 {4.20} <6.00> {4.00} (1.09) {1.38}	2.89 <3.00> (1.83)	62.08 <72.00> (29.70)	24.39 % (43.07 %) [40/164]	71.81 <73.67> (11.47)	53.60 % <52.19 %> (13.43 %)
	Increases					77.98 <83.33> (25.27)	64.60 % (47.97%) [104/ 161]	77.96 <76.67> (44.22)	56.55 % <53.49 %> (17.12 %)
	All costs	–				70.15 <76.67> (27.83)	44.84 % (49.80 %) [178/ 397]	74.28 <75.00> (29.71)	55.11 % <52.00 %> (15.08 %)

In line with Hypothesis 3*iv*, arbitrators were less likely to set final prices that were below original prices under aligned incentives ($M = 6.61$ %, SD = 24.95 %) compared to fixed fees ($M = 17.07$ %, SD = 37.78 %; $Z = 2.52$, $p = 0.0117$; Cohen's $d = 0.326$) (see also Table S2.4 in Appendix S2). Arbitrators were also more likely to set final prices that were equal to the sellers' counteroffers under aligned incentives ($M = 30.58$ %, SD = 46.27 %) compared to fixed fees ($M = 19.51$ %, SD = 39.79 %; $Z = 1.99$, $p = 0.0464$; Cohen's $d = 0.257$). Yet, arbitrators were as likely to set final prices which were egalitarian under aligned incentives ($M = 19.01$ %, SD = 39.40 %) and fixed fees ($M = 19.51$ %, SD = 39.79 %; Z = 0.10, $p = 0.9207$; Cohen's $d = 0.013$).

In line with Hypothesis 3*v*, the seller's share of the surplus of the transaction was higher under aligned incentives ($M = 45.32$ %, SD = 14.50 %) compared to fixed fees ($M = 42.00$ %, SD = 16.39 %; $t(817) = 3.03$, $p = 0.0022$; Cohen's $d = 0.215$) (see also Table S2.5 in Appendix S2).

In Table 3, we also show that, regardless of the incentives of the human arbitrator, the cost adjustment of final prices was more likely when the cost of production went up than when it went down ($Z = 7.18$, $p < 0.001$; Cohen's $d = 2.212$ for the aligned-incentives treatment; $Z = 4.88$, $p < 0.001$; Cohen's $d = 1.259$ for the fixed-fee treatment). This is a major difference with the automated arbitration of Study 1 according to which final prices were always adjusted to updated production costs, regardless of whether they increased or decreased. In the same vein, final prices set by arbitrators were higher in Study 2 ($M = 74.21$, SD = 17.42) than in Study 1 ($M = 69.44$, SD = 19.94; $t(537) = 2.93$, $p = 0.0035$; Cohen's $d = 0.254$). Human arbitrators were also more likely to set final prices which were egalitarian ($M = 19.26$ %, SD = 39.52 %) compared to Study 1 ($M = 10.85$ %, SD = 31.15 %; $Z = 2.75$, $p = 0.0060$; Cohen's $d = 0.025$). The behavior of human arbitrators was thus more favorable to the seller than the automated arbitrators of Study 1. It follows that the surplus of the sellers was higher in Study 2 ($M = 44.27$ %, SD = 16.84 %) compared to Study 1 ($M = 41.62$ %, SD = 16.88 %; $t(1788) = 3.32$, $p < 0.001$; Cohen's $d = 0.157$). This suggests human arbitrators were driven by fairness motives and attempted to limit the differences in the share of surplus between parties.

In line with Hypothesis 3*vi*, overall revenues were higher in the aligned-incentives treatment ($M = 453.78$, SD = 197.75) than in the fixed-fee one ($M = 407.50$, SD = 203.95; $t(898) = 3.48$, $p < 0.001$; Cohen's $d = 0.232$) (see also Table S2.6 in Appendix S2).

8.3. Discussion

Study 2 extended the first study by replacing automated arbitrators by humans thus allowing us to assess the role of arbitrators' incentives on the management of dispute resolution and on the buyer-seller relationship. In particular, the second study allowed us to test whether aligning the incentives of the arbitrator with the transaction value helps foster profitable buyer-seller transactions. We found support for the prediction that aligning incentives improves efficiency. This occurred because arbitrators with aligned incentives implemented arbitration outcomes that were more favorable to sellers so to trigger positive reciprocity and boost production beyond what is specified in the original contract. As a consequence, arbitration also has a positive spillover effect that benefits buyers, thereby increasing total social welfare.

9. General discussion

Our paper is the first to show that the efficiency of dispute resolution mechanisms hinges upon informational and motivational factors. Arbitration mechanisms which have access to extensive information about the case and that provide aligned incentives to arbitrators, tend to foster efficiency.

9.1. Theoretical implications

Building on a novel game-theoretic model, the Contractual Dispute Resolutin Game (CDRG), we show that informational and motivational factors are critical in understanding the efficiency of arbitration mechanisms. In particular, we show that arbitrators with accurate information, by facilitating risk sharing between the parties of the transaction, can promote profitable transactions. This effect adds to previous theoretical works in the dispute resolution literature that have stressed the need to make arbitration costly so as to promote early settlements and avoid disputes (see Dickinson, 2020 for a review). By contrast, our study emphasizes the benefits of arbitration as a fact-finding mechanism, which had long been recognized by practitioners (Park, 2010). In addition, our model is one in which the contract signed is not complete in the sense that sellers could fail to comply with it (at a cost) or decide to go beyond the contract. This feature of the transaction implies that we could study the commitment of the seller to the contract after a dispute had occurred and after an arbitration outcome had been issued. This critical and practically relevant feature of disputes had been left aside in the theoretical and experimental literature on dispute resolution, despite early acknowledgement of its importance (Notz and Starke, 1978). Our study showed that sellers were likely to go beyond the terms of the contract even in case of a dispute. More importantly, this behavior was most likely when the dispute was handled by a human arbitrator whose incentives were aligned with the value of the transaction.

9.2. Methodological contribution

Our paper developed a new experimental platform that could provide fertile common ground for researchers across organizational disciplines who are interested in collecting data on dispute resolution mechanisms. To our knowledge, this is the first experimental setup that incorporates arbitration mechanisms in contractual disputes. Besides, our design is a novel example of a framed real-effort experiment which are popular in the social psychology and organizational behavior literature of dispute resolution (De Dreu and Carnevale, 2005). We combined this framed design with the use of monetary incentives and the absence of deception that are critical features of economic experiments (Bardsley et al., 2010). Yet, our design is still highly stylized so as to allow us to make precise game-theoretic predictions. Following up on the work of Lumineau and Oxley (2012), it might be valuable to extend our approach to study more complex contractual settings. For example, we could consider cases in which certain dimensions of the transaction (such as quality) cannot be contracted upon because they are not verifiable by court (Tirole, 1999). We might also extend our analysis to more complex organizational settings. In particular, we might extend our setup to a case in which the contractual decisions of the two parties are made by organizational members that have potentially conflicting interests, so that there are agency costs in addition to interfirm disputes (Jensen and Meckling, 1976; Eisenhardt, 1989).

9.3. Organizational and societal implications

Our findings put forth that organizations can promote profitable transactions by leveraging two key features of arbitration: accurate information and aligned incentives. At a theoretical level, these dimensions have been identified as critical in the resolution of disputes *within* firms (Alchian and Demsetz, 1972; Rowe, 1987; Goss, 1995; Tadelis and Williamson, 2012). For example, Tadelis and Williamson (2012) refer to the arbitrator within a firm as an interface-coordinator whose incentives are aligned with profits, and Alchian and Demsetz, (1972) emphasize the need for a centralized supervisor (the 'specialist') who collects all relevant information about organizational transactions. In addition to providing empirical evidence for these conjectures, our results highlight that information and incentives are likely to be key for the efficient resolution of disputes *between* firms.

At a practical level, one may wonder whether aligning the incentives of arbitrators, although recommendable, is a feasible enterprise. Although contingent fees that depend on the outcome of the case are common in the legal system, most arbitrators are paid fixed fees (Drahozal, 2006). Contingent fees could indeed be problematic if they threatened arbitrators' impartiality (IBA, 2024). However, the aligned-incentives structure we propose concerns situations in which there are gains from exchange between the parties so that the good completion of the transaction can be beneficial to all parties involved. In this case, our fee structure, which involves giving a share of the value of the completed transaction to the arbitrator, does not compromise the arbitrator's impartiality, as the arbitrator's sole objective is to facilitate the realization of gains from exchange between the parties.[21]

We also note that dispute resolution within firms resembles the situation we have studied in this paper in which an authority who acts as an arbitrator will typically benefit from the good completion of the transaction (Alchian and Demsetz, 1972; Rowe, 1987; Goss, 1995; Tadelis and Williamson, 2012). For example, consider a dispute between the managers of several divisions over transfer pricing, where the transfer pricing manager of the conglomerate firm acts as the internal arbitrator.

[21] Furthermore, this type of contingent fees could reduce the upfront costs associated with arbitration that can often discourage parties from soliciting an arbitrator (Ulmer, 2010; Stipanowich, 2010).

Finally, by reducing uncertainty regarding the outcome of a dispute, the desirable features of arbitration identified in our study are likely to be relevant to any well-functioning legal system that supports economic growth. For example, Djankov et al. (2007) show that private credit develops faster in countries in which more accurate information is available about debtors.

Data & code availability

The software and instructions for CART (the Car Assembly Real-effort Task) are stored at OSF: https://osf.io/tgp35/.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

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