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Cooperative Game Theory: Examining Promise, Trust and Contract Interplay

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Abstract

Purpose – This study aims to examine the interplay between promise, trust, and contract in cooperative game theory under conditions of moral hazard and information asymmetry. It seeks to identify how intrinsic promise-keeping behavior influences agent decisions, utility distribution, and social surplus maximization, with application to public–private contracting contexts.

Methodology – Building on Chen's (2000) framework, the study develops a cooperative game model applied to a case study of a local government–contractor bridge project governed by an incomplete contract. The model stresses a critical value parameter (x) representing the contractor's intrinsic utility from keeping a promise. A numerical simulation is conducted using hypothetical parameters to evaluate how varying x impacts contractor behavior (honest vs. cheating), parties utility, and social surplus.

Findings – The simulation identifies a behavioral tipping point at $x = 6000$, below which opportunistic behavior dominates, reducing social surplus and government utility. When x meets or exceeds this threshold, honest behavior becomes utility-maximizing for the contractor, significantly improving outcomes for both parties.

Originality – The study's novelty lies in simulating the behavioral threshold of the trust parameter (x) within a cooperative game model, quantifying its impact on agent behavior and social surplus under incomplete contracts.

Practical implications – The findings suggest that intrinsic trust mechanisms, such as long-term partnerships, reputation systems, and community accountability, can serve as cost-effective substitutes or complements to formal enforcement in incomplete contracts.

Introduction

The concept of Moral Hazard has been extensively studied in game theory. It is a situation where one party is encouraged to take risks, knowing that another party will bear the consequences of those risks. A classic example of this is the relationship between insurers and the insured. The insurer bears the financial risk if the insured party suffers a loss, but the insured party may be less worried about taking more risks because they are not bearing the full cost of the loss.

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In the business context, moral hazard can manifest in relationships between buyers and sellers, or service providers and clients. The seller or service provider may have an incentive to provide lower quality goods or services, knowing that the buyer or client is not fully informed or cannot easily assess the quality being delivered.

Reputation and trust then play an important role in mitigating moral hazard. Reputation can serve as a signal of quality and can help buyers and clients assess the trustworthiness of the seller or service provider. Trust, on the other hand, can serve as a foundation for building long-term relationships between parties.

This is where the concept of promise, a non-binding commitment, and contract, a binding agreement with enforceable terms, enters the theoretical scene. Contracts aim to align incentives and reduce moral hazard through formal obligations. Yet, some contracts are not complete. In many real-world transactions, not all contingencies can be foreseen or fully specified. Hence, the interplay of promise, trust, and contract forms a rich and nuanced framework for understanding cooperation and value creation under conditions of uncertainty and asymmetry.

This study aims to extend the idea of reputation and trust in understanding the behaviour of two parties in market transactions bound to shape outcomes under conditions of moral hazard and information asymmetry. Building on foundational work such as Chen (2000), we explore theoretical models, practical applications, and emerging trends, including the role of technology in enhancing verifiability and trust. Additionally, we integrate a case study of a local government–contractor relationship in infrastructure development to illustrate how these concepts operate in practice and influence social surplus.

Literature Review

Game theory offers a structured framework for analyzing interactions between players or agents. The offered framework can be distinguished into two broad categories: non-cooperative and cooperative games. Non-cooperative games are executed on the premise that agents would make decisions independently, do not form alliances among parties, as they consider their own interest (Ahmad & Al-Fagih, 2024). Conversely, cooperative game theory main paradigm is about how agents could bond coalitions to mutual objectives. Coalitions and collaborations form a binding agreement that explains how the total gain would be distributed. (Chalkiadakis et al., 2012). Cooperative games paradigm is especially relevant in business contexts where joint ventures, partnerships, or contractual relationships necessitate collaboration and surplus sharing.

In cooperative game theory, the collective benefit that would be portioned over the cooperating agents is often termed as social surplus. Social surplus refers to the total value created by cooperation, typically conceptualized as the sum of the agents' utilities or payoffs (Otaki et al., 2017). However, achieving optimal surplus distribution often hinges on addressing challenges related to moral hazard and information asymmetry.

Moral hazard is an effect that arises when one party in a transaction has the incentive to act in a way that is hidden from the other party and potentially detrimental to them (Dionne, 1982). This often occurs in settings of asymmetric information, where one agent has more or better information than the other.

To mitigate the inefficiencies caused by moral hazard, studies have emphasized the importance of reputation and trust. Reputation has been a feature which represents public measure of an agent (particularly seller or service provider) reliability based on the assessment of the agent historical behaviour and past interactions (Mui & Halberstadt, 2002). Despite the urgency of reputation in bridging ideal outcome transaction among agents, Chen (2000) examines how establishing reputation is not necessarily always the case for optimal outcome to happen.

Chen (2000) provides an example of tipping culture in restaurants in the United States. This phenomenon can be described using the standard economic model with two players moving sequentially. This situation leads to an example of an inefficiency problem under incomplete contract. The waiter will provide a service according to their belief on the amount of the tip that will be given by the customer. Simultaneously, the customer will decide the tip amount based on the service level given.

Nevertheless, Chen (2000) studies how in many other experiences, the situation is not captured exactly the same as earlier example. Instead, a customer tends to leave a good tip even though the service level might not be adequate. This introduces the hypothesis of agent's quality and tendency to keep promise as a product of social convention and norms. This quality has to be matched also with the waiter's attitude to build trust, taking for granted that the customer will behave honestly even when it is not in their monetary interest, hence trustworthiness has led the waiter to provide top quality service.

Back to the insurance example, moral hazard would present because of the nature of unknowingness. Asymmetric information becomes a root of problem for dishonest, opportunistic insured. Knowing that the insurer would not know about their insured health condition, circumstances like adverse selection & moral hazard problem are bound to happen (Xiang & Wang, 2014).

Looking at insurance company case, relying only on promise and trust would be naive considering opportunistic customer would be highly probable to present. This is where the presence of contract is crucial as it creates a system of incentives that encourages both parties to act in a mutually beneficial way and ensures that each party is held accountable for their actions. This helps to protect against fraud, abuse, and other forms of moral hazard and helps to ensure that insurance remains affordable and available to those who need it. Evidence of usefulness of contracts was studied on how to design optimal insurance contracts (Asimit & Boonen, 2018).

Contract is then divided by two types, complete and incomplete contract (Baker & Krawiec, 2006). Complete contracts specify every possible detail and outcome related to a transaction, leaving no room for ambiguity or interpretation. In contrast, incomplete contracts do not specify every possible detail and therefore may be subject to interpretation and negotiation between the parties involved. Chen (2000) discusses how verifiability differs for each type of contract where complete contract means provision of quality being agreed is verifiable, but if the agreed upon quality is higher than what can be verified, then it is incomplete contract.

Describing contracts that way, develops follow-up question about residual right that explains which agent has the right to define whether the quality that goes beyond what can be verified is actually delivered. Following this, Chen (2000) develops two models that account for arrangements that assign the residual right to buyer (denoted as BP, or buyer act as the promisor) and as well as to seller (denoted as SP, or seller act as the promisor) and examines situation where social surplus is maximized.

Research Methods

Model Formulation and Study Case: Cooperative Game of Local Government and Contractor in Bridge Infrastructure Project

Cooperative games between buyer and seller are modelled where a transactional relationship takes place. The study case used here is about a contractor as seller/service provider, and local government as buyer/client in a project where the contractor is hired to build a new bridge for a city. Model formulation will be illustrated for the remaining section of this study and also how it is applied in the context of our case study.

$$q \in \{q_h, q_l\} \\ q_h > q_l \geq 0 \tag{1}$$

In building a bridge, the quality of the bridge is measured by the materials used, design, and structural integrity. The quality here is measured in real numbers suppose q_h represent the highest quality that is 10, and q_l is a measure of lowest quality which is 6. q tells the actual quality of the built bridge.

$$C(q) = cq \\ V(q) = vq \\ v > c > 0 \tag{2}$$

$C(q)$ here represents the contractor cost and expense in building the bridge, and $V(q)$ serves as the value of the service to local government. In later case, the actual quality q is observed by both parties after the project is done. A term called recording device is used to record the actual quality, making it verifiable at the end. Recording device arrangement is generated for the provision of this tool, denoted as $T\ (q, q_t)$.

$$T\ (q, q_t) = \begin{cases} \infty\ ,\ if\ q = q_l, q_t = q_h \\ T\ ,\ if\ q = q_t = q_h \\ 0\ ,\ if \begin{cases} q = q_t = q_l \quad or \\ q = q_h\ and\ q_t = q_l \end{cases} \end{cases} \tag{3}$$

$T\ (q, q_t)$ is the cost of installing recording device with q_t being the minimum quality value to make the assessment of quality verifiable. In our case, the recording device could be hiring third-party assessor that would collect documentation and assessment of material used, design and structural integrity.

Suppose that actual q is 6 ($q = q_l$), there will be no need to hire an assessor because it will be obvious that an assessment cannot be conducted if $q_t = q_h$. By assigning value of infinity, the model illustrates the impossibility of initiating recording device. And if actual q is 10, the use of assessor is effective as he can confirm that the quality of the bridge is indeed matching the requirement of q_t which also happen to be the highest quality for the bridge (q_h). Furthermore, if the government only requires the bridge is built in bare minimum standard, then recording device will be 0 denoting it will not be needed as it does not matter anymore whether the contractor delivers even highest quality bridge.

$$W(q^*, q_t^*) = vq^* - cq^* - T(q^*, q_t^*) \tag{4}$$

Formula above explains how much the social surplus is generated from the bridge project transaction, here denoted as $W(q^*, q_t^*)$. We have q^* as qualities that is delivered, and q_t^* being quality that is recorded.

In the case of building a bridge, it is difficult to fully specify or verify the quality of the service provided, as there may be unforeseen issues that arise during construction, such as inclement weather or unforeseen geological features. Additionally, there may be ongoing negotiations and adjustments required throughout the project to ensure the quality of the service provided. Therefore, incomplete contract would be more realistic to be made.

Moreover, assigning the residual right to the service provider is more suitable in the case of building a bridge, as it allows for flexibility and negotiation between the parties involved. The service provider, in this case, the contractor, is better positioned to make the necessary adjustments and define the quality of the service beyond what can be verified ($q_t < q$). Additionally, the contractor has the necessary expertise and resources to deliver the service, making it more efficient to assign the residual right to them.

Building a bridge is also considered as an SP because it requires a high level of expertise and specialized knowledge, which the contractor is better positioned to provide. For example, the contractor must have a deep understanding of civil engineering, structural design, and construction management, as well as the ability to manage and coordinate multiple teams and subcontractors. The contractor must also ensure that the bridge meets safety and regulatory requirements and is built to withstand the expected usage and environmental conditions.

The fees charged to the local government then are often decided upfront, while the quality of the service may depend on the efforts of the contractor. Furthermore, infrastructure projects often involve complex and unpredictable situations such as when availability of materials, equipment, and labor may be affected by external factors, such as supply chain disruptions or labor strikes.

An agent in this model study case has tendency to maximize their monetary benefit. In this case, the contractor may be dishonest if they could gain large monetary gains. This led to variable x being introduced, representing critical value at which the contractor would break a promise. If the monetary gains have lower value than x, they will not cheat. It can be seen as explicit utility (good feeling) for contractor in keeping promises.

Given this situation, the payoff of the contractor can be calculated as below

$$U_s(q, q_t, p) = \begin{cases} p - cq + x, & if\ contractor\ be\ honest \\ p - cq_t, & if\ contractor\ cheats \end{cases} \tag{5}$$

U_s explains contractor utility in an agreed contract of (q, q_t, p) with q being the agreed quality to be delivered. q_t represents the quality that will be recorded. And p defines the payment contractor will receive from their client. Contractor will cheat only if $p - cq + x > p - cq_t$. For instance if cost of delivering agreed quality (cq) would be 10,000 and contractor know that providing certain quality with cost of 4000 (cq_t) would be sufficient to make it verifiable, as long as their good feeling of being honest has value of 6000, the contractor will be honest.

Similarly, utility for local government as client denoted as U_b will be

$$U_b(q, q_t, p) = \begin{cases} vq - p, & if\ contractor\ be\ honest \\ vq_t - p, & if\ contractor\ cheats \end{cases} \quad (6)$$

Results and Discussion

To illustrate the behavioral dynamics embedded in the model, a numerical simulation is conducted using hypothetical values. The simulation explores how a contractor's internal motivation to honor a promise, or critical value, denoted by x influences the decision to either fulfil or cheat on the quality agreed upon in an incomplete contract setting.

Simulation Setup

The model assumes a contractual relationship between a local government and a contractor tasked with building a bridge. The quality of the bridge is quantified on a scale from 6 (minimum verifiable quality) to 10 (maximum desirable quality). The following parameters were defined:

$$\begin{aligned} q &= 10 \\ q_t &= 6 \\ cq &= 10{,}000 \\ cq_t &= 4{,}000 \\ vq &= 18{,}000 \\ vq_t &= 10{,}0000 \\ p &= 12{,}000 \\ x &\in [0, 8000] \end{aligned} \quad (7)$$

The contractor chooses to deliver q (honest) or q_t (cheat) based on whether the net benefit of honesty (critical value of x) exceeds the profit from cheating. Derived from previous equation which define the situation where contractor would cheat, the decision rule is simplified as:

$$\text{Contractor cheats if } x < cq - cq_t \quad (8)$$

Simulation Outcomes

The simulation is run using previously defined parameters to better understand how the behavioral variable x influences contractor decisions and social outcomes. The simulation observes the dynamic of multiple variables of interest value namely U_s, U_b, Social Surplus for both if the contractor cheats or being honest given different value of x from 0 to 8000 with increment value of 500. The result is presented into tabular form below.

Table 1. Simulation outcomes (tabular recapitulation)

x (Critical Value until Cheat)	U_s (if honest)	U_s (if cheat)	U_b (if honest)	U_b (if cheat)	Social Surplus (if honest)	Social Surplus (if cheat)	Contractor Behavior
0	2000	8000	6000	-2000	8000	6000	Cheat
500	2500	8000	6000	-2000	8500	6000	Cheat
1000	3000	8000	6000	-2000	9000	6000	Cheat
1500	3500	8000	6000	-2000	9500	6000	Cheat
2000	4000	8000	6000	-2000	10000	6000	Cheat
2500	4500	8000	6000	-2000	10500	6000	Cheat
3000	5000	8000	6000	-2000	11000	6000	Cheat
3500	5500	8000	6000	-2000	11500	6000	Cheat
4000	6000	8000	6000	-2000	12000	6000	Cheat
4500	6500	8000	6000	-2000	12500	6000	Cheat
5000	7000	8000	6000	-2000	13000	6000	Cheat
5500	7500	8000	6000	-2000	13500	6000	Cheat
6000	8000	8000	6000	-2000	14000	6000	Honest
6500	8500	8000	6000	-2000	14500	6000	Honest
7000	9000	8000	6000	-2000	15000	6000	Honest
7500	9500	8000	6000	-2000	15500	6000	Honest
8000	10000	8000	6000	-2000	16000	6000	Honest

The table recapitulation of the simulation above clearly shows a behavioral tipping point of the contractor at $x = 6000$. When $x < 6000$, contractor maximises utility (U_s) by cheating, compensating government utility and overall social surplus. However, once $x \geq 6000$, honest behaviour becomes utility-maximizing for contractor, resulting in improvement in both parties' benefit.

The dynamics are further visualized in figures below.

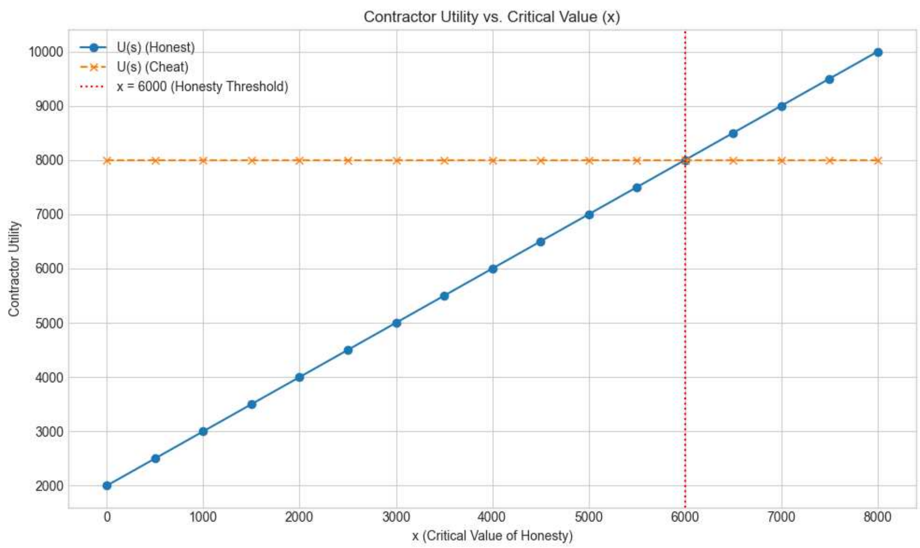

Figure 1. Contractor Utility vs Critical Value (x)

Figure 1 illustrates the contractor's utility under both behavioral options across increasing values of x. When $x < 6000$, contractor chooses to cheat as the utility is maximised at 8000. The intersection at $x = 6000$ represents the point of behavioral change, where promise-keeping becomes as profitable as cheating. When $x > 6000$, even to cheat will generate less utility now which make being trustworthy is rewarding more than just keeping promise.

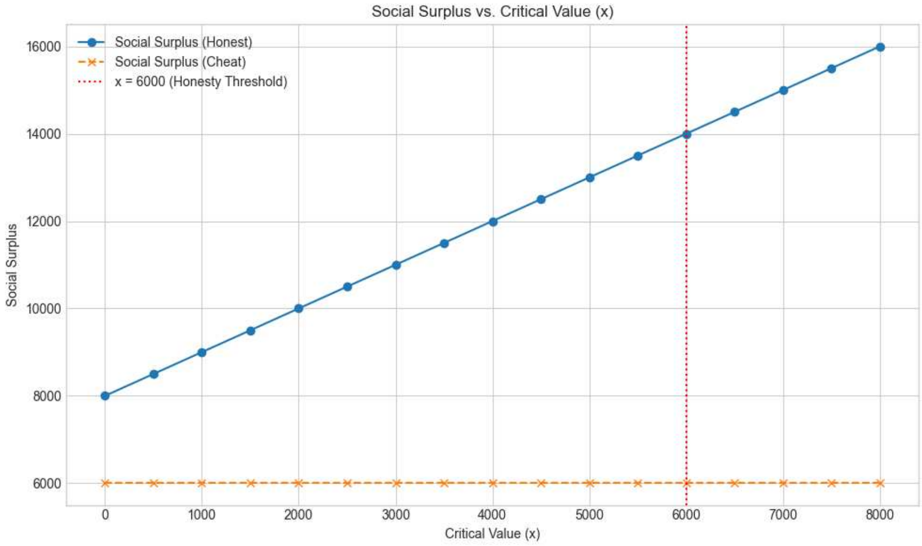

Figure 2. Social Surplus vs Critical Value (x)

Figure 2 depicts the corresponding dynamics in social surplus. It basically affirms that in the perspective of overall social surplus, being honest would be the best thing to do for both of the parties. As the contractor shifts from opportunism to honesty, reputation is more likely to be established.

Figure 3 below shows how honesty threshold value of x would shift decision between cheating and being honest.

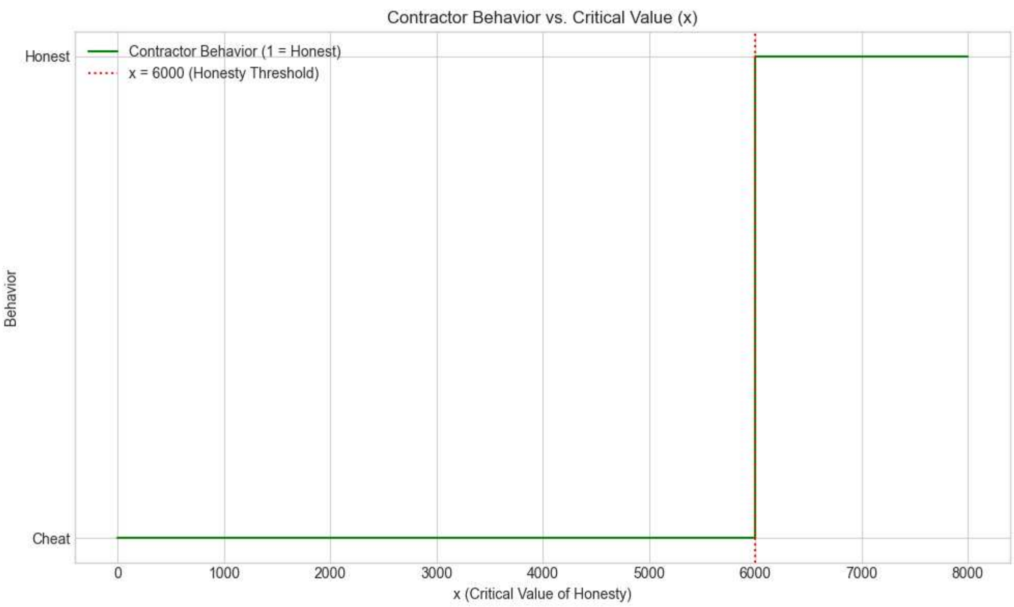

Figure 3. Contractor Behaviour vs Critical Value (x)

Behavioral Interpretation

The simulation reveals several critical behavioral and policy-relevant insights:

- Trust as a Threshold Variable: Trust (modeled critical value of x) does not incrementally improve outcomes; instead, it acts as a threshold variable. Below the critical point, opportunistic behavior dominates. Above it, cooperating is preferred.
- Incentive-Compatible Design: If contractors are known to possess low x values, formal mechanisms (e.g., verifiable contracts, third-party monitoring) may be necessary to prevent cheating. However, if x is sufficiently high—due to cultural norms, professional standards, or intrinsic ethics—then reliance on informal promise-keeping may be both efficient and cost-saving, since assessing third-party or recording device might not be needed.
- Social Surplus Maximization: The presence of a high x not only reflective on contractor having good moral stance, but also increases government utility, leading to a social surplus maximization. This reinforces the theoretical claim that trust-enhancing mechanisms (through reputation) are not merely ethical complements but economic assets.
- Policy Leverage Points: In public-private partnerships, strategies that boost intrinsic trust—such as long-term contractor relationships, reputation scoring, or community accountability—can substitute or supplement incomplete contracts, leading to better outcomes under uncertainty.

Conclusion

This study case provides a practical comprehension on how promise, trust and contract put in interplay. x plays a huge role in affecting not only contractor utility (U_s), but also local government's (U_b) and social surplus (W). The higher the x would indicate a higher tendency of contractor in keeping their promise. And at the same time, local government would expect their contractor to have large x as it will increase the chance for them being provided the agreed quality considering the verifiable quality that can be recorded is lower than what they expect.

Simulation results support this reasoning by showing a clear behavioral threshold at $x = 6000$, beyond which the contractor's best response shifts from cheating to keeping the promise. When x is below this point, delivering only the verifiable minimum quality becomes more profitable; but as x increases, the intrinsic value of honesty overtakes gains from opportunism. This behavioral switch is mirrored in the resulting social surplus, which rises substantially once the contractor chooses to respect the agreement.

This concept of economical model is advantageous in assessing behaviour of an agent in cooperative game and could be used in determining the most optimal outcome for both parties in term of social surplus. However, in reality, some parties would interpret and see promise as non-negotiable thing. There is a situation when integrity and righteousness outweigh monetary benefit. Thus, x is indefinite and most likely makes contractor gaining less that they could, and perhaps as well as the social surplus generated. This demeanour put the economical model in neglect.

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