General Model for the Creation of Social Capital Based on Non-cooperative Game Theory[1]

Modelo general para la creación de capital social desde la teoría de juegos no cooperativos

Modelo Geral para a Criação de Capital Social com Base na Teoria dos Jogos Não Cooperativos

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[Artículos]

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Abstract

This article analyzes social capital in Colombia and how to create it in distrustful societies using game theory. Networking generation and trustful environments are intimately related to development, lowering transactional costs and helping societies to create better interchange processes under regulated institutions. However, there are societies, such as the Colombian one, where building trust is difficult due to the country's history, conflict, and dubious contract bargains. In Colombia and some Latin American countries, most negotiations rely on the assumption that the counterparty wants a tremendous advantage or has an obscure desire when doing business. Still, it is possible to generate confidence through non-cooperative games, in which prior cooperation or trust between market players is unnecessary. The proposed model in this article shows how two agents who do not cooperate and do not have confidence in a competitive environment get higher earnings in the medium and long term in private contractual relationships if they consider their goodwill as a critical variable in their profits calculation and choose the agreement performance strategy.

Keywords: non-cooperative game theory, social capital, trust, business goodwill, contracts, obligations, obligation fulfillment, relationship networks.

Resumen

Este artículo analiza el capital social en Colombia y cómo crearlo c en sociedades con bajos niveles de confianza mediante la teoría de juegos no cooperativos. La generación de redes y entornos de confianza está íntimamente relacionada con el desarrollo, lo que recude los costos de transacción y ayuda a las sociedades a crear mejores procesos de intercambio bajo instituciones reguladas. Sin embargo, hay sociedades, como la colombiana, en las que generar confianza resulta demasiado difícil debido a la historia, los conflictos y la negociación contractual. En Colombia y algunos países de Latinoamérica, la mayoría de las negociaciones parten del supuesto de que la contraparte quiere una ventaja mayor o tiene un deseo oscuro cuando está haciendo negocios. Aun así, es posible generar confianza mediante el uso de juegos no cooperativos, en los que no es necesaria la cooperación ni la confianza previa entre los actores del mercado. El modelo propuesto en este artículo muestra cómo dos agentes, que no cooperan y no tienen confianza en un entorno competitivo, obtienen mayores ganancias a mediano y largo plazo en las relaciones contractuales privadas de tracto sucesivo, si consideran su buen nombre como una variable clave en sus ganancias y eligen la estrategia de cumplimiento de sus acuerdos.

Palabras clave: teoría de juegos no cooperativos, capital social, confianza, buen nombre comercial, contratos, obligaciones, cumplimiento de la obligación, redes de relacionamiento.

Resumo

Este artigo analisa o capital social na Colômbia e como criá-lo em sociedades desconfiadas usando a teoria dos jogos. A geração de redes e ambientes de confiança está intimamente relacionada ao desenvolvimento, reduzindo os custos de transação e ajudando as sociedades a criar melhores processos de intercâmbio sob instituições regulamentadas. No entanto, existem sociedades, como a colombiana, onde construir confiança é difícil devido à história, conflitos e negociações contratuais duvidosas do país. Na Colômbia e em alguns países da América Latina, a maioria das negociações se baseia na suposição de que a contraparte quer uma tremenda vantagem ou tem um desejo obscuro ao fazer negócios. Ainda assim, é possível gerar confiança por meio de jogos não cooperativos, nos quais a cooperação ou confiança prévia entre os agentes de mercado não é necessária. O modelo proposto neste artigo mostra como dois agentes que não cooperam e não têm confiança em um ambiente competitivo obtêm maiores ganhos a médio e longo prazo em relacionamentos contratuais privados se considerarem sua boa vontade como variável crítica no cálculo de seus lucros e escolherem a estratégia de desempenho do acordo.

Palavras-chave: teoria dos jogos não cooperativos, capital social, confiança, boa vontade nos negócios, contratos, obrigações, cumprimento de obrigações, redes de relacionamento.

Introducción

Based on surveys conducted in 2004 by the NGO Transparencia por Colombia (Mayorga, 2005), it has been argued that the efforts made for the generation of social capital have not given the expected results in Colombia since it is necessary to consolidate further relationships of trust and social networks between different members of society. Moreover, indicators of trust in institutions in Colombia show a drastic fall compared with 2005 indicators (Sudarsky & García Díaz, 2020). Also, *"*The previous results are corroborated in two macro-results in the fall of Interpersonal Trust and the increase in the Perception of corruption, where it reached the most negative levels of all measurements when 2005 a direction was recorded hopefully.*"* (Sudarsky & García Díaz, 2020, p. 356).

In forming institutions (understood as the rules of the game and the interrelation between social actors), agents have not participated equally, which has caused feelings of exclusion and lack of social confidence, thus confirming some approaches by North (1998). The agents assume strategic behaviors that do not have adjustment mechanisms to obtain consensus.

At this point, it is vital to understand what social capital is:

> The great value of the term [social capital] is that it emerges as an integral concept of the different analytical perspectives of the social disciplines to solve common dilemmas of

> collective action: how to overcome distrust, avoid opportunistic behavior, and consequently provide greater incentives for cooperative solutions. (Caro, 2006, p.38).

Sudarsky and García Díaz (2020) consider social capital an asset from human relationships that allow individuals to obtain collective goals. This behavior positively impacts institutions, commercial interchange, and society in general.

Therefore, social capital is a benefit that encompasses many areas of daily life, such as the administration of justice, the negotiations on social benefits, political agreements, and a reliable social environment with transparent interrelationship networks. Also, social capital is a prerequisite for the formulation and implementation of public policies that are effective in the achievement of social goals.

However, as an example, Kliksberg (as cited in Caro, 2006) starts from the premise that to generate social capital in Latin America, there must be a cultural change that necessarily involves strengthening ethical behaviors associated with citizen awareness. Regarding institutional legitimacy in the region, these authors state that, according to Transparency International, citizens show high skepticism and distrust towards the transparency of political parties, governments, and all governmental processes (see also Sudarsky & García Díaz, 2020).

Regarding equity, established as a primary value in the generation of social capital, Latin America has one of the lowest Gini coefficients.[4] For these authors, it shows a dramatic reality of poverty and social exclusion in the region due to the concentration of wealth in the upper levels of society, widening the gap between rich and poor and pointing out the influence of poverty in the construction of social capital as a result of the absence of cultural values already mentioned.

In this regard, Kliksberg (as cited in Caro, 2006) states that although the association among the poor is more remarkable, their capacity to produce changes in high spheres of economic movements and political power is almost inexistent. This is why, for the author, the scarcity of social capital in the region explains its unsatisfactory economic performance.

However, another question arises: How do we create social capital in societies? There are two significant approaches to answering this question. One proposes that cooperation is the way to generate social capital (Fukuyama, 1999). The other approach can start from non-cooperative relationships (Myerson, 1991). This work will take the second approach.

[4] The Gini coefficient of income is a statistical measure of inequality in the income distribution of individual recipients that varies between 0 and 1. It is an indicator of inequality calculated by relating a theoretical line of perfect income distribution to the actual distribution curve of the country. It ranges from 0 to 1, with 0 being perfect distribution and 1 being absolute inequality.

The Social Capital Concept

Se In general terms, authors have agreed that social capital is a resource produced within social networks and is based on those elements of the social organization that make collective action easier among community members for mutual benefit. However, studies have varied in specifying which "those elements" are, as well as their nature and scope (Acosta & Gual, 2021). This is partly because each study responds to specific questions in its particular field and partly because the specifications of its concrete manifestations vary according to the cultural, social, or local context of the main objects of study. However, the consulted authors agreed that the practical application of the rules will determine a higher level of well-being of a society or an individual within it. Consequently, social capital engenders a trustworthy system that provides security for players and promotes cooperation between them (Coleman, 1987; Sarmiento Cristancho et al., 2017).

After reviewing the definitions of social capital, the norms or institutions that allow cooperation and reinforce the commitments acquired are at the core of the concept.

Table 1. Main Concepts of Social Capital

Thinker	**Approach to the concept**
Bourdieu (1986)	Resources, actual or potential, linked to possession of an enduring network of more or less institutionalized relationships of mutual recognition
Baker	Actors obtain a resource from specific social structures for later use in achieving their interests; it is created through relationship changes between actors
Putnam (1993)	Networks, regulations, and trust-based relationships that facilitate coordination and cooperation for mutual benefit
Portes	The ability of actors to assure benefits under membership in social networks or other social structures
Woolcok (1998)	Rules and networks (in society) that facilitate collective action
Nahapiet and Ghoshal (1998)	The sum of current and potential resources rooted in, available through, and derived from the relationship networks inherent to an individual or social unit
Knoke (1999)	The process by which social actors create and mobilize connections between and from organizations to gain access to the resources of other social actors
Fukuyama (1999)	Institutionalized informal rules that promote cooperation between two or more individuals

Cohen and Prusak (2001)	Trust, mutual understanding, and shared values and behaviors bind members of human networks and communities together in a way that makes cooperative action possible
World Bank (2003)	Institutions, relationships, and norms that govern the quality and quantity of a society's social interactions and contribute to economic and social development

Source: Adapted from de Puente & Torrella (2003). Taken from: Vazquez Caro

The importance of norms within the concepts of social capital is undeniable; however, authors differ in the way in which behavioral norms are internalized, imposed, and complied with, which has an impact on the policies that are intended for the generation of social capital (Palomares & Calonje, 2015)

In our opinion, a complete definition is given by Caro (2006): "Institutions are understood as formal and informal game rules and the relationship networks established in a society generate a reliable social environment that facilitates collective action" (p. 25). This definition gathers all the necessary elements of judgment to understand social capital from different angles to the extent that it combines the elements of discussion raised by different authors. It also conceives trust and the reliability of the social environment as the central function of social capital. However, for the present study, the definition described may not be appropriate if we intend to generate social capital from cooperative game theories.

We will analyze the way market agents (players) behave and relate to each other under the assumption that they may have asymmetric or incomplete information and, from this point, how adjustment mechanisms based on negotiation are designed to build trust and social welfare that ultimately represents an increase in social capital when an aggregate of individual relationships is made.

The Possibility of Generating Negative Social Capital

Analyzing the neutrality of generating positive or negative social capital is relevant. The concept refers to the importance of institutions in creating incentives for market actors, which, in turn, will forge favorable environments for welfare.

However, the type of collective action that may be subject to this process is not specified, with the possibility that its virtues may be taken to businesses or markets that act against society itself. In this case, there would not be an application of formal rules but rather the procurement of perverse incentives through informal rules and the certainty of their penalization. For example, an organized

criminal group, through this process, would build significant trust and a favorable environment for its criminal acts, contrary to society's laudable desires for welfare.

Approach to Social Capital from Cooperative and Non-cooperative Game Theories

Game theory can be defined as a study that interrelates the strategies of people in decision-making, in which the decision of one of the parties (players) affects the strategies of the other players as predictive situations of the natural world. This theory has become a fundamental tool of analysis in sciences, applicable mainly in the fields of Economics and Sociology (Monsalve, 2003). Two kinds of game theories can help the present study: cooperative and non-cooperative games.

Approach to social capital from cooperative games

It is necessary to start from Elinor Ostrom's (2003) analysis to review social capital from a cooperative game perspective. In her research work on social capital and collective action, she speaks of three ways for social capital generation: i) trust and norms of reciprocity, ii) networks and civil participation, and iii) rules and institutions. The author observes social capital as an attribute of individuals who, thanks to their relationships, increase their ability to solve problems collectively.

Ostrom (2003) states that the theories of collective action refer to scenarios where groups of individuals have a common interest, but that interest has a potential conflict with the individual interest, concluding that individuals alone could not solve their problems by themselves but need a third party or an external incentive (cooperative behavior) to do so.

Moreover, Ahn (2000, as cited in Ostrom, 2003), establishes that if there is a sufficient number of selfish individuals and the material benefits derived from defection are not very high, there is a balance that makes cooperation persist. Even if the number of non-egoists is considerable, defection constitutes another equilibrium for the game. He points out that to make reciprocity prevail as a social pattern of interaction, it is necessary not only to avoid the temptation of the "free rider" but also to coordinate actions efficiently.

Ostrom (2003) states that no set of formal rules regulates the totality of social relations so that the practical or non-formal rules can fill the gaps in the legal system. For this, individuals must invest in the design, enforcement, surveillance, review, and penalization of their own rules, assuming that they can solve their problems together through collective action. Still, no formal rule guarantees the success of the practical rules, for which individuals must consider environmental and cultural conditions.

Approach to social capital from non-cooperative games

On the other hand, social consensus is almost impossible to achieve under a non-cooperative theory. Taking into account the practical difficulties for reaching consensus (specifically in Colombia and LATAM countries, as explained before)—taking a Hobbesian position on the matter—, it is necessary to broaden the spectrum of study considering non-cooperative games (Gibbons, 2003) and Nash equilibrium[5] (Myerson, 1999).

In these kinds of games, individuals have a set of strategies at their disposal and some incentive allocations to execute such strategies. The decision-making to use one or the other strategy is done independently, without announcing the strategy to other individuals or considering their actions, wishing to maximize their profits. Still, the individual's actions will depend on the actions, expectations, and beliefs of the others.

Traditionally, trust building requires cooperation and collective action to generate social capital and trust networks (Putnam, 1993); however, individuals are not willing to cooperate and forge networks of trust that ultimately contribute to collective action (Olson, 1992), but rationally tend towards maximization of individual profits without cooperation. So, is there another way, other than cooperative theories—the foundation of collective action—, to generate social capital and build trust?

Model for the creation of social capital from non-cooperative games

To answer the above question, this work formulates this hypothesis: If in a repeated, non-cooperative strategic game with incomplete information[6], a positive externality is introduced, then trust is built between players to the extent that this externality is greater than the incentive to breach a contract. However, if the externality is less than the incentive for not breaching the contract, the betrayal of one of the players occurs. Social capital is measured as the cumulative result of game winnings (under trust) each time the game is played (García & Fino, 2014; Sänger, 2015)

[5] "Nash (1950b) formally defined an equilibrium of a noncooperative game to be a profile of strategies, one for each player in the game, such that each player's strategy maximizes his expected utility payoff against the given strategies of the other players. If we can predict the behavior of all the players in such a game, then our prediction must be a Nash equilibrium." (Myerson, 1999, p. 6)

[6] Based on the problem raised, it can be inferred that parties have incentives to hide information, or else there would be no such asymmetries, which would allow efficient contracts to be obtained. The information asymmetry is based on a problem of trust (basic problem of social capital). As players have incentives to keep relevant information within a contractual relationship, an environment of distrust is generated within all stages of contract elaboration. A game has incomplete information when a player does not know the profits of the other player as in the case of auctions; and a game will be static when the decisions made by players are made simultaneously and finally dynamic when such decisions are made sequentially. (Gibbons, 2003)

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N.º 59 | julio-diciembre del 2023

In simultaneous or consecutive decision-making (games), one of the major problems faced by the economy is the asymmetry of information, which increases transaction costs and makes it impossible to achieve efficient and optimal equilibrium points for the parties. Information asymmetry prevents efficient agreements from being reached in the negotiations; we consider the concept of efficiency in contractual matters in its technical and social aspects. The former refers to the set of knowledge applied in science that transforms one reality into another, making it possible to produce the exact quantities of productive factors at a lower cost. In other words, lower transaction costs are incurred in contract drafting, reflecting the genuine will of the parties and having the necessary stipulations that guarantee performance or facilitate its indemnification in case of breach within the execution part.

On the other hand, social efficiency will be equated to Pareto improvement, in which any change where some individual obtains more profit without diminishing the profit of any other individual to the extent that an individual can improve his situation without detriment to his counterpart.

Based on the problem raised, it can be inferred that parties have incentives to hide information, or else there would be no such asymmetries that allow efficient contracts to be obtained. In this vein, information asymmetry is based on a problem of trust. As players have incentives to hide relevant information within a contractual relationship, distrust occurs within all stages of contract drafting.

This motivated failure, whose origin is an improper use of communication channels, has been addressed by game theory, whose answers are based on the reduction of non-compliance risk but do not seek to improve communication channels or an increase in trust, which represents an increase in the amount of social capital within a given community, as noted below.

The game's characteristics allow us to deliberate on whether it is possible to talk about social capital without cooperation or, on the contrary, social capital is linked exclusively to cooperation between individuals. It is pertinent to clarify that it is not a question of substituting collective actions by individual ones but instead of determining how they influence the behavior of individuals in their contract relations with others under information asymmetry and distrust.

Therefore, the proposed model aims to show how institutions are used in individual actions (rules of the game determined by strategies and assumptions; North, 1998) to build trust and social capital, away from collective action, starting from a rational individual who seeks to maximize their earnings without any cooperation, as long as the player's decisions are influenced by an externality (goodwill).

a) Game description

The model consists of two parts: In the first part, players are influenced by goodwill (SIC Concepto No. 02080643, 2002) in their payments according to their strategies. In the second part, the game analyses the player's payments without considering goodwill. Subsequently, the matrices are compared, and the perfect Nash equilibria are found in the subgames.

The model applies to any contractual relationship with successive tract (Ospina, 1994), that is, to relationships between two or more individuals who have different obligations that differ in time and cannot comply in one moment, where the gains always depend on the action or actions of the other player (performance of or failure to perform the agreement) and the externality (goodwill). In this context, externality is "an action of an agent that directly affects the environment of the other agent" (Varian, 1992). Consequently, to consider the model as the development of a contractual relationship, the greatest intangible asset that a player (contractor) has is his goodwill (applied in the model as the externality).

In Colombia, goodwill is a legal concept developed, among others, by the Superintendence of Industry and Trade. In this context, goodwill is the "(…) prestige that the merchant has gained in its business relations, its fame and reliability among suppliers, employees, financial institutions and, in general, the group of people the merchant is related with" (SIC Concepto n.º 02080643, 2002).

Accordingly, the Colombian Supreme Court has stated that goodwill is a countable asset composed of different items (Corte Suprema de Justicia, 2001). These items can be contained in Equation 1:

$$Gw = fp + (ia + mkt + ex + ql + ggp + cf) \qquad (1)$$

Where Gw is goodwill; fp is future profits; ia is intangible assets; mkt is the excellent position in the market; ex is the experience; ql is the quality of the merchandise or service; ggp is good governance policies, customer service, good relations with workers and their job stability; cf is the confidence in the financial sector.

For the model, the variables different from future profits are unchanged (ceteris paribus), so they have no strategic effect in the game. This assumption is because, in a trustful environment, agents will maintain their contractual relationships with those who fulfill their obligations. The other items require individual analysis, making the model impossible to create (Equation 2):

$$(ia + mkt + ex + ql + ggp + cf) = 0 \qquad (2)$$

So

$$Gw = fp$$

In the game, the externality applies in the model when, during the performance of an installment contract, an interested third party appears who could affect the expected profit of one of the contractual parties, offering more money if they choose to breach the contract (also breaking the trust in the contractual relationship).

Formal elements of the game

- ☐ There are two players in the market: a contracting party and a contractor.
- ☐ Both players have two pure strategies: to perform or not to perform the contract.
- ☐ The contracting party receives a benefit under compliance with the contractor, given that he, in turn, has a contract that needs the materials that the contractor sells.
- ☐ The third party offers the contractor a more significant sum for the breach at each game stage.
- ☐ The game is non-cooperative.
- ☐ There is a suitable purpose of the contract.
- ☐ The purpose of the contract is the supply of construction materials.
- ☐ The contract between a contracting party and a contractor does not have performance policies or any penalties due to breach, which could increase the contractor's breach costs.
- ☐ The strategies of each agent consider both the good and the externality.
- ☐ The profits depend on the performance of the contract and the externality.
- ☐ Players have incomplete, perfect information, and the game is repeated.
- ☐ Player's strategies are affected by goodwill (the externality).
- ☐ The goodwill will equal the expected benefits since they will have future payments in the long-term contractual relationship. Therefore, the value of goodwill is measured as the subsequent payment that the contracting parties would receive.
- ☐ The generation of social capital will depend on the valuation the contracting party and a contractor place through their goodwill.

The game with the externality

The contractor (CTR) has signed a contract for the supply of construction materials with a contracting party (CP), which has no guarantees to increase the breach costs. The contract consists

of three partial deliveries of material, having the particularity that at each delivery time, the CTR is the only supplier of all the merchandise.

Additionally, the CTR possesses only enough quantity to fulfill the partial delivery. Also, in each delivery, a third party is offering additional money for those materials, implying a breach of his previous contract in case of acceptance. For the first delivery, the third party is willing to pay the contractor an additional 50 % of the construction materials price.

Under the described assumptions and considerations, if the CTR and the CP decide to "perform" the contract taking into account the externality, the former will obtain a profit of 200: 100 as contract payment plus 100 corresponding to the added goodwill (calculated as the future payment or benefit). In the same way, the CP will receive 600 from the 300 of the payment of the contract that he, in turn, can perform and the 300 corresponding to the "goodwill" that he gains.

If the CTR decides to "breach" and the CP "performs," the former will obtain a profit of 50 for the 150 that the third party is paying for the breach of contract or sale of the material to him minus 100 corresponding to the loss of goodwill (because of the breach of the contract and betrayal of trust, he will not receive future payments). For his part, the CP will obtain a profit of 0, represented by 300 of his increase in goodwill minus 300 of the contract that he could not perform.

Continuing with the game, if the CTR opts to "perform" the contract and the CP decides to "breach," the CTR, despite not receiving the payment for the materials, will make a profit of 100 as a result of the increase in "goodwill" (he is a trustful party). In contrast, the CP will make a negative gain of -300 for the loss of goodwill and the breach of the other contract.

Finally, if both players choose "not to perform," neither will obtain a gain or loss from the goodwill, the CTR will receive 150 due to the payment from the third party, while the CP will receive 0.

Table 2. Payment Matrix 1

		C	
		Comply	Non comply
cta	Comply	(200 , 600)	(100 , -300)
	Non comply	(50 , 0)	(150 , 0)

Source: Prepared by the authors.

The subgame has only one Nash equilibrium (Nash, 1950), representing the optimal strategy for each player and considering the other strategies (perform, breach) and the externality.

Let us move on to the second installment, where the third party offers the CTR an additional 100 % of the price the CP pays for the construction materials. Maintaining the assumptions and

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considerations described, with the increase in the amount that the third party is willing to pay, the payments are modified as follows:

Suppose the CTR and the CP decide to "perform," as in the previous subgame. In that case, the former will obtain a profit of 200: 100 for the payment of the materials plus 100 corresponding to the "goodwill." For his part, the CP will receive 600: 300 from the contract that he, in turn, can perform and 300 corresponding to the goodwill gained.

If the CTR decides, in this second installment, to play "breach" while the CP wants to "perform," the CTR will obtain a profit of 100. From the 200 that the third party will pay for the sale of the materials, 100 are subtracted because of the loss of goodwill. On the other hand, if the CP plays "perform," he will get a profit of 0 that results from the increase in his goodwill at 300 minus -300 because he will not be able to perform the other contract.

Now, continuing with the game in its second stage, if the CTR chooses to "perform" the contract and the CP decides to "breach," the CTR, despite not receiving payment for the materials, will get a gain of 100 as a result of the increase in his goodwill. The CP will obtain -300 for the loss of goodwill because of the chosen strategy.

Finally, if both players choose to "breach," neither will obtain a gain or loss from the goodwill and consequently, the CTR will receive 200 due to the payment from the third party while the CP receives 0.

Table 3. Payment Matrix 2

		C	
		Comply	Non comply
cta	Comply	(200 , 600)	(100 , -300)
	Non comply	(100 , 0)	(200 , 0)

Source: Prepared by the authors.

Like the previous subgame, the second installment has only one Nash equilibrium, representing the optimal strategy for each player and considering each other's strategies (perform, perform).

Finally, the third stage of the game will be carried out. In this stage, the third party offers the CTR an additional 200 % of the price that the CP is willing to pay for the construction materials.

Suppose the CTR decides to play "perform," and the CP decides to "perform," as in the previous subgames. In that case, the former will obtain a profit of 200: 100 he receives for the payment of the materials plus 100 corresponding to the goodwill. The latter will receive a profit of 600 thanks to the sum of the goodwill (300) and the expected profit on the contract (300).

If the CRT decides, in this third delivery, to play "breach," he will earn a profit of 200 because of the 300 that he will receive for the breach of the contract minus 100 corresponding to the loss of goodwill. If the CP's strategy is to "perform," he will obtain a profit of 0 because of the increase of his goodwill (300), minus 300 from the other contract that he will not be able to perform.

Continuing with the game in its third stage, if the CTR chooses to "perform" the contract and the CP decides to "breach," the CTR, despite not receiving payment for the materials, will make a profit of 100 as a result of the increase in goodwill. In contrast, the CP will lose 300 per the loss of goodwill when using that strategy.

Finally, if both players decide to "breach," neither will obtain a gain or loss from the goodwill and consequently, the CTR will receive 300 due to the payment they are offering to play this strategy. In contrast, the CP will receive 0.

Table 4. Payment Matrix 3

		C	
		Comply	Non comply
cta	Comply	(200 , 600)	(100 , -300)
	Non comply	(200 , 0)	(300 , 0)

Source: Prepared by the authors.

Like the previous subgame, the third installment has only one Nash equilibrium, representing the optimal strategy for each player and considering each other's strategies (perform, perform).

Applying the backward induction procedure (Collel, 1995) in each subgame, we obtained as a result the following matrix:

Table 5. Payment Matrix 4

		C	
		Comply	Non comply
cta	Comply	**(600 , 1800)**	**(500 , 900)**
	Non comply	**(450 , 1200)**	**(550 , 1200)**

Source: Prepared by the authors.

The Nash equilibrium of the game is the "perform, perform" strategy. It is the optimal strategy for each player when the externality is considered because it represents greater profits for both parties and more significant social benefit.

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The game without the externality (goodwill)

Under the same described assumptions and considerations and without taking into account the externality (goodwill), the payments of the game will change, and the efficient breach of contracts will be the strategical choice[7]:

In the first stage, if the CTR and the CP decide to "perform," the former will obtain a profit of 100 due to the payment of the materials. The latter will receive 300 as a result of the profit of the contract that he, in turn, can perform.

If the CTR decides to play "breach," he will profit 150 for what the third party is willing to pay for the materials and the contractual breach. For its part, the CP will have a negative profit of 300 because it cannot perform the contract and, in turn, do not have the materials he needs to perform the other contract.

However, if the CTR choses to "perform" the contract and the CP decide to "breach," the CTR will make a profit of 0 since he is not paid for the materials. Meanwhile, the CP will get a profit of 0 because he will probably not be interested in performing the other contract and, therefore, receiving the expected profits.

Finally, if both players choose to "breach," neither will make a profit or loss and consequently, the CTR will receive 150 due to the third party's payment to play this strategy. In contrast, the CP will receive 0.

Table 6. Payment Matrix 5

		C	
		Comply	Non comply
cta	Comply	(100 , 300)	(0 , 0)
	Non comply	(150 , -300)	(150 , 0)

Source: Prepared by the authors.

The subgame has only one Nash equilibrium, representing the optimal strategy for each player and considering the strategies of the other (breach, breach) and the efficient breach of contract theory.

Let us move on to the second installment, where the third party offers the CTR an additional 100 % of the price the contracting party is paying. If the CTR and the CP decide to "perform," the former

[7] "The concept of efficient breach of contracts refers preliminarily to those cases in which a party is tempted to breach the contract he has entered into because the benefit derived from such a breach exceeds the benefit derived from performance. So. if the profit of the breach of a contract is higher than that which the party expects to obtain with its performance and the damages suffered by the counterparty are limited to the loss of expected profit, there will be an incentive to default." (Lopez, 2018, p. 335)

will obtain a profit of 100 due to the payment of the materials. The CP will receive 300 due to the gain from the contract, which he, in turn, can perform.

If the CTR decides to play "breach," he will obtain a profit of 200 because of the extra money offered by the third party and the breach of the contract. On the other hand, the CP will lose 300 because he would not be able to perform his contract for not having the needed materials.

Continuing with the game, if the CTR chose to "perform" the contract and the CP decides to "breach," the CTR will obtain a profit of 0 since he is not paid for the materials. In contrast, the CP will make a profit of 0 because he will probably not be interested in performing the other contract and, therefore, receiving the expected profits.

Finally, if both players choose to "breach," neither will make a profit or loss, and consequently, the CTR will receive 200 due to the payment from the third party to play this strategy, while the CP will receive 0.

Table 7. Payment Matrix 6

		C	
		Comply	Non comply
cta	Comply	(100 , 300)	(0 , 0)
	Non comply	(200 , -300)	(200 , 0)

Source: Prepared by the authors.

The subgame has only one Nash equilibrium, representing the optimal strategy for each players and considering the strategies of the other (breach, breach).

Finally, the third stage of the game will be carried out. In this stage, the third party offers the CTR an additional 200 % of the price that is being paid by the CP for the construction materials.

If the CTR and the CP decide to play "perform," the former will obtain a profit of 100 due to the payment of the materials. For his part, the CP will receive 300 due to the gain from the contract that he, in turn, can perform.

If the CTR decides to play "breach," he will profit 300 from the amount that the third party is paying for the breach of contract or non-delivery of material. Instead, the CP will have a loss of -300 because he will not be able to perform the contract that he has.

Continuing with the game, if the CTR opts for "performing" the contract and the CP decides to "breach," the CTR will make a profit of 0 since he is not paid for the materials. In contrast, the CP will make a profit of 0 because he is not interested in performing the other contract and, therefore, receiving the expected profits.

Finally, if both players choose to “breach,” neither will obtain a profit or loss for the “goodwill,” and consequently, the CTR will receive 300 due to the payment he is being offered to play this strategy. In contrast, the CP will receive 0.

Table 8. Payment Matrix 7

		C	
		Comply	Non comply
cta	Comply	(100 , 300)	(0 , 0)
	Non comply	(300 , -300)	(300 , 0)

Source: Prepared by the authors.

The subgame has only one Nash equilibrium, representing the optimal strategy for each player and considering the strategies of the other (breach, breach) and the efficient breach of contract theory.

Applying the procedure of backward induction in each subgame, the resulting payment matrix is as follows:

Table 9. Payment Matrix 8

		C	
		Comply	Non comply
cta	Comply	**(400 , 300)**	**(300 , 0)**
	Non comply	**(450 , -300)**	**(650 , 0)**

Source: Prepared by the authors.

The Nash equilibrium of the game is the “breach, breach” strategy. It is the optimal strategy for each player because it represents higher profits for both parties.

Comparison of the Two Game Applications

However, suppose the two variants of the model previously developed are compared. In that case, each reaches a Nash equilibrium that, in the case of the externality game, is to perform since it represents the most outstanding profits for both players. In contrast, if the externality is not considered, the optimal strategy is breach, breach.

When comparing the payments of both equilibria and considering the externality (goodwill of the players), payments are 600 for the CTR and 1,800 for the CP; on the contrary, without the externality, payments are 650 for the CTR and 0 for the CP. So, there is additional social value creation and higher profits in applying the externality to a contractual relationship (goodwill is an intangible asset).

Accordingly, it can be deduced that it is more efficient for both the CTR and the CP to consider the goodwill of a contractual relationship since there is more significant value creation for the players and society.

Interpretation of the Model Regarding the Generation of Social Capital and Trustful Contractual Environments

It is possible to understand the contractual relationships between agents like a game. If the game is repeated, non-cooperative, and with imperfect information, and an externality is introduced, then trust is built. Therefore, under trustful contractual environments, social capital can be understood as the sum of the added value resulting from each moment of the game because of the increase in goodwill.

In this context, trust, as the basis of social capital, originated regardless of cooperation: It is an added value to the contractual relationship, which, at each moment of the game, implies a higher profit for both players. Consequently, in the presence of externalities, the optimal strategy of the CTR is to perform if the increase in confidence that agents will have (because of the goodwill) has a more excellent value than the price that the third party is paying to the CTR for the breach, contrary to the efficient breach of contract theory.

In this way, the model shows how, from the application of the externality, trust is built among the players represented in the increase of goodwill, which is equal to the increase in future profit. Therefore, the social capital corresponds to the sum of the values added to the individual profits of the model in each delivery, applying the externality (Equation 3):

$$Ks = \uparrow Gw1 + \uparrow Gw2 + \uparrow Gw3 \qquad (3)$$

Nevertheless, the model shows the possibility of social capital destruction if the CTR decides to betray the trust put in him by the CP after having met a previous delivery.

Conclusions

The concept of social capital provides a bridge between the economy and the social behavior theories, allowing us to understand the conditioning that market agents receive through formal and informal behavioral laws and how continuous contractual relationships can create added value to society through trust-building.

- The model showed how individual actions are determined by institutions (rules of the game) so that parties to a contract can build trust by considering goodwill. Therefore, it is possible to conceive social capital away from collective action, starting from rational individuals seeking to maximize their gains without cooperation.
- Trust, the basis of social capital, could be built regardless of cooperation and appears as an added value to the contractual relationship at each stage of the game when the externality is considered and represents a more significant payoff for both players. Also, it represents a social gain when applied to other contractual relationships in a society.
- Consequently, the social capital could be understood, in a contractual relationship, as the sum of the values added to the individual gains each player receives in each Nash equilibrium of the game stages, applying the externality.
- Destruction of social capital is possible to the extent that the contractor decides to betray the trust put in him by the contracting party after having earned it earlier. Also, negative social capital could be produced if parties apply trust-building environments to illegal activities.
- The game has the following limitations: i) only two players are considered, ii) the action of the contractor causes an externality in the other agent, iii) the profits depend on the performance of the contract and the externality, iv) the players have incomplete, perfect information and the game is repetitive, and vi) the game is sequential, so the contracting party makes the first move concerning the contractual decision.
- This article allows further development of the model with incomplete information, whose solution is a Bayesian equilibrium using the concept of signals (Salanié, 1997), in which the first move is random.
- Another possible development is to expand the game from two to three or more players and build trust between them.

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