



Research Article

Sustainable Development in The Blockchain: The Implicit Case of the Jevons Paradox

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Abstract

Sustainable contracts represent a new paradigm in the management of economic relations, integrating the principles of flexibility, strategic cooperation and social responsibility. This article analyzes that the result of the research on sustainability identifies sustainable contracts as a mechanism to reduce the natural risk permeated by the need to maximize the joint utility of the parties, overtaking the research of blockchain as a means of transmitting experiences. Through a theoretical-analytical and methodological descriptive-documentary approach, the contributions of disciplines concurrent with the study of sustainable development are examined. The results indicate that sustainable development integrates the adoption of contracts of this criterion during the dynamics of convenience with the technologies of the 21st century such as blockchain. This study proposes the need for a conceptual model oriented to contractual sustainability based on the need for friendly energy that strengthens the learning documented by blockchain technology that currently represents the balance of risks and strategic cooperation.

Keywords

Sustainable Development, Variable Negotiation, Utility, Cooperation, Blockchain, 'Jevons Paradox'.

1. Introduction

In the contemporary economic context, characterized by volatile markets, high competition and dynamic regulatory environments, traditional contracts present structural limitations to ensure long-term stability and efficiency. Contractual rigidity, information asymmetry and increasing legal conflicts have generated the need to rethink classic negotiation schemes.

Against this backdrop, sustainable contracts emerge as a strategic response to these challenges. This approach incorporates economic, social and environmental principles in the structuring of agreements, promoting more equitable, resilient and adaptable relationships. At the same time, variable negotiation is consolidating as a key tool that allows modifying contractual conditions depending on the context, reducing risk exposure and optimizing joint benefits.

However, the dawn of the 21st century offers an opportunity to understand how to respond to environmental conditions by leveraging available resources; such as energy, which plays a fundamental role in the development of business organizations and social contexts. This entails the challenge of simultaneously managing energy efficiency and resource preservation amidst rising demand.

Stanley (1901, as cited in [York et al., 2022](#)) argued that technological efficiency could Jevons' paradox addresses the challenge facing current generations by highlighting the constant tension surrounding energy source efficiency; it underscores that, while technological improvements demonstrate greater efficiency in the face of fossil fuel dependence, they are often accompanied by an increase in market demand. A factor that could negate the energy savings anticipated from such efficiency.

This study aims to examine, from a theoretical perspective, the role of sustainable development in the negotiation processes for sustainable contracts and, consequently, its impact on risk reduction and the maximization of sustainable utility or environmental benefits.

The rigid frameworks characteristic of traditional contracts formalizes immediate benefits and provides certainty regarding potential non-compliance, renegotiations, litigation, and financial losses. However, a challenge arises in balancing fundamental objectives amidst economic dynamics driven by new technological challenges, which prioritize the need to minimize risk while simultaneously maximizing efficiency and environmental utility. In today's dynamic environments, inflexible contracts increase organizational vulnerability and diminish the parties' capacity to adapt.

Faced with this scenario, the following question arises: How does sustainable development coexist with the expectations of economic agents, as documented in contracts and mediated by resources such as blockchain? From this point of view, this study analyzes the impact of variable negotiation on sustainable contracts as a mechanism to reduce risk and maximize joint economic utility.

2. Theory of Utility and Extended Economic Rationality

Classical utility theory in economics has demonstrated that economic agents focus on maximizing expected returns and, consequently, may perceive prevailing conditions in a biased manner ([Teitelbaum, 2026](#)).

However, Smith's dual ideal—republican liberty and prosperity for the less fortunate—inspired a reevaluation of the competitive sentiment, offering alternatives to the criteria expected by agents. The first, from contractual formalization, which in turn is achieved from two operational and objective approaches: the criterion of "effective competitive constraints" and the criterion of "most vulnerable consumers" ([Makris, 2025](#); [Teitelbaum, 2026](#)).

The first criterion concerns personalized conditions prioritized in the agent's interest through contracting processes subject to variables considered by that agent—characterized by switching costs and inertia stemming from the need for protection. Individualized circumstances lacking justification may fall within the scope of exploitative abuse. For its part, the second criterion entails the application of a *de minimis* rule designed to protect the parties—that is, to overcome vulnerability in general terms—enabling them to access a level of protection as opposed to having none at all. The concept of the agent perceived as vulnerable constitutes a manifestation of economic policy. ([Micklitz, 2006](#); [Sandefur, 2010](#)).

In this regard, the persistence of variables associated with both criteria and the conclusion of contractual processes are insufficient to avert the risk. It is worth considering a rational basis for achieving the expected outcomes—one that fosters new approaches grounded in economic theory focused on agent behavior, the nature of which renders the agent permanently vulnerable. This facilitates an approach to defining the group of vulnerable agents, as established in the case law of supervisory authorities and the courts ([Irshad, 2024](#)). However, a radical mitigation scenario that overlooks specific nuances or lacks a predominant selection criterion would lead to ineffective results. Furthermore, recognizing various distribution criteria based on levels of vulnerability would aid supervisory efforts.

From the perspective of the theory of the firm, a business organization is the result of a nexus of contracts arising from the creation of networks that influence the local context, thereby generating interdependencies among firms through such agreements ([Danese & Romano, 2025](#); [Ghodoosi, 2022](#); [Granovetter, 1985](#); [Luongo & Sepe, 2025](#)).

Various theoretical approaches seek to explain the voluntary decision to enter into contracts or binding agreements based on mutual interest. Within the framework of New Institutional Economics, the *homo economicus* assumption—which views the signing of contracts as a rational act driven by self-interest—represents a one-dimensional approach to human interaction. This perspective is not fully supported by empirical evidence regarding actual human behavior. ([Granovetter, 1985](#); [Ratsimandresy & Miemczyk, 2024, p. 2](#)). Notions such as "embedding" and the perspective of relational exchange are considered more integrative ([Postel, 2024](#); [Williamson, 1975](#)). The latter that binding transactions on the market are not governed solely by economic interest.

In this sense, a topic of constant discussion is sustainability that ceases to be a concept of promotion of development and care of the environment to disrupt the integral principles on which society operates from a complex context of networks, persuading consumers, companies, associations and government to manage solutions to face their own vulnerabilities. This perspective focuses its attention on the observance of contracts that, constituted under the approach to convenience to the environmental health of the planet and the social welfare of society over the economic benefit of groups and individuals (Ecologically Dominant (Burke & Morley, 2023; Macneil, 1978).

These exposes the ecological strength, the improvement of well-being and the implementation of actions to the viability of productive activities, anticipating environmental weakening. Sustainability is the principle that structures and guides contractual and management decisions in the network, ensuring that economic relations do not compromise the social or natural environment. From this, the company coordinates its own network of results from compliance with sustainability principles throughout the network, interconnecting contracts that facilitate sustainability and incorporate principles of protection.

To ensure compliance with processes linked to specific contracts and the development of groups and situations subject to environmental conditions, emphasis is placed on collaboration between the parties, alternative dispute resolution, and the integration of legal technology, with the aim of mitigating risks associated with regulatory changes and the nature of conduct (Montabon et al., 2016).

Based on (CBR) factors, the conceptual elements of innovation in sustainable systems stand out as determining elements: Cost (C): complexity of the product or unit cost; Benefit (B): strategic importance of the supplier/product; Risk (R): probability of default or failure of the supplier (Gough, 2022). Initiating different types of contracts that, from a CBR space can lead to different expected effects as a minimum; one-off; strategic; transactional; shared; high level with focus on benefits and risk; of highest level of coordination and deep strategic relationship (Gough, 2022). The Contract types based on the C–B–R dimensions are summarized in Table 1.

Table 1: Contract types Based C–B–R Dimensions

No.	Contract type	Predominant B–R focus	C– Criterion	Attribute
1	Market contract	Low/non-integrated C–B–R	Market	Spot purchasing, minimal contact, and limited contractual relationship.
2	Transactional contract – R	R	Risk reduction	Specific transaction between buyer and multiple suppliers, emphasizing risk reduction.
3	Transactional contract – C	C	Cost/complexity reduction	Supplier selection based on total costs, processes, and complexity.
4	Transactional contract – B	B	Benefit maximization	Focus on the benefits the supplier can provide.
5	Transactional contract – CB	C + B	Efficiency and benefits	Combines cost/complexity reduction with benefit realization.
6	Transactional contract – RCB	R + C + B	Comprehensive management	Simultaneously considers risks, costs/complexity, and benefits.
7	Relational focus – CB	C + B	Relational-strategic	Few suppliers, higher commitment and trust; joint focus on costs and benefits.
8	Relational focus – RCB / partial VI	R + C + B	Relational-integrated	Deep strategic relationship; considers risks, costs, and benefits; may be combined with partial vertical integration.

Source: (Gough, 2022)

Understanding the scope and feasibility of the proposals by reducing uncertainty or contractual stochasticity is one of the foundations of game theory, which assumes the ability of actors to face insecurity from different decision scenarios. However, in this approach, actors have limited information and must make decisions under conditions of uncertainty (Cheng, 2024).

In this regard, energy markets provide an empirical and conceptual context where cost levels, uncertainty, interdependence, and the demand for sustainability highlight the need to move beyond purely transactional contractual agreements. When viewed as interdependent systems and sectors, a deficiency in an agent's network structure generates a systemic effect and undermines the quality of contracts, highlighting the influence of interpretation on decision-making. In other

words, a shortcoming within the system fosters conflicts among peers regarding contracting decisions and impacts both collective performance and the reliability of the binding instrument (Cheng et al., 2024, Wang et al., 2025).

An alternative is the integration of Deep Reinforcement Learning (DRL) provides a tool for real-time strategy optimization allowing agents to adapt to fluctuating conditions amid interaction with the environment, learn from these interactions and update their strategies so that accumulated rewards are maximized. While, Evolutionary Game Theory (EGT) is centric to the learning and strategy-adoption processes within repetitive interplays among a population. The superiority of EGT over classical Game Theory (GT) is particularly pronounced in scenarios involving dynamic interactions among numerous players, as observed in the EM (Cheng et al., 2024).

3. Methodology

The present study was developed under a qualitative approach, with an exploratory design. This allowed us to identify contributions in the existing research on contracts, sustainable contracts and their negotiation strategy under the criterion of variability.

To identify the main lines of research and the results obtained during the 2021–2024 period, publications were gathered from ScienceDirect (<https://www.sciencedirect.com>) and Google Scholar. Initially, records related to "sustainable development" obtained via Google Scholar highlighted the importance of the topic. Subsequently, the results were analyzed using ScienceDirect, and a spreadsheet containing the records was downloaded in Excel format. This enabled the generation of a bibliometric network map in VOSviewer (<https://www.vosviewer.com>), thereby providing relational perspective on the subject under analysis.

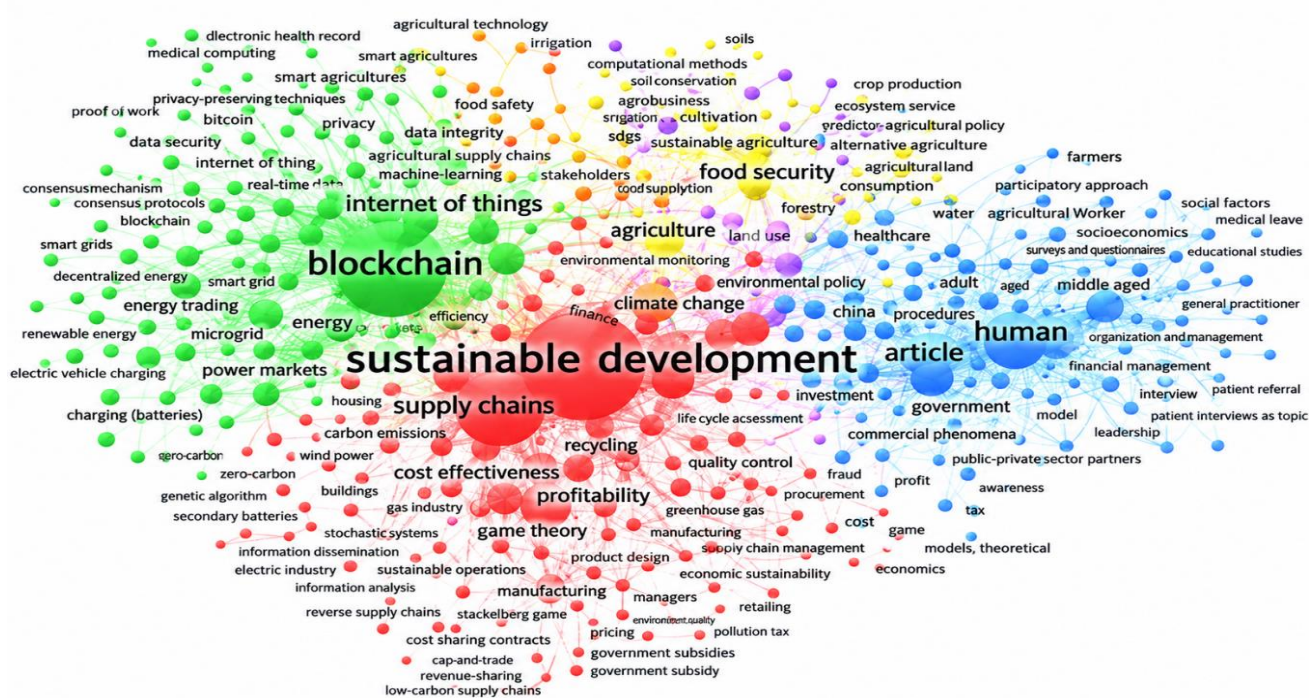


Figure 1. Source: Authors' Elaboration Using Results from <https://www.vosviewer.com>.

Figure 1 displays the keyword co-occurrence network regarding sustainable development using nodes, identifying the main lines of research, thematic relationships, and the concepts structuring the analyzed scientific literature, based on the following:

- **Central node:** sustainable development

The concept of "sustainable development" occupies a central position and stands out due to its size. This suggests that one of the fundamental themes in the analyzed results relates to economic, environmental, technological, and organizational issues.

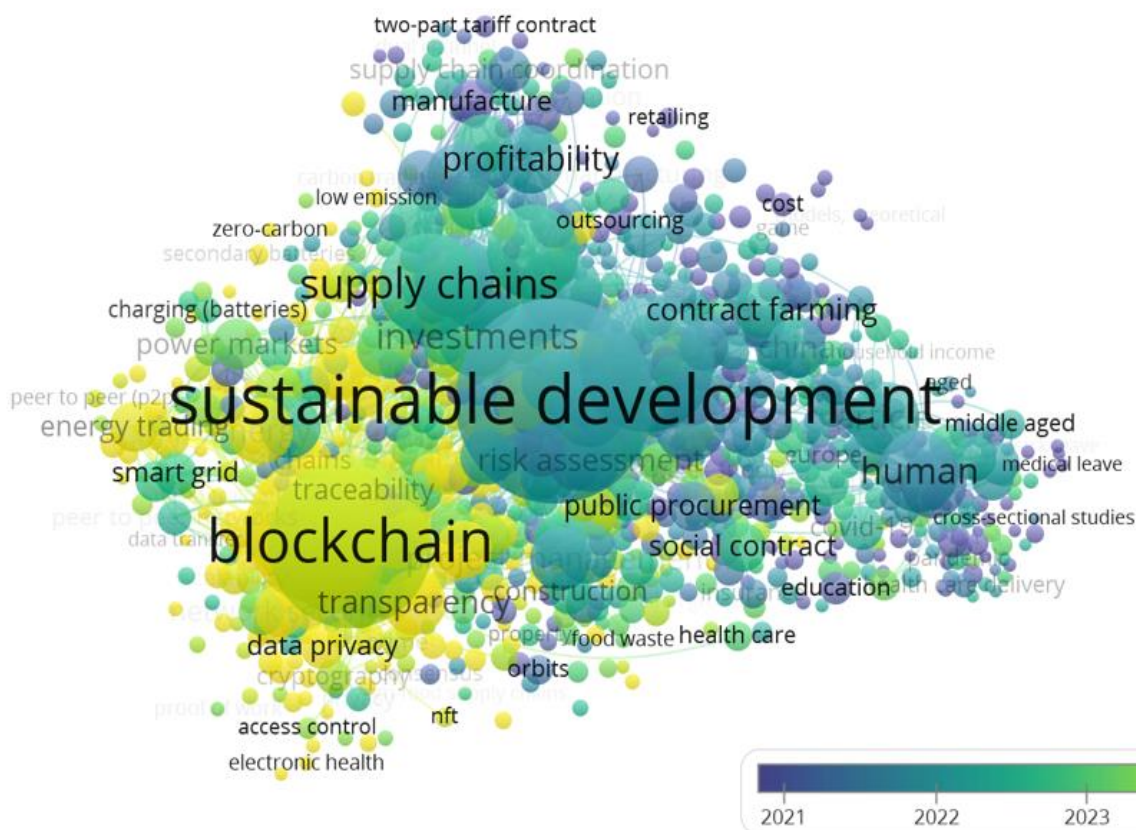
- Concepts such as blockchain, the Internet of Things, energy, energy trading, and renewable energy appear here. This reflects digitalization, energy resource management, and technologies that can contribute to sustainability. Key sub-themes include sustainable contracts and market development within the context of trading practices.

- Terms such as supply chains, profitability, recycling, manufacturing, and game theory appear here. This suggests that sustainable development is studied from the perspectives of production efficiency, profitability, the circular economy, and organizational strategic decision-making.

- Key terms include: human, governance, healthcare, financial management, leadership, and organization and management. This indicates a research focus centered on institutions, management, services, and the social dimensions of development.

- Terms such as agriculture, food security, water, land use, and sustainable agriculture stand out. This group links sustainability with agrifood systems, land use, and natural resource management.

The abundance of topics related to sustainable development highlights the importance of blockchain technology—as a means of organizing data into blocks to record information—and of the research structures that demonstrate the depth of this subject during the 2021–2024 study period.



Núm.	Keyword	Frequency of occurrences (%)	Frequency of link proportion (%)
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1	Sustainable development	24.55	17.28
2	Blockchain	16.94	18.05
3	Block-chain	12.56	16.24
4	Sustainability	11.27	7.53
5	Smart contract	8.82	11.46
6	Supply chains	6.35	7.84
7	Smart contracts	5.59	7.06
8	Supply chain management	5.27	5.5
9	Commerce	4.36	4.77
10	Decision making	4.28	4.27

Source: Authors' Elaboration Using Results from <https://www.sciencedirect.com>.

According to the results, "Sustainable development" shows the highest relative frequency, accounting for 24.55% of the occurrences among the ten terms. On the other hand, there is a duplication involving the term "blockchain"—which represents 16.94% of occurrences and accounts for the largest share of total link strength (18.05%)—and the term "Block-chain," which represents 12.56% of occurrences and 16.24% of total link strength. This spelling variant creates duplication and reinforces the term's relevance within the context of sustainable development. Finally, "Smart contract" and "smart contracts" together account for 14.41% of occurrences, demonstrating the thematic importance of smart contracts within sustainable development as a collective topic.

A potential difference between traditional and sustainable contracts lies in the flexibility of negotiation processes when faced with uncertainty. Flexibility is often incorporated into contracts through relational and formal approaches—based either on strong personal relationships between business partners or on bargaining power and negotiation skills. Contractual documents frequently lack mechanisms for managing contingencies or flexible clauses; in such cases, a lack of knowledge regarding how to employ these elements hinders their use. Furthermore, in certain situations, companies may choose to rely on relational capability (Cheng et al., 2024).

The case of sustainable contracts is linked to the technological advances of the current century, which demand interventions and, simultaneously, environmental protection processes in which flexibility is part of the capacity to adapt negotiations to new environmental requirements.

In this context, Transaction Cost Economics (TCE) explains the dynamics of supplier negotiations and their impact on organizational performance. Meanwhile, the Resource-Based View (RBV) highlights the strategic importance of leveraging resources to generate a competitive advantage. These frameworks underscore the relevance of open communication, joint problem-solving, and the creation of shared value—factors that contribute to strengthening supplier relationships and improving operational efficiency. At the same time, disparities arise from power imbalances, divergent expectations, and cultural differences—elements that can hinder relationship development and negatively affect performance. Such instabilities may be attributed to differences regarding ESG (environmental, social, and governance) criteria, which could explain their implementation and the resulting outcomes. (Wang et al., 2022).

4. Discussion

Sustainable contracts are part of the management processes through which organizations adapt their own systems to the challenges posed by society as a necessity of the 21st century; thus, sustainable contracts reflect the progress organizations have made based on their ability to respond to public challenges related to sustainable development and propose new guidelines, along with a rediscovery of the social dimension of intergenerational justice.

In particular, the capacity of sustainable contracts to transform organizations, communities and regional contexts is widely publicized, leading to a new definition of a contractual instrument focused on the organizational capacity of binding networks. It is through the structure and application of networked processes (Huntjens & Kemp, 2022)

The transitions to sustainability will not succeed without a different economy and a new social contract with rights and duties to care for the environment and the well-being of others, including future generations (Huntjens & Kemp, 2022).

In a more complex social context, a different social contract is not only desirable from the point of view of sustainability, equity, justice and equality, but is also necessary to restore public trust in politics, government, business and each other.

Social and business management tools are viewed as part of the processes that lead to environmental outcomes and, therefore, include social objectives that serve as a basis for deeper reflection on the characteristics of decision-making processes (Wang et al., 2025). A comprehensive approach to networked processes, equipped with visualization capabilities to enable organizations to enter into contracts with a sustainable focus within the social context, highlights that outcomes are shaped within the context of specific application areas based on varying capacities for negotiation and learning. Thus, data infrastructure and analytical models can be combined with project management routines to align global objectives with local realities, fostering coordination among different actors and facilitating long-term institutional learning (Cheng et al., 2024).

Beyond the processes stemming from experience in managing and formalizing agreements, the results obtained via VOSViewer reveal contextual imbalances affecting contract flexibility and negotiation; as these contracts are shared within a network, they highlight the need for a sustainable approach.

Blockchain technology, a revolutionary innovation, has achieved a great impact in various areas and markets, allowing all network participants to reach an agreement, recording data stored in a blockchain with a common history available to all, eliminating possibilities of any fraudulent activity in transactions and without the need for intermediation of a third party. Each transaction in a blockchain is secured with a digital signature that proves it's in short, the data stored in the blockchain is (Nystén-Haarala et al., 2010), (Bennet et al., 2024).

However, the challenge of conflict with corporate confidentiality policies and data protection regulation (Fan et al., 2025). When examining the concept of blockchain, a follow-up criterion is the conceptualization of the good and the prevailing justice that attributes value creation to it; promotion of meritocracy and guarantee of responsibility for actions that are related to social dynamics (Kelsen, 2022). That is, those that from a techno-deterministic and reductionist approach of society underestimate the complexities of permanent social structures, relationships and social change. Achieving individual (and collective) freedom is not achieved by challenging the "system", but rather by conforming to the "natural principles" of free market and technological progress (Kloppenburger et al., 2022). Conflicting interests and social ties are commodified and absorbed by the financial logic of blockchain technology, creating—based on its own structure—a new form of management that simultaneously seeks to ensure environmental protections.

5. Conclusion

A monitoring criterion in the opportunities posed by sustainable development is focused on the new ways of managing development from the care and protection of natural resources. Specifically, the way in which sustainability processes in the market in the 21st century is tried to benefit given the behavior of organizations and their ways of intervening in the surrounding life processes.

In this sense, the agreements signed through sustainable contracts show the importance of learning processes that can currently be converted into large scales of data and information through tools such as blockchain.

This approach allows us to recognize that there are forms of understanding and great similarities in the behavior of agents that should pursue the fulfillment of certain purposes, especially those focused on mechanisms of participation and management of achievements involve development.

Blockchain is a digitized tool from which transfers in information contribute to learning through the behavior of data and thus its valuation to the contribution of a permanent improvement in the construction of agreements and results.

However, the differentiated capabilities among the managing agents themselves contribute directly to an increasingly simple understanding focused on the ease of access to such records and information systems that raises the Jevons paradox, evidence the need to recognize that technological progress has increased the efficiency of resources as it has happened with blockchain and with it its dependence on its use away from the ability to decrease demand.

Declarations

Author Contributions

Oscar González Muñoz, Ph.D.: Supervision, Conceptualization, Investigation, Data Curation, Formal Analysis, Writing – Original Draft. Verónica Alejandra González Muñoz, Ph.D.: Methodology, Writing – Review & Editing.

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Conflict of Interest

The authors declare no conflict of interest.

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