

Smart Contracts and Enforceability Under U.S. Commercial Law

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Received: 31 December 2025; **Accepted:** 23 January 2026; **Published:** 28 February 2026

Abstract: The development of blockchain technology has introduced smart contracts as a new form of automated commercial agreement. Smart contracts are self-executing programs that perform contractual obligations when predetermined conditions are met, reducing the need for intermediaries and increasing efficiency in commercial transactions. Their growing use raises important legal questions regarding their validity and enforceability under existing legal systems, particularly under U.S. commercial law. This article examines the legal nature and enforceability of smart contracts within the framework of United States commercial law. It analyzes whether smart contracts satisfy the essential elements of contract formation, including offer, acceptance, consideration, and mutual assent. The article also explores the applicability of the Uniform Commercial Code (UCC) and its role in recognizing electronic and automated agreements. The article concludes that smart contracts can be legally enforceable under U.S. commercial law if they meet traditional contract requirements. Existing legal principles are flexible enough to accommodate smart contracts, making them a reliable tool for modern digital commerce.

Keywords: Smart contracts, blockchain technology, contract formation, U.S. commercial law, Uniform Commercial Code (UCC), electronic contracts, legal enforceability, digital transactions, automated agreements, blockchain law.

Introduction: In recent decades, rapid technological innovation has significantly transformed the structure and operation of commercial transactions. The emergence of digital communication, electronic commerce, and decentralized technologies has altered how parties negotiate, form, and enforce contractual relationships. One of the most influential technological developments in this context is blockchain technology, which enables secure, transparent, and decentralized recordkeeping without relying on traditional intermediaries such as banks, brokers, or legal enforcement institutions. Among the various applications of blockchain technology, smart contracts have attracted particular attention due to their potential to fundamentally change the way contractual obligations are performed and enforced.

The concept of smart contracts was first introduced in the 1990s by computer scientist Nick Szabo, who described them as computerized transaction protocols that execute contractual terms automatically. However, the practical implementation of smart

contracts only became feasible with the development of blockchain networks, particularly after the introduction of programmable blockchain platforms such as Ethereum. These platforms allow developers to create self-executing agreements that operate according to predefined instructions embedded in computer code. Once deployed, smart contracts execute automatically when specified conditions are satisfied, without requiring further human intervention.

This automation represents a major shift from traditional contract enforcement mechanisms. Historically, contract performance has depended largely on the voluntary compliance of the parties or, in cases of dispute, on judicial enforcement through courts and legal institutions. Smart contracts, by contrast, rely on technological enforcement rather than institutional enforcement. The blockchain ensures that once contractual conditions are met, the agreed-upon actions—such as transferring funds, releasing digital assets, or recording ownership—occur

automatically and cannot easily be altered or reversed. This feature enhances efficiency and reduces the risk of non-performance, fraud, or delay.

The increasing adoption of smart contracts has been particularly evident in sectors such as financial services, digital asset trading, supply chain management, insurance, and international commerce. In financial transactions, smart contracts enable automated payments, lending, and asset transfers without the need for traditional financial intermediaries. In supply chain operations, they facilitate automatic verification of delivery and payment execution upon confirmation of shipment. Similarly, insurance companies can use smart contracts to automatically process claims when predefined conditions, such as verified events, are met. These applications demonstrate the broad commercial potential of smart contracts and their capacity to improve transactional efficiency and transparency.

Despite these advantages, the growing use of smart contracts raises important legal questions, particularly regarding their enforceability under existing legal frameworks. Commercial law in the United States has traditionally been based on principles developed long before the emergence of blockchain technology. These principles assume that contracts are expressed in written or spoken language and that disputes are resolved through judicial interpretation and enforcement. Smart contracts challenge these assumptions by expressing contractual terms in computer code and relying on automated execution rather than judicial enforcement.

A central legal issue is whether smart contracts satisfy the fundamental requirements necessary to form a legally binding contract under U.S. commercial law. These requirements generally include offer, acceptance, consideration, mutual assent, and legality. While smart contracts can technically perform contractual functions, questions remain about whether code-based agreements adequately reflect the parties' intent and whether automated execution aligns with traditional legal doctrines. Furthermore, issues such as coding errors, lack of flexibility, jurisdictional uncertainty, and the inability to easily modify or terminate blockchain-based agreements create additional legal complexity.

U.S. law has taken significant steps to recognize electronic contracts and digital signatures through legislation such as the Electronic Signatures in Global and National Commerce Act and the Uniform Electronic Transactions Act. These laws establish that electronic agreements cannot be denied legal effect solely because they are in electronic form. Additionally, the Uniform Commercial Code provides a flexible

framework for contract formation in commercial transactions, allowing agreements to be formed through electronic and automated means. These legal developments suggest that smart contracts may be enforceable under existing legal principles, provided that they meet traditional contract formation requirements.

At the same time, courts and lawmakers continue to face challenges in adapting traditional legal doctrines to decentralized and automated technologies. Unlike conventional contracts, smart contracts operate across decentralized networks that may involve multiple jurisdictions, anonymous participants, and autonomous execution mechanisms. This raises questions about applicable law, dispute resolution, liability, and remedies in cases of error or breach. Moreover, judges and legal practitioners must interpret technical code, which may not always clearly reflect the parties' legal intentions.

The enforceability of smart contracts is therefore not only a technical issue but also a legal and institutional one. It requires the integration of technological innovation with established legal principles to ensure that contractual relationships remain reliable, fair, and enforceable. Understanding how smart contracts fit within the framework of U.S. commercial law is essential for businesses, legal professionals, regulators, and policymakers as they navigate the evolving digital economy.

This article examines the legal status and enforceability of smart contracts under U.S. commercial law. It analyzes the fundamental principles of contract formation, the applicability of existing electronic commerce legislation, the role of the Uniform Commercial Code, and the challenges associated with automated contract execution. By exploring these issues, the article aims to clarify the legal framework governing smart contracts and assess their implications for the future of commercial transactions.

Definition and Legal Nature of Smart Contracts

When discussing smart contracts, the first question to touch upon is the terminology and the meaning of the term. The question is whether smart contracts are really contracts at all where a smart contract is just a type of contract. In the existing scholarship, there is a tendency to draw dichotomies and lament vague and confused nomenclature or point out that the notion "smart contract" is actually a misnomer, that smart contracts are neither smart nor that they are contracts, which seems to be true. It has been remarked that "Smart Contract" is an ironic and unfortunate misnomer, and it would be better off being referred to as 'an "automated transaction manager" or "ATM", but

that... has already been taken'. What seems to be the case is that legal contracts will require, at least for the near future, a blend between code and natural language. These ties in with the previous point about Smart Contracts being a method of performance of parts or entire commercial transactions, rather than a contract. Together they lead to an ad hoc answer to the question: smart legal contract can be enforceable when it is a part of an otherwise enforceable and valid natural language contract, imposing a method of performance. That much seems obvious. If two parties agree on a method of performance the court is extremely unlikely to invalidate such a clause because it pertains to an automated coded method. Some commentators go as far as to claim that 'smart contracts' are merely computer programmes that parties use to perform their contracts not agreements or contracts. Allen's view is a riposte to the critique laid out by Pardolesi et al. arguing that: 'there is no barrier to a single instrument, written in formal language [i.e code], embodying both the contract as such and its automated mechanism of performance.

Smart Contracts can be said to be self-enforcing in the sense that once the Smart Contract has been concluded, and is stored on a blockchain, if the condition is satisfied the assets will change hands, even if the original parties to the contract no longer wish them too. They can also be said to be self-enforcing in the sense that the discretion whether or not to abide by the terms of the contract is taken away from the parties, and once they have concluded a Smart Contract they will abide by the terms (generally). Accordingly, it is submitted that this kind of broad attacks on Smart Contracts' identity as contracts can be rejected, and it cannot be stated that Smart Contracts will never be contracts. Another line of argument is that 'smart contracts are... not agreements – they are technology for enforcing agreements'. The argument goes that a piece of code unaccompanied by any legal terms 'may not satisfy the requirement of a legally binding contract'. This objection could be met in two ways: (1) it is clear that if a smart contract is just a method of performing of one or more clauses of a natural language (traditional) contract, then the code itself will not be the contract; (2) a pure smart contract (without a corresponding natural language contract) will not be a valid binding contract unless the elements discussed above are satisfied. Accordingly, it is wrong to state that a smart contract will "never" be a legally-valid contract, it is right to think that some Smart Contracts will fall short of constituting a valid contract, just as a note or natural language communication may fall short of constituting a traditional contract because some defining requirement of a contract in law is

missing.

From a legal perspective, smart contracts are not necessarily a new category of contracts but rather a new method of expressing and performing contractual obligations. Legal scholars emphasize that the term "smart contract" can refer to different but related concepts. The first concept refers to smart contract code, which is the computer program that automatically executes contractual terms. This code may represent the entire agreement or only certain aspects of it.

The second concept refers to smart legal contracts, which combine traditional legal language with automated execution mechanisms. In such cases, the legal agreement exists in written form, while the performance of certain obligations is carried out automatically by software. This distinction is important because the legal enforceability of smart contracts depends not only on the presence of computer code but also on whether the essential legal elements of a contract are satisfied. Courts focus on the existence of mutual agreement, intent, and consideration rather than the specific format in which the contract is expressed. Under commercial law, contracts may be formed through various methods, including written documents, verbal agreements, and electronic communications. Smart contracts represent an extension of this principle, using computer code as the medium for expressing agreement and performing obligations.

Smart contracts possess a hybrid nature, combining both legal and technological characteristics. On one hand, they function as legal agreements that create rights and obligations between parties. On the other hand, they operate as technological tools that automate contractual performance. This hybrid nature creates both advantages and challenges. Automation increases efficiency and reduces enforcement costs, but it also raises questions about legal interpretation, liability, and flexibility. For example, if a smart contract contains a coding error, determining whether the code or the parties' original intent should control the outcome becomes a complex legal issue. Furthermore, smart contracts may operate across multiple jurisdictions, creating uncertainty regarding applicable law and enforcement authority. These challenges highlight the need for legal systems to adapt to emerging technological developments while preserving fundamental principles of contract law.

Smart contracts represent an important evolution in the way commercial agreements are formed and enforced. Their ability to automate contractual performance enhances efficiency, reduces reliance on

intermediaries, and increases trust in digital transactions. At the same time, smart contracts do not replace traditional legal principles. Instead, they function within existing legal frameworks, which continue to govern issues such as contract formation, interpretation, liability, and dispute resolution. As blockchain technology continues to develop, smart contracts are expected to play an increasingly significant role in commercial transactions, particularly in areas involving digital assets, financial services, and international trade.

Essential Elements of Contract Formation Under U.S. Law

The enforceability of any contract under the legal system of the United States depends on the presence of certain essential elements required for valid contract formation. These elements are rooted in common law principles and statutory provisions, including the Uniform Commercial Code (UCC), which governs commercial transactions involving goods. Regardless of whether a contract is formed through traditional written agreements, electronic communications, or smart contract code operating on blockchain systems, the same fundamental legal requirements must be satisfied. These elements include offer, acceptance, consideration, mutual assent, capacity, and legality. Each of these components plays a crucial role in establishing a legally binding contractual relationship.

An offer is the initial step in contract formation and represents a clear and definite proposal made by one party (the offeror) to another party (the offeree). The offer must communicate a willingness to enter into a legally binding agreement on specific terms, with the intention that acceptance by the other party will create a contract. To qualify as a valid offer under U.S. law, the proposal must contain sufficiently definite terms. These typically include essential details such as the identity of the parties, the subject matter of the agreement, the price or method of determining the price, and the obligations of each party. Courts evaluate whether a reasonable person would interpret the offer as a serious intention to create legal obligations rather than merely an invitation to negotiate. In the context of smart contracts, an offer may be expressed through computer code deployed on a blockchain network. For example, a seller may create a smart contract offering digital assets at a specified price. By making this smart contract publicly accessible, the seller communicates the terms under which another party may accept the offer. The automated nature of smart contracts does not prevent the existence of a valid offer, provided the contractual terms are clear and accessible. Additionally, under the Uniform Commercial Code, an offer may be made in

any manner sufficient to show agreement, including electronic and automated systems. This flexible approach allows modern technological methods, including blockchain-based smart contracts, to satisfy the offer requirement.

Acceptance is the expression of agreement by the offeree to the terms of the offer. It must demonstrate a clear and unconditional willingness to be bound by the offer's terms. Once acceptance occurs, a binding agreement is generally formed. Acceptance must correspond directly to the terms of the offer. This principle, known as the "mirror image rule" under common law, requires that acceptance match the offer without modification. If the offeree attempts to change the terms, the response may be considered a counteroffer rather than acceptance. Acceptance may be expressed through various methods, including written communication, verbal agreement, conduct, or electronic interaction. U.S. law recognizes that acceptance may also occur through actions that clearly demonstrate agreement. For example, clicking an "I agree" button, sending payment, or performing contractual obligations may constitute valid acceptance. In smart contracts, acceptance is typically demonstrated through interaction with the contract code. For instance, when a user sends cryptocurrency to a smart contract address in accordance with the contract terms, this action indicates acceptance of the offer. The blockchain records this interaction, providing verifiable evidence of acceptance. The use of automated systems does not invalidate acceptance. U.S. electronic commerce laws explicitly recognize that contracts may be formed through electronic agents, including automated computer programs, without direct human involvement at the time of execution.

Consideration refers to the exchange of something of legal value between the parties. It is a fundamental requirement for contract enforceability because it demonstrates that each party is providing something in return for the other party's promise or performance.

Consideration may take various forms, including:

- Payment of money
- Transfer of goods or property
- Provision of services
- Promise to perform or refrain from performing certain actions

The law does not require consideration to be equal in value, but it must be legally sufficient. Courts generally do not evaluate whether the exchange is economically fair, provided that both parties voluntarily agreed to the exchange. In smart contracts, consideration often involves digital assets, cryptocurrency, or electronic

transfers of value. For example, a buyer may transfer cryptocurrency in exchange for ownership of a digital asset or access to a service. This exchange satisfies the requirement of consideration because both parties provide something of value. The presence of automated performance does not eliminate the need for consideration. Smart contracts must still involve an exchange of value in order to be legally enforceable under contract law principles.

The final essential element of contract formation is legality. A contract must involve lawful subject matter in order to be enforceable. Agreements involving illegal activities, such as fraud, illegal gambling, or prohibited transactions, are not enforceable under U.S. law. Even if all other elements of contract formation are present, a contract will be considered void if its purpose violates the law or public policy. This principle also applies to smart contracts. For example, a smart contract designed to facilitate illegal transactions would not be legally enforceable, regardless of its technological validity. Courts focus on the legality of the underlying agreement rather than the method of execution. Smart contracts must satisfy the same legal requirements as traditional contracts in order to be enforceable. Although smart contracts use technological mechanisms to automate performance, they do not replace fundamental legal principles.

Courts evaluating smart contract disputes will examine whether:

- A clear offer was made
- Acceptance occurred
- Consideration was exchanged
- Mutual assent existed
- Parties had legal capacity
- The agreement involved lawful subject matter

If these elements are present, the smart contract may be recognized as a legally binding agreement under U.S. commercial law. The use of blockchain technology may strengthen contract enforceability by providing reliable evidence of agreement, performance, and transaction history. However, legal enforceability ultimately depends on compliance with established legal requirements rather than technological implementation alone.

Applicability of the Uniform Commercial Code (UCC)

The Uniform Commercial Code (UCC) is one of the most important legal frameworks governing commercial transactions in the United States. It provides standardized rules that regulate the formation, performance, and enforcement of contracts involving the sale of goods and other commercial activities.

Although the UCC was developed before the emergence of blockchain technology and smart contracts, its flexible and technology-neutral provisions allow it to apply to modern digital transactions, including smart contracts, under appropriate circumstances.

The UCC has been adopted, with minor variations, by all fifty U.S. states, making it a uniform and consistent legal framework for commercial transactions across the country. Its primary purpose is to promote certainty, predictability, and efficiency in commerce by establishing clear rules governing contractual relationships between businesses and individuals. As smart contracts increasingly facilitate commercial transactions, the applicability of the UCC to these automated agreements has become an important legal issue.

Article 2 of the UCC governs contracts involving the sale of goods. One of its most important provisions is Section 2-204, which establishes a flexible standard for contract formation. It provides that a contract for the sale of goods may be formed in any manner sufficient to show agreement, including conduct by both parties recognizing the existence of a contract. This provision is particularly significant for smart contracts because it does not require contracts to be written in traditional legal language. Instead, agreement may be demonstrated through actions, electronic communications, or automated systems. Smart contracts, which execute based on programmed instructions and user interactions, can satisfy this requirement if the parties' conduct demonstrates mutual agreement. Furthermore, UCC Section 2-206 provides that acceptance may occur through any reasonable means unless the offer specifies a particular method of acceptance. This allows acceptance through electronic interaction with smart contract systems, such as transferring digital assets or initiating blockchain transactions. The flexibility of these provisions ensures that the UCC can accommodate modern contracting methods, including automated and blockchain-based agreements.

The UCC recognizes that commercial transactions may be conducted through electronic and automated systems. Although earlier versions of commercial law assumed human interaction in contract formation, modern commercial practices increasingly rely on automated technologies. Under UCC principles, a contract may be formed through the interaction of electronic agents, which are computer programs capable of performing actions without direct human intervention. Smart contracts fall within this category because they operate as autonomous software programs that execute contractual terms

automatically. The recognition of automated transactions ensures that contracts formed through smart contract systems are not invalid simply because they are executed by computer code rather than human action. Instead, courts examine whether the parties intentionally used the automated system to create contractual obligations. This approach reflects the UCC's broader goal of supporting commercial innovation while maintaining legal certainty. Smart contracts are particularly relevant in transactions involving the sale of goods, which fall under Article 2 of the UCC. In such transactions, smart contracts may be used to automate various contractual functions, including:

- Processing payments
- Confirming delivery of goods
- Transferring ownership rights
- Enforcing contractual conditions

For example, a smart contract may be programmed to release payment automatically once delivery of goods is verified through digital tracking systems. This automated process fulfills the essential contractual obligations of both parties. The UCC does not require contracts to be performed manually. Automated performance through smart contracts is consistent with the UCC's emphasis on commercial efficiency and practical business practices. However, the UCC applies primarily to contracts involving goods rather than services. Therefore, the applicability of the UCC to smart contracts depends on the nature of the underlying transaction.

One of the most important features of the UCC is its technology-neutral approach. The UCC does not require contracts to be formed using specific technologies or formats. Instead, it focuses on whether the parties intended to create a binding agreement. This flexibility allows the UCC to adapt to technological developments such as electronic contracts, digital signatures, and smart contracts. Courts interpreting the UCC have consistently emphasized that commercial law must evolve to accommodate modern business practices. Smart contracts represent a new method of performing contractual obligations, but they do not fundamentally alter the legal principles governing contract formation and enforcement. As long as smart contracts satisfy the essential requirements of agreement, consideration, and commercial intent, they may be enforceable under the UCC.

The applicability of the UCC to smart contracts provides an important legal foundation for their enforceability. By recognizing contracts formed through electronic and automated systems, the UCC supports the use of smart

contracts in commercial transactions. The UCC ensures that smart contracts involving the sale of goods or secured transactions may be legally enforceable if they meet the fundamental requirements of contract formation. This legal recognition promotes confidence in blockchain technology and encourages innovation in digital commerce. As smart contracts become more widely used, courts and lawmakers may continue to interpret and adapt UCC provisions to address new technological developments. The UCC's flexible and adaptive framework ensures that it will remain relevant in the evolving digital economy.

CONCLUSION

The emergence of smart contracts represents a significant technological advancement in the formation and performance of commercial agreements. By enabling automated execution of contractual obligations through blockchain technology, smart contracts enhance efficiency, transparency, and reliability in commercial transactions. Their ability to eliminate intermediaries and reduce enforcement costs has made them an increasingly important tool in various sectors, including financial services, digital asset management, supply chain operations, and international commerce. Despite their technological innovation, smart contracts do not exist outside the traditional legal framework. Their enforceability under U.S. commercial law depends on their compliance with established legal principles governing contract formation. As demonstrated in this article, smart contracts are capable of satisfying essential legal requirements such as offer, acceptance, consideration, mutual assent, capacity, and legality. The fact that contractual terms are expressed in computer code rather than natural language does not prevent the formation of a legally binding agreement, provided that the parties' intent to create legal obligations can be established.

The Uniform Commercial Code plays a particularly important role in supporting the legal recognition of smart contracts. Its flexible and technology-neutral provisions allow contracts to be formed through electronic and automated means, making it well suited to accommodate blockchain-based agreements. By recognizing automated transactions and electronic contracting mechanisms, the UCC provides a legal foundation for the enforceability of smart contracts in commercial transactions involving goods and secured interests. At the same time, smart contracts present certain legal and practical challenges. Issues such as coding errors, lack of flexibility, jurisdictional uncertainty, and the difficulty of interpreting technical code may complicate their legal application. Courts and legal practitioners must adapt existing legal doctrines

to address these challenges while ensuring that contractual relationships remain fair and enforceable. The integration of legal and technological expertise will be essential in resolving disputes and developing appropriate regulatory frameworks.

Ultimately, smart contracts represent an evolution in the method of contractual performance rather than a replacement of traditional contract law. Existing legal principles are sufficiently adaptable to accommodate this emerging technology. As blockchain technology continues to develop and become more widely adopted, smart contracts are likely to play an increasingly significant role in commercial transactions. Ensuring their legal enforceability within established legal frameworks will be essential for promoting trust, innovation, and stability in the modern digital economy.

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