

# FORCE MAJEURE IN THE AGE OF DIGITAL ASSETS: A NEW FRAMEWORK FOR INTERNATIONAL CRYPTOCURRENCY MARKETS

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*“The life of the law has not been logic; it has been experience.”*  
— Justice Oliver Wendell Holmes, Jr.<sup>1</sup>

## INTRODUCTION

In an era in which teenagers can become crypto millionaires overnight, sports arenas rebrand for digital currencies, and Elon Musk’s tweets about Dogecoin move markets, cryptocurrency has become impossible to ignore—but its underlying smart contracts pose an even more revolutionary challenge to contract law.<sup>2</sup> These self-executing digital agreements, which automatically enforce obligations through code rather than courts, have begun to reshape international commerce in ways that traditional legal frameworks never anticipated.<sup>3</sup> When a smart contract, managing millions in cross-border transactions, fails, it raises a pressing question: How does the centuries-old force majeure doctrine apply when “force” can be a bug in the code and the “majeure” can happen at the speed of light, or whether force majeure should even play a role at all?<sup>4</sup>

The United Nations Convention on International Sale of Goods (“CISG”)

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1. OLIVER WENDELL HOLMES, *THE COMMON LAW* (Mark DeWolfe Howe ed., Harvard Univ. Press 1963) (1881).

2. See Amy Francombe, *Billion dollar babies: meet the teenagers making a fortune off cryptocurrency*, STANDARD (Apr. 7, 2022), <https://www.standard.co.uk/lifestyle/cryptocurrency-money-teenagers-tiktok-social-media-influencers-b993101.html> [<https://perma.cc/H63U-BP8F>]; Jordan Greer, *Why did Staples Center become Crypto.com Arena? Home venue for Lakers, Clippers undergoes name change*, SPORTING NEWS (Dec. 25, 2021, at 07:45 EST), <https://www.sportingnews.com/us/nba/news/staples-center-crypto-com-arena-name-change-lakers-clippers/28kzrkjlkxyx1rzo7rj18r64j> [<https://perma.cc/V7Q8-WG82>]; Catherine McGrath, *Dogecoin soars 15% as Elon Musk replies ‘D.O.G.E’ to question about proposed Department of Government Efficiency*, FORTUNE CRYPTO (Oct. 18, 2024, at 16:36 EDT), <https://fortune.com/crypto/2024/10/18/dogecoin-soars-15-as-elon-musk-replies-d-o-g-e-to-question-about-proposed-department-of-government-efficiency/> [<https://perma.cc/4TLW-RW3U>].

3. Jerome Desbonnet & Oded Vanunu, *The rise of smart contracts and strategies for mitigating cyber and legal risks*, WORLD ECON. F. (July 16, 2024), <https://www.weforum.org/stories/2024/07/smart-contracts-technology-cybersecurity-legal-risks/> [<https://perma.cc/LBE5-GVZ7>].

4. *Id.*

has been the backbone of international commercial contracts since the 1980s.<sup>5</sup> The CISG was drafted when contracts were written on paper, and examples of force majeure were natural disasters, wars, or government action.<sup>6</sup> Today, smart contracts have the capability to facilitate billions of dollars in international business transactions through decentralized finance (“DeFi”) platforms, while the CISG’s traditional approach to force majeure appears increasingly antiquated.<sup>7</sup> For example, WazirX’s loss of approximately \$230 million occurred after attackers exploited a vulnerability in a smart contract-controlled multi-signature wallet, which automatically governed access to customer funds.<sup>8</sup> These types of events are largely un contemplated by Article 79 of the CISG.

From ancient Mesopotamian clay tablets to today’s distributive ledger technology, commercial contracts have evolved to meet the needs of their time. Smart contracts represent more than mere technological progress—they fundamentally alter contractual relationships. While a traditional international sale of goods contract might excuse performance due to a port closure or trade embargo, the question arises: what happens when a smart contract’s oracle fails, triggering an unstoppable cascade of automated transactions across multiple jurisdictions?<sup>9</sup> The emergence of distributive ledger technology and cryptocurrency markets necessitates a fundamental reconceptualization of what constitutes an act beyond human control in digital commerce.

This Note argues that the CISG’s force majeure provision is inadequately equipped to address the unique vulnerabilities inherent in distributive ledger technology, e.g., smart contract malfunctions, consensus attacks, and protocol

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5. Evaldas Cerkesas, *The Aspects of International Sale of Goods Contracts*, ESAS CONSULTING (Nov. 9, 2020), <https://esasconsulting.eu/en/insights/international-sale-of-goods-contract/> [https://perma.cc/9SK5-C39M].

6. Larry A. DiMatteo, *Contractual Excuse Under the CISG: Impediment, Hardship, and the Excuse Doctrines*, 27 PACE INT’L L. REV. 258, 300 (2015).

7. Roomy Khan, *DeFi—Financial Alchemy in a Trillion-Dollar Market*, FORBES (Aug. 7, 2024), <https://www.forbes.com/sites/roomykhan/2024/08/07/defi--financial-alchemy-in-a-trillion-dollar-market/> [https://perma.cc/XKC2-TJ8C]; Yogesh Shinde, *Smart Contracts in Trade Finance Market to hit USD 37.95 billion by 2034*, SCOOP (Dec. 31, 2025), <https://scoop.market.us/smart-contracts-in-trade-finance-market-news-2/> [https://perma.cc/UUJ3-C7U6].

8. E.g., *Crypto absurdity: WazirX plan to socialise losses deeply flawed*, FIN. EXPRESS (July 30, 2024), <https://www.financialexpress.com/opinion/crypto-absurdity-wazirx-plan-to-socialise-losses-deeply-flawed/3568360/> [https://perma.cc/YQZ2-KG3F].

9. An oracle is a third-party service that allows smart contract to access real-world data from external sources, essentially acting as a bridge between the blockchain and the outside world. Further explanation of oracles is found later in the Note. See Malanii Oleh & Lavrenenko Viktor, *Blockchain Oracles: Their Importance, Types, and Vulnerabilities*, HACKEN (Nov. 22, 2023), <https://hacken.io/discover/blockchain-oracles/> [https://perma.cc/9S6S-YWSK]; see Philipp Tamussino et al., *Impact of Sanctions on Contracts*, COVINGTON (May 23, 2022), <https://www.cov.com/-/media/files/corporate/publications/2022/05/impact-of-sanctions-on-contracts.pdf> [https://perma.cc/BJV8-YV8T]; Noam Elstein, *What Is the Blockchain Oracle Problem, And Why Does it Matter?*, SILENT DATA (Nov. 14, 2024), <https://www.silentdata.com/blog/what-is-the-blockchain-oracle-problem-and-why-does-it-matter> [https://perma.cc/2TH3-85PL].

failures.<sup>10</sup> Drawing parallels from traditional financial institutions' force majeure triggers during cybersecurity breaches, this Note proposes that force majeure provisions must evolve to encompass both conventional catastrophic events and novel digital disruptions in international business transactions. This Note proceeds as follows. Part I of this Note will explain the background and framework of smart contracts. Part II examines the force majeure clause of the CISG, Article 79(1). Part III briefly explains force majeure under the Uniform Commercial Code ("UCC"). Part IV of this Note will examine several approaches to fix the inadequacies of the CISG and different interpretations of Article 79(1) of the CISG. Part V of this Note will provide a recommendation to businesses entering into smart contract transactions and proposes a force majeure clause to protect vulnerable parties. Lastly, part VI will provide a brief conclusion and final thoughts on smart contracts and Article 79.

## I. BACKGROUND OF SMART CONTRACTS

### A. Definitions and Existing Framework

The concept of smart contracts was attributed to Nick Szabo, an American computer scientist and researcher of digital currencies in 1994.<sup>11</sup> Although, back in the late 1600's, German Mathematician Gottfried Wilhelm Leibniz had a similar idea of turning all legal arguments into matters of pure logic that could potentially be resolved by a machine.<sup>12</sup> But Mr. Szabo's turned his idea into reality; his early conception of a smart contract was a "computerized transaction protocol that executes the terms of a contract."<sup>13</sup> Simply put, a smart contract is a digital version of a normal paper contract, that automatically verifies

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10. Consensus attacks are malicious attempts to take control of a blockchain network by manipulating its agreement mechanism, typically to reverse transactions or halt operations. See Oleh Malanii, *Consensus Mechanisms In Blockchain: A Deep Dive Into The Different Types*, HACKEN (June 30, 2025), <https://hacken.io/discover/consensus-mechanisms/> [<https://perma.cc/63ND-PGQB>]. Protocol failures refer to the breakdown, malfunction, or violation of established rules, procedures, or technical standards that govern communication, security, or operational processes. See *id.*

11. *Smart Contract*, CFI, <https://corporatefinanceinstitute.com/resources/valuation/smart-contract/#:~:text=Essentially%2C%20a%20smart%20contract%20is,of%20digital%20currencie s%2C%20in%201994/> [<https://perma.cc/2BSP-SPHN>] (last visited Feb. 2, 2025).

12. Gottfried Wilhelm Leibniz was a German polymath active as a mathematician, philosopher, scientist, and diplomat who is credited, alongside Sir Isaac Newton, with the creation of calculus, binary arithmetic, and statistics. See BUSINESS INSIDER, *Stephen Wolfram Explains How Smart Contracts Will Work* (YouTube, Sep. 27, 2018), <https://www.youtube.com/watch?v=IddTrcE5Qwo> [<https://perma.cc/MPY2-QLXY>]; see Oscar Schwartz, *In the 17th Century, Leibniz Dreamed of a Machine That Could Calculate Ideas*, SPECTRUM (Nov. 4, 2019), <https://spectrum.ieee.org/in-the-17th-century-leibniz-dreamed-of-a-machine-that-could-calculate-ideas> [<https://perma.cc/XN3J-8BDA>].

13. Nick Szabo, *Smart Contracts*, SATOSHI NAKAMOTO INST. (1994), <https://nakamoto.institute.org/library/smart-contracts/> [<https://perma.cc/5XHA-LZEY>].

fulfillment and enforces and performs the terms of the contract.<sup>14</sup> The most famous real-world example is a vending machine.<sup>15</sup> The owner of the vending machine stocks it, which is accepted when a buyer inserts payment and selects an item; the code running the vending machine takes over to perfect performance.<sup>16</sup> The vending machine verifies input, dispenses the buyer's selection, and returns any required change.<sup>17</sup> In even simpler terms, when X happens, Y automatically happens without any further action from the two parties.<sup>18</sup>

Smart contracts provide several advantages over traditional paper contracts: they minimize the risk of transactions failing, cut down on administrative overhead and service expenses, streamline business operations through automated execution, and use digital ledger technology ("DLT") security.<sup>19</sup> Many industries such as logistics, trade, manufacturing, the public sector, and real estate stand to benefit from the evolution of smart contracts.<sup>20</sup> Smart contracts enable these industries to handle certain types of contracts, insurance, orders, supply chain management, and licensing more securely and accurately than ever before.<sup>21</sup> However, not all smart contracts are created equal.

Professor Max Raskin's distinction hinges on their revocability: strong smart contracts are virtually impossible to modify or revoke once executed, while weak smart contracts remain subject to external intervention like courts.<sup>22</sup> This creates a problem in contract law, as courts and lawmakers must balance the immutable, self-executing benefits of strong smart contracts with the need for legal oversight and consumer protection because the strength of smart contracts lies partly within their security and inflexibility.<sup>23</sup> Therefore, the underlying principle society must remember is that a contract is still a contract, whether smart or traditional—it's a documented agreement between two

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14. *Smart Contract*, *supra* note 11.

15. Laura E. Jehl & Brian Bartish, *Blockchain 'Smart Contracts' – A New Transactional Framework*, BLOOMBERG L. (May 2018), <https://www.bloomberglaw.com/external/document/X4SGO17O000000/tech-telecom-professional-perspective-blockchain-smart-contracts/> [<https://perma.cc/XZD8-XDBX>].

16. *Id.*

17. *Id.*

18. DEAN ARMSTRONG KC, DAN HYDE & SAM THOMAS, *BLOCKCHAIN AND CRYPTOCURRENCY: INTERNATIONAL LEGAL AND REGULATORY CHALLENGES* 47 (2nd ed. 2022).

19. Hamed Taherdoost, *Smart Contracts in Blockchain Technology: A Critical Review*, 14 *INFORMATION* 117 (2023).

20. Renato Fazzone & Jessica de Brignac, *Understanding the Functionality and Benefits of Smart Contracts for Corporations*, FTI CONSULTING, <https://www.ftitechnology.com/resources/blog/understanding-the-functionality-and-benefits-of-smart-contracts-for-corporations> [<https://perma.cc/H4UC-VX7V>] (last visited Feb. 17, 2026).

21. *Id.*

22. Professor Max Raskin is an Adjunct Professor of Law at New York University. Professor Raskin teaches a course titled *Digital Currency, Blockchains and the Future of Financial Services*. See ARMSTRONG KC, HYDE & THOMAS, *supra* note 18; see Max Raskin, *The Law and Legality of Smart Contracts*, 1 *GEO. L. TECH. REV.* 305, 310 (2017).

23. Raskin, *supra* note 22.

parties.<sup>24</sup>

A real-world example of how smart contracts are used today is in agricultural supply-chain tracking, particularly in the Australian wine industry.<sup>25</sup> In September 2020, Australian agricultural technology firm Entrust announced that it would use Hedera’s hashgraph public distributed ledger to help prevent wine fraud by allowing consumers to verify a bottle’s authenticity.<sup>26</sup> More than a dozen wineries in South Australia’s Clare Valley are participating in the project, which is tracking over 250,000 liters of wine.<sup>27</sup> Entrust’s system records location and time data on an immutable ledger, allowing producers to track products from grapes through bottling and distribution.<sup>28</sup> This use of distributed ledger technology shows how smart contract systems can increase transparency and trust in real-world commercial supply chains.<sup>29</sup>

That same immutability and automation that make smart contracts attractive in commerce have also placed them squarely in the crosshairs of federal regulators and courts. In *Van Loon v. Department of the Treasury*, the United States Court of Appeals for the Fifth Circuit confronted a critical distinction between mutable and immutable smart contracts in reviewing the federal government’s sanctions against Tornado Cash, a decentralized protocol that relies on immutable smart contracts to facilitate private cryptocurrency transactions.<sup>30</sup> The Fifth Circuit framed the question as whether immutable smart contracts—those not owned, operated, or alterable by any person or entity—could constitute “property” subject to sanctions under federal law.<sup>31</sup> Drawing a sharp distinction from mutable contracts, which remain subject to human control or modification, the Fifth Circuit held that Tornado Cash’s immutable smart contracts were not sanctionable property because they were incapable of being owned or controlled by an identifiable legal actor.<sup>32</sup> Notably, the Fifth Circuit engaged in a detailed, highly technical explanation of DLT and cryptocurrency mechanics, signaling both the judiciary’s increasing technological literacy and the likely trajectory of future smart contract litigation.<sup>33</sup>

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24. *The Emergence of Smart Contracts on a Blockchain*, ORACLE (Aug. 23, 2022), <https://www.oracle.com/blockchain/what-is-blockchain/smart-contracts-blockchain/> [https://perma.cc/6CJP-QGA6].

25. *Australian fine wines tracked by Entrust on Hedera Hashgraph’s DLT*, LEDGER INSIGHTS (Sep. 21, 2020), <https://www.ledgerinsights.com/australia-fine-wine-traceability-entrust-hedera-hashgraphs-dlt/> [https://perma.cc/CER9-9ZER].

26. *Id.*

27. *Id.*

28. *Id.*

29. *Id.*

30. 122 F.4th 549, 550-55 (5th Cir. 2024).

31. *Id.* at 554.

32. *Id.* at 555, 565-66.

33. *Id.* at 554-60.

*B. Digital Ledger Technology*

Smart contracts operate on a decentralized digital ledger; the most popular form is blockchain technology.<sup>34</sup> Some other types of DLT include Directed Acyclic Graphs (“DAG”), hashgraph, and Holochain.<sup>35</sup> A blockchain is a decentralized digital ledger that records data in linked, tamper-resistant blocks, allowing participants in the network to collectively verify and trust the accuracy of the information without relying on a central authority.<sup>36</sup> Dr. Thibault Schrepel has identified four main characteristics that differentiate the blockchain from ordinary computers: (1) the blockchain is decentralized; (2) the blockchain relies on unstoppable code; (3) blockchains are pseudonymous; (4) blockchains are immutable.<sup>37</sup> The first characteristic, decentralization, means no singular user controls the information on the blockchain and that no one oversees maintaining its proper functioning.<sup>38</sup> All information exchanged on the blockchain is transmitted between each node (a computer connected to the network).<sup>39</sup>

Second, the blockchain relies on consensus mechanisms, the most common of which are Proof of Work, Proof of Stake, and Proof of Burn.<sup>40</sup> Proof of Work was the first of its kind, originally introduced by Bitcoin.<sup>41</sup> Proof of Work blockchains use a huge amount of computing power because miners all over the world are racing to solve a math puzzle.<sup>42</sup> Whoever wins gets to add the latest transactions to the blockchain and earns a fixed amount of cryptocurrency as a prize.<sup>43</sup> After the block is proposed, the other nodes in the network independently verify it and update their own copies of the blockchain to reflect the same transaction history.<sup>44</sup> The benefits of Proof of Work include a secure,

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34. *What is Decentralization in Blockchain?*, PLASMA (Dec. 13, 2025), <https://www.plasma.to/learn/decentralization-in-blockchain> [<https://perma.cc/7FAY-9GTH>].

35. This Note will discuss digital ledger technology through the lens of blockchain only.

36. *See generally* Zach Church, *Blockchain, explained*, MIT SLOAN SCH. MGMT. (May 25, 2017), <https://mitsloan.mit.edu/ideas-made-to-matter/blockchain-explained> [<https://perma.cc/VHM3-FTLV>] (providing an overview of blockchain technology as a decentralized, consensus-based system for recording tamper-resistant transaction data).

37. Dr. Thibault Schrepel is an Associate Professor of Law at Vrije Universiteit Amsterdam and Faculty Affiliate at Stanford University (CodeX Center) who has focused most of his research on blockchain antitrust, computational antitrust, and complexity theory. *See* Thibault Schrepel, *Collusion by Blockchain and Smart Contracts*, 33 HARV. J.L. & TECH. 117, 119-121 (2019).

38. *Id.* at 119.

39. *Id.* at 120.

40. Consensus mechanisms are protocols that bring all nodes of a distributed blockchain network into agreement on a single data set. They act as the verification standards through which each blockchain transaction gets approved. *See id.*

41. *What is “proof of work” or “proof of stake”?*, COINBASE, <https://www.coinbase.com/learn/crypto-basics/what-is-proof-of-work-or-proof-of-stake> [<https://perma.cc/V9XN-JNZF>] (last visited Feb. 16, 2025).

42. *Id.*

43. *Id.*

44. *Id.*

decentralized blockchain, but its downsides include an energy-intensive process and difficulty scaling to accommodate a vast number of transactions.<sup>45</sup>

Ethereum developers recognized the inefficiencies of Proof of Work and developed Ethereum 2.0, which employs a faster, less resource-intensive consensus mechanism called Proof of Stake.<sup>46</sup> In this system, staking serves a similar function to mining in Proof of Work; network validators stake their own cryptocurrency for the chance to validate new transactions, update the blockchain, and earn rewards.<sup>47</sup>

Blockchain technology relies on a distributed ledger in which transactions are grouped into sequential “blocks” that are cryptographically linked to one another.<sup>48</sup> Because each block contains a hash of the prior block, altering a past transaction would require rewriting the entire chain, making retroactive manipulation computationally impractical.<sup>49</sup> The transactions are validated through a consensus mechanism—proof of work or proof of stake—by which independent nodes on the network agree on the legitimacy and ordering of transactions.<sup>50</sup> Once validated, transactions are broadcast to the network and recorded on the ledger, where they become publicly visible and resistant to later modification.<sup>51</sup>

Blockchain systems distinguish between users and nodes through cryptographic key pairs.<sup>52</sup> Nodes possess network addresses that allow them to participate in validation, while users control wallets identified by public keys or derived public addresses.<sup>53</sup> A public key functions much like a bank account number: it can be shared with others to receive funds.<sup>54</sup> By contrast, a private key operates as a form of authorization credential; only the holder of the private key can cryptographically sign and execute transactions transferring assets from the associated wallet.<sup>55</sup> The private key, therefore, does not primarily protect a user’s identity, but rather ensures exclusive control over the asset’s stores in the wallet.<sup>56</sup>

Although blockchain transactions are publicly recorded, they are best

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45. *Id.*

46. *Id.*

47. See *What is “proof of work” or “proof of stake”?*, *supra* note 41 (explaining validator responsibilities, the 32-ETH staking requirement, and the potential loss of stake through slashing).

48. Schrepel, *supra* note 37, at 119-21.

49. Esthon Medeiros, Jr., *Blocks, Chains, and Hashes*, MEDIUM (Nov. 30, 2023), <https://medium.com/@esthon/blocks-chains-and-hashes-b3bc323b978e> [<https://perma.cc/DZ77-Q567>].

50. *Id.*

51. *Id.*

52. *Blockchain payments in 2026: A step by step guide for businesses*, BVNK (Jan. 5, 2026), <https://bvnk.com/blog/blockchain-payments> [<https://perma.cc/2FBG-M36H>].

53. *Id.*

54. *Id.*

55. *Id.*

56. *Id.*

described as pseudonymous, not anonymous.<sup>57</sup> Wallets are identified by alphanumeric strings rather than by real-world names, which makes it difficult—but not impossible—to link transactions to specific individuals.<sup>58</sup> When users publicly associate their identities with a wallet address, or when transaction patterns are analyzed across platforms, attribution may become feasible.<sup>59</sup> When the blockchain records the transfer of digital assets between wallets, it does not typically record the underlying legal or commercial rationale for those transfers.<sup>60</sup> This feature is not unique to blockchain-based transactions, however, as traditional financial systems likewise do not publicly disclose the contractual or commercial reasons underlying most payments.<sup>61</sup> Accordingly, smart contracts are not inherently designed to obscure transactional purpose, but instead automate performance by conditioning asset transfers on the satisfaction of predefined, verifiable criteria—such as the submission of a bill of lading in an international sale.<sup>62</sup> This Note will consider smart contracts in their most popular form—the blockchain.

### *C. Challenges in Smart Contracts*

Although blockchain networks themselves are designed to be highly resistant to tampering, smart contracts built on top of those networks present distinct and unresolved risks. The cryptographic integrity of the blockchain does not guarantee that the code governing a smart contract accurately reflects the intentions of the contracting parties.<sup>63</sup> Instead, most vulnerabilities arise not from failures of the blockchain infrastructure, but from errors in contract design, implementation, and use.<sup>64</sup>

These risks were famously illustrated by the 2016 attack on The DAO, a decentralized investment vehicle implemented through smart contracts on the Ethereum blockchain.<sup>65</sup> Exploiting a flaw in the contract's code rather than any weakness in the blockchain itself, an attacker was able to drain approximately

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57. Richard Peters, *Unraveling crypto crimes through blockchain tracing*, HKA (Sep. 3, 2025), <https://www.hka.com/article/crypto-crimes-blockchain-tracing/> [<https://perma.cc/52CS-DXFR>].

58. Anna Buczak, *Is Bitcoin Anonymous? The Myth of Anonymity Debunked*, ULAM LABS (Dec. 30, 2024), <https://www.ulam.io/blog/is-cryptocurrency-anonymous#> [<https://perma.cc/J5XF-D77V>].

59. *Id.*

60. Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, BITCOIN (Aug. 21, 2008), <https://bitcoin.org/bitcoin.pdf> [<https://perma.cc/AHV7-SETE>].

61. ANDREAS PARK, *DEFI VS. TRADFI: INSTITUTIONS AND INDUSTRIAL ORGANIZATION* 6-7 (Oct. 5, 2025), <https://wifpr.wharton.upenn.edu/wp-content/uploads/2025/10/WIFPR-DeFi-Vs-TradFi-Park.pdf> [<https://perma.cc/6JVB-B5FW>].

62. Raskin, *supra* note 22, at 306-07.

63. Fabio Bassan & Maddalena Rabitti, *From Smart Legal Contracts to Contracts on Blockchain: An Empirical Investigation*, 55 *COMPUT. L. & SEC. REV.* 1, 15-16 (Nov. 2024).

64. *Id.*

65. *Smart Contract Challenges*, HEDERA, <https://hedera.com/learning/smart-contracts/smart-contract-challenges> [<https://perma.cc/3Q5A-2M76>] (last visited Feb. 8, 2025).

\$60 million worth of Ether by repeatedly triggering an automated withdrawal mechanism.<sup>66</sup> The incident demonstrated that even when transactions are immutably recorded and cryptographically validated, errors in contract logic can produce outcomes that are economically devastating and legally unintended.<sup>67</sup>

More broadly, smart contracts remain vulnerable to coding mistakes that cause contractual performance to diverge from the parties' shared commercial expectations.<sup>68</sup> The risk is particularly acute when contracts depend on complex conditions—such as the submission of shipping documents, confirmation of delivery, or the satisfaction of multiple approval requirements—before payment is released.<sup>69</sup> Because many smart contract applications are still relatively novel and lack standardized drafting models, these contracts often operate in an experimental space where legal intent must be translated into precise computational instructions, with little tolerance for ambiguity or later correction.<sup>70</sup>

A further category of risk arises not from the blockchain or the contract code, but from user behavior and surrounding technical infrastructure.<sup>71</sup> Smart contracts rely on users to securely manage private cryptographic keys that authorize transactions.<sup>72</sup> If those keys are compromised through weak passwords, phishing attacks, malware, or other forms of social engineering, unauthorized parties may gain control over contract execution.<sup>73</sup> In such cases, the resulting loss reflects neither a failure of blockchain security nor a contractual breach in the traditional sense, but rather a breakdown in the mechanisms by which parties access and control their digital assets.<sup>74</sup> Accordingly, smart contracts' automatic and irreversible execution raises unresolved questions under Article 79 of the CISG about whether coding failures are excusable impediments or risks assumed by the parties.

## II. FORCE MAJEURE UNDER THE CISG

### *A. Background of the CISG*

The United Nations Commission on International Trade Law (“UNCITRAL”) stands as the primary body responsible for developing and

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66. *Id.*

67. *Id.*

68. See Bassan & Rabitti, *supra* note 63.

69. *Id.*

70. *Id.*

71. Jerome Desbonnet & Oded Vanunu, *The rise of smart contracts and strategies for mitigating cyber and legal risks*, WORLD ECON. F. (July 16, 2024), <https://www.weforum.org/stories/2024/07/smart-contracts-technology-cybersecurity-legal-risks/> [https://perma.cc/YSQ9-BVTV].

72. Sarwar Sayeed, Hector Marco-Gisbert & Tom Caira, *Smart Contract: Attacks and Protections*, 8 IEEE ACCESS 24416, 24417 (2020).

73. *Id.* at 24420.

74. *Id.*

maintaining the legal frameworks that govern international trade and investments.<sup>75</sup> In cross-border commercial transactions, parties frequently operate against the backdrop of fundamentally different legal systems, creating uncertainty at the moment of contracting. Consider a transaction in which Seller A, located in Country X, contracts with Buyer B in Country Y. Each party is familiar with its own domestic commercial law, but they have little knowledge of the other party's legal regime. Insisting on the application of one party's national law risks strategic advantage, increased transaction costs, and perceived unfairness. The UNCITRAL was established to precisely address this problem by promoting harmony among contracting states and modernizing international commercial law through widely accepted legal standards.<sup>76</sup> Its flagship achievement in this area, the CISG, provides a neutral, internationally recognized framework that reflects a balanced approach of civil law and common law traditions.

The UNCITRAL developed the text of the Convention on Contracts for the International Sale of Goods ("CISG") in Vienna in 1980.<sup>77</sup> As of March 2025, 97 countries across the globe have adopted the CISG.<sup>78</sup> The motive behind the promulgation of the CISG is to provide "a modern, uniform, and fair regime for contracts for the international sale of goods."<sup>79</sup> To that end, courts in all contracting states are obligated to apply the CISG when the parties have chosen it or when Article 1(1)(a) or (b) governs the transaction.<sup>80</sup> As courts across different jurisdictions apply the CISG to recurring commercial disputes, a growing body of interpretive case law emerges that clarifies the meaning and operation of its provisions in practice.<sup>81</sup> Although the CISG is a legislative instrument rather than a common-law code, this transnational jurisprudence functions as an informal supranational body of law.<sup>82</sup> As Professor Larry A.

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75. UNITED NATIONS COMM'N ON INT'L TRADE LAW, <https://uncitral.un.org/en> [<https://perma.cc/73PR-YHXP>] (last visited Dec. 13, 2024).

76. *Id.*

77. *United Nations Convention on Contracts for the International Sale of Goods* (Vienna, 1980) (CISG), U.N. COMM'N ON INT'L TRADE L., [https://uncitral.un.org/en/texts/salegoods/conventions/sale\\_of\\_goods/cisg](https://uncitral.un.org/en/texts/salegoods/conventions/sale_of_goods/cisg) [<https://perma.cc/79BV-K5QW>] (last visited Feb. 17, 2025).

78. *CISG: Table of Contracting States*, INST. INT'L COM. L. (Dec. 9, 2024), <https://iicl.law.pace.edu/cisg/page/cisg-table-contracting-states> [<https://perma.cc/5CQC-AJM4>].

79. *United Nations Convention on Contracts for the International Sale of Goods* (Vienna, 1980) (CISG), *supra* note 77.

80. Boris Praštalo, *CISG as the (Rules of) Law Applicable to the Arbitration Agreement: Exploration from an English Perspective*, KLUWER ARB. BLOG (June 3, 2024), <https://legalblogs.wolterskluwer.com/arbitration-blog/cisg-as-the-rules-of-law-applicable-to-the-arbitration-agreement-exploration-from-an-english-perspective/> [<https://perma.cc/GHT8-X56B>].

81. See Larry A. DiMatteo et al., *The Interpretive Turn in International Sales Law: An Analysis of Fifteen years of CISG Jurisprudence*, 24 NW. J. INT'L L. & BUS. 299 (2004).

82. See CAMILLA B. ANDERSEN, *UNIFORM APPLICATION OF THE INTERNATIONAL SALES LAW: UNDERSTANDING UNIFORMITY, THE GLOBAL JURISCONSULTORIUM AND EXAMINATION AND NOTIFICATION PROVISIONS OF THE CISG* 23 (2007); Larry A. DiMatteo, *The CISG and the Presumption of Enforceability: Unintended Contractual Liability in International Business Dealings*, 22 YALE INT'L L. J. 111 (1997).

DiMatteo observes, the CISG contemplates that “national stare decisis is to be supplanted by an informal supranational stare decisis,” under which courts are expected to consider and engage with foreign CISG decisions to promote uniformity, while retaining discretion to depart where differences in fact, law, or context so require.<sup>83</sup>

### B. Article 79(1)

While the term “force majeure” itself does not appear in the CISG, it is well-agreed upon that Article 79 of the CISG is a force majeure provision. To avoid liability for breach under Article 79, the non-performing party must prove: (1) an impediment to performance; (2) that prevented performance; (3) was beyond the party’s control; (4) could not reasonably have been taken into account at the time of the conclusion of the contract; (5) and, along with its consequences, could not have been avoided or overcome.<sup>84</sup>

The standard of force majeure under the CISG is a high one and set against a strong general principle of *pacta sunt servanda*—promises must be kept—and for the most part, been interpreted and applied narrowly.<sup>85</sup> Specifically, financial difficulties will almost never satisfy this standard.<sup>86</sup> For example, *Macromex Srl. v. Globex Int’l Inc.*, demonstrates this limitation on Article 79 excuses.<sup>87</sup> Seller Globex International had a contract to deliver chicken to a buyer in Romania. Because of the outbreak of bird flu, the Romanian government banned imports. When chicken prices rose substantially during the

83. DiMatteo, *supra* note 82.

84. See U.N. Convention on Contracts for the International Sale of Goods art. 79, Apr. 11, 1980, S. Treaty Doc. No. 98-9, 1489 U.N.T.S. 3. Stating that:

(1) A party is not liable for a failure to perform any of his obligations if he proves that the failure was due to an impediment beyond his control and that he could not reasonably be expected to have taken the impediment into account at the time of the conclusion of the contract or to have avoided or overcome it or its consequences.

(2) If the party’s failure is due to the failure by a third person whom he has engaged to perform the whole or a part of the contract, that party is exempt from liability only if:

(a) he is exempt under the preceding paragraph; and  
(b) the person whom he has so engaged would be so exempt if the provisions of that paragraph were applied to him.

(3) The exemption provided by this article has effect for the period during which the impediment exists.

(4) The party who fails to perform must give notice to the other party of the impediment and its effect on his ability to perform. If the notice is not received by the other party within a reasonable time after the party who fails to perform knew or ought to have known of the impediment, he is liable for damages resulting from such non-receipt.

(5) Nothing in this article prevents either party from exercising any right other than to claim damages under this Convention.

85. JACK GRAVES, *THE ABCS OF THE CISG* 150 (2014).

86. *Id.*

87. *Macromex Srl. v. Globex Int’l Inc.*, Case No. 50181T 0036406, Interim Award, at 9 (Am. Arb. Ass’n, Int’l Ct. for Disp. Resol., Oct. 23, 2007), [https://cisg-online.org/files/cases/7564/fullTextFile/1645\\_53897288.pdf](https://cisg-online.org/files/cases/7564/fullTextFile/1645_53897288.pdf) [<https://perma.cc/H3XG-3EF7>].

contract period, seller attempted to claim an Article 79 exemption after failing to deliver the contracted goods.<sup>88</sup> Despite having alternative means to perform—including shipping to ports outside Romania—seller chose not to pursue these options because they could secure higher profits by selling the chicken elsewhere.<sup>89</sup> The tribunal emphasized that a party must “do all in his power to carry out his obligation” rather than await events that might justify non-performance.<sup>90</sup> Therefore, the tribunal rejected the seller’s exemption claim, finding that the seller’s desire to capitalize on market changes for financial gain did not constitute an impediment under Article 79.<sup>91</sup>

Force majeure and hardship are frequently invoked in international trade when unforeseen events make performance impossible or impracticable.<sup>92</sup> While Article 79 of the CISG provides a framework for exemption from liability when performance becomes impossible due to unforeseen circumstances, it does not prevent parties from contracting around it.<sup>93</sup> The CISG offers statutory authority for interpreting contract provisions, filling gaps, and governing issues not addressed by the contract.<sup>94</sup> Parties often incorporate International Chamber of Commerce (“ICC”) clauses to tailor their contracts, effectively supplementing or bypassing Article 79 to better suit specific needs.<sup>95</sup> The ICC, a membership organization of international businesses, has promulgated model Force Majeure and Hardship Clauses that attempt to provide clear and concise provisions for excusing or modifying contractual obligations in such cases.<sup>96</sup>

### *C. The Model Law on Electronic Commerce*

The UNCITRAL adopted the Model Law on Electronic Commerce (“MLEC”) in 1996.<sup>97</sup> The purpose of the MLEC is to enable and facilitate commerce conducted using electronic means by providing national legislators with a set of internationally acceptable rules aimed at removing legal obstacles and increasing legal predictability for electronic commerce.<sup>98</sup> Specifically, the

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88. *Id.*

89. *Id.*

90. *Id.*

91. *Id.*

92. *ICC Force Majeure and Hardship Clauses*, INT’L CHAMBER COM., [https://iccwbo.org/business-solutions/model-contracts-clauses/icc-force-majeure-and-hardship-clauses/#:~:text=Force%20majeure%20and%20hardship%20are,the%20contract%20\(hardship\)%20occur](https://iccwbo.org/business-solutions/model-contracts-clauses/icc-force-majeure-and-hardship-clauses/#:~:text=Force%20majeure%20and%20hardship%20are,the%20contract%20(hardship)%20occur) [<https://perma.cc/N2UG-ND4Y>] (last visited Feb. 8, 2026).

93. *Ajax Tool Works, Inc. v. Can-Eng Mfg. Ltd.*, No. 01-C-5938, 2003 WL 223187, at 3 (N.D. Ill. Jan. 30, 2003).

94. *Id.*

95. INT’L CHAMBER OF COM., *supra* note 92.

96. *Id.*

97. *UNCITRAL Model Law on Electronic Commerce (1996) with additional article 5 bis as adopted in 1998*, U.N. COMM’N ON INT’L TRADE L., [https://uncitral.un.org/en/texts/ecommerce/modellaw/electronic\\_commerce](https://uncitral.un.org/en/texts/ecommerce/modellaw/electronic_commerce) [<https://perma.cc/7E42-XYVY>] (last visited Feb. 5, 2026).

98. *Id.*

MLEC establishes the principle of treating paper-based and electronic information equally under the law.<sup>99</sup> The MLEC was the first legislative text to adopt the fundamental principles of non-discrimination, technological neutrality, and functional equivalence that are regarded as the founding elements of modern electronic commerce law.<sup>100</sup> The important principle of non-discrimination ensures that a document would not be denied legal effect, validity or enforceability solely on the grounds that it is in electronic form.<sup>101</sup> A similar principle was adopted by the UCC in the 1998 revision of Article 9, defining the term “record” to mean “information that is inscribed on a tangible medium or which is stored in an electronic or other medium and is retrievable in perceivable form.”<sup>102</sup> Professor Frank Sullivan explains that “[t]he idea was to make the UCC ‘medium neutral’ . . . parties may use virtually any medium for communicating with one another and memorializing their agreements.”<sup>103</sup>

By the 2000s, legislation implementing provisions of the MLEC had been adopted by over 100 countries, most notably, the United States (Electronic Commerce Security Act 1998), the Philippines (Electronic Commerce Act 2000), and the Republic of Korea (Basic Law on Electronic Commerce 1999).<sup>104</sup> Moreover, uniform legislation influenced by the MLEC and the principles on which it is based has been prepared in the United States as the Uniform Electronic Transactions Act, adopted in 1999 by the National Conference of Commissioners on Uniform State Law.<sup>105</sup> Specifically, the MLEC was adopted by all U.S. states except New York.<sup>106</sup>

The MLEC provides a set of suggested guidelines for national governments to incorporate into their domestic legal systems.<sup>107</sup> Unlike the CISG, which is a binding international treaty ratified by 97 countries, the MLEC is not mandatory and allows countries the flexibility to adopt, modify, or expand its scope to suit

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99. *Id.*

100. *Id.*

101. *Id.*

102. Frank Sullivan, Jr., *New Law Amends the Uniform Commercial Code to Accommodate Emerging Technologies*, 57 IND. L. REV. 775, 778 (2024).

103. *See id.* at 779. Professor Frank Sullivan is the Bicentennial Professor at the Indiana University Robert H. McKinney School of Law. He served as a Justice of the Indiana Supreme Court (1993-2012). He is also a member of the American Law Institute and a Commissioner from Indiana on the Uniform Law Commission.

104. *Electronic Commerce*, U.N. COMM’N ON INT’L TRADE LAW, <https://uncitral.un.org/en/texts/ecommerce> [<https://perma.cc/83DK-DKAA>] (last visited Feb. 5, 2026); *see* Renuad Sorieu, Jennifer R. Clift & Jose Angelo Estrella-Faria, *Establishing a Legal Framework for Electronic Commerce: The Work of the United Nations Commission on International Trade Law (UNCITRAL)*, 35 INT’L LAW. 107, 114-15 (2001).

105. Sorieu, Clift & Estrella-Faria, *supra* note 104, at 115.

106. *Electronic Transactions Act*, UNIF. L. COMM’N, <https://www.uniformlaws.org/committees/community-home?CommunityKey=2c04b76c-2b7d-4399-977e-d5876ba7e034> [<https://perma.cc/7U6S-4RQM>] (last visited Feb. 5, 2026).

107. Henry Deeb Gabriel, *The Advantages of Soft Law in International Commercial Law: The Role of UNIDROIT, UNCITRAL, and the Hague Conference*, 34 BROOK. J. INT’L L. 655, 666 (2009).

their domestic needs.<sup>108</sup> If parties want to avoid the CISG applying to their international sales contract, they must agree and expressly manifest that intention in their contract.<sup>109</sup>

### III. FORCE MAJEURE UNDER THE UCC

#### *A. Background of the UCC*

The Uniform Commercial Code (“UCC”) was first published in 1952, with the goal of harmonizing the laws of sales and commercial transactions in the United States.<sup>110</sup> The UCC was written through a collective effort of experts in commercial law, attorneys, federal judges, legislators, and law professors from all around the United States.<sup>111</sup> Article 2 of the UCC governs the sales of goods, part of the original UCC sections approved in 1951.<sup>112</sup> The UCC is not limited to the sales of goods under Article 2, but also governs commercial leases (Article 2A), bank deposits and collections (Article 4), and secured transactions (Article 9).<sup>113</sup> In this respect, the CISG differs from the UCC, as the CISG is limited to sales of goods and, of course, the CISG is on an international scale rather than just operating in the United States.<sup>114</sup> But both have similar goals: like the CISG, the UCC aims to make business transactions consistent and efficient across all states.<sup>115</sup> The visionary behind the UCC, Karl Llewellyn, envisioned default terms that ultimately reduced contracting costs, mirroring arrangements most commercial parties engage in.<sup>116</sup> Unlike the CISG, the UCC has made significant strides in fostering a legal system that accommodates new technologies, such as

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108. José Angelo Estrella Faria, *Legal Harmonization Through Model Laws: The Experience of the United Nations Commission on International Trade Law (UNCITRAL)*, [https://www.justice.gov.za/alraesa/conferences/2005sa/papers/s5\\_faria2.pdf](https://www.justice.gov.za/alraesa/conferences/2005sa/papers/s5_faria2.pdf) [<https://perma.cc/KB2F-V3UN>] (last visited Feb. 5, 2026) (on file with author).

109. *E.g.*, *Travelers Prop. Cas. Co. of Am. v. Saint-Gobain Tech. Fabrics Canada Ltd.*, 474 F.Supp.2d 1075, 1082 (D. Minn. 2007) (“[A]bsent an express statement that the CISG does not apply, merely referring to a particular state’s law does not opt out of the CISG.”).

110. *See* William A. Schnader, *A Short History of the Preparation and Enactment of the Uniform Commercial Code*, 22 U. MIAMI L. REV. 1 (1967).

111. *Uniform Commercial Code* (UCC), DUKE L., <https://law.duke.edu/lib/research-guides/ucc> [<https://perma.cc/K9E7-WN5R>] (last visited Feb. 6, 2026).

112. *Uniform Commercial Code*, UNIF. L. COMM’N, <https://www.uniformlaws.org/acts/ucc> [<https://perma.cc/854Y-E69C>] (last visited Feb 6, 2026).

113. *Id.*

114. *See* Kristen David Adams & Candance M. Zierdt, *United Nations Convention on Contracts for the International Sale of Goods*, A.B.A. (June 18, 2015), [https://www.americanbar.org/groups/business\\_law/resources/business-law-today/2015-june/united-nations-convention/](https://www.americanbar.org/groups/business_law/resources/business-law-today/2015-june/united-nations-convention/) [<https://perma.cc/2LUB-5Z43>].

115. COUNTY OFFICE LAW, *What is the Purpose of the Uniform Commercial Code (UCC)* (YouTube, Feb. 1, 2025), <https://www.youtube.com/watch?v=VsCDdY2DuCY> [<https://perma.cc/YSN2-FT7U>].

116. Sullivan, *supra* note 102, at 776 (citing Robert E. Scott, *The Rise and Fall of Article 2*, 62 LA. L. REV. 1009, 1015 (2002)).

DLT.<sup>117</sup>

### *B. UCC § 2-615 Force Majeure Clause*

In the United States, UCC § 2-615 (Excuse by Failure of Presupposed Conditions) sets forth the default force majeure framework applicable to contracts for the sale of goods.<sup>118</sup> The Official Comments to § 2-615 further illuminate the drafters' intent and provide interpretive guidance. The Official Comments explain that § 2-615 excuses sellers when performance is "commercially impracticable," not merely impracticable.<sup>119</sup> A "collapse in the market" or "increased costs," by themselves, are not a justification under § 2-615.<sup>120</sup>

Courts commonly apply a three-part test to determine whether § 2-615 excuses a nonperforming seller: (1) the seller must not have assumed the risk of some unknown contingency; (2) the nonoccurrence of the contingency must have been a basic assumption underlying the contract; and (3) the occurrence of that contingency must have made performance commercially impracticable.<sup>121</sup> If an event was foreseeable, it was not "a contingency the non-occurrence of which was a basic assumption on which the contract was made. . . ."<sup>122</sup>

A leading case on this issue is *NIPSCO. v. Carbon County Coal*, where the plaintiff agreed to buy a certain amount of coal from the defendant every year for 20 years.<sup>123</sup> The price was set at the time that the parties entered into the

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117. See generally *id.* at 778 (arguing that the UCC's default rules make it more adaptable to new commercial technologies).

118. See U.C.C. § 2-615 (A.L.I. & UNIF. L. COMM'N 1977) (impracticability in the sale of goods):

(a) delay in delivery or non-delivery in whole or in part by a seller who complies with paragraphs (b) and (c) is not a breach of his duty under a contract for sale if performance as agreed has been made impracticable by the occurrence of a contingency the non-occurrence of which was a basic assumption on which the contract was made or by compliance in good faith with any applicable foreign or domestic governmental regulation or order whether or not it later proves to be invalid.

(b) Where the causes mentioned in paragraph (a) affect only a part of the seller's capacity to perform, he must allocate production and deliveries among his customers, but may this portion include regular customers not then under contracts as well as his own requirements for further manufacture. He may so be allocated in any manner which is fair and reasonable.

(c) The seller must notify the buyer seasonably that there will be delay or non-delivery and, when allocation is required under paragraph (b), of the estimated quota thus made available for the buyer.

119. See U.C.C. § 2-615, Comment 1 & 3.

120. See *id.*, Comment 4.

121. *Exelon Generation Co., LLC v. General Atomics Technologies Corp.*, 559 F. Supp. 2d 892 (N.D. Ill. 2008); *Hancock Paper Co. v. Champion Intern. Corp.*, 424 F. Supp. 285 (E.D. Pa. 1976); *Roth Steel Products v. Sharon Steel Corp.*, 705 F.2d 134 (6th Cir. 1983).

122. UCC § 2-615.

123. 799 F.2d 265, 267-69 (7th Cir. 1986).

contract, but it was subject to escalation.<sup>124</sup> The parties included a force majeure clause within the contract, providing that the plaintiff could stop buying coal under the contract “for any cause beyond [its] reasonable control . . . including but not limited to . . . orders or acts of civil authority . . . which wholly or partly prevent . . . the utilizing . . . of the coal. . . .”<sup>125</sup>

Later, the price of the coal under the contract escalated to the point the plaintiff requested permission from the Indiana Public Service Commission to increase its fuel charges to its customers.<sup>126</sup> The commission granted the request but required the plaintiff to make a good-faith effort to decrease its prices by finding an alternative source.<sup>127</sup> The plaintiff found cheaper coal and stopped purchasing from the defendant.<sup>128</sup> The Seventh Circuit held that the plaintiff, as a party to a fixed-price contract, could not excuse performance for frustration of purpose or impossibility.<sup>129</sup> A force majeure clause cannot be interpreted to excuse a buyer from performance due to a change in market price.<sup>130</sup> This excuse would nullify a central term of the contract.<sup>131</sup> According to the court, a fixed-price contract explicitly assigns the risk of market-price increases to the seller and market-price decreases to the buyer.<sup>132</sup> Having examined the court’s approach under the UCC and CISG to tangible objects like chickens and coal, we now turn to a more complex scenario: How might courts analyze force majeure clauses in smart contracts, where code execution is instantaneous and cryptocurrency prices fluctuate continuously in a twenty-four hours global market?

#### IV. COMMERCIAL IMPRACTICABILITY IN A TRUSTLESS ENVIRONMENT

##### *A. Oracle Approach*

Smart contracts, like many emerging innovations, face certain limitations. At the same time, excessive regulation risks undermining the very efficiencies that make smart contracts attractive. One recurring challenge concern how smart contract should account for force majeure events, a problem for which some scholars propose the use of oracles. As Professor Eric Tjong Tjin Tai explains, an oracle is “the entity or communication channel by which the smart contract system receives information about the external world.”<sup>133</sup> Oracles enable smart

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124. *Id.* at 267.

125. *Id.* at 274.

126. *Id.* at 267.

127. *Id.*

128. *Id.*

129. *Id.* at 275-76.

130. *Id.*

131. *Id.*

132. *Id.* at 278.

133. Eric Tjong Tjin Tai, *Force Majeure and Excuses in Smart Contracts*, 26 EUR. REV. PRIV. L. 787, 789 (2018).

contracts to respond to real-world events, such as a hotel room unlocking upon a guest's payment or a storage unit releasing merchandise when payment has been received.<sup>134</sup>

Professor Tjong Tjin Tai categorizes oracles into three types: First, automated oracles; these respond to automated signals, such as a self-driving car that registers when it has been involved in an accident.<sup>135</sup> Second, trusted third party ("TTP") oracles; these involve human intervention, like a courier confirming delivery to a specified address.<sup>136</sup> Lastly, expert oracles; these provide evaluative functions, such as assessing damage or the quality of delivered goods.<sup>137</sup> While TTP and expert oracles are currently being executed by humans, Professor Tjin Tai suggests that artificial intelligence ("AI") will eventually fill this role.<sup>138</sup>

Expanding on these oracle classifications, Ethereum co-founder Vitalik Buterin has highlighted various projects that have developed specialized oracles serving different functions.<sup>139</sup> According to Mr. Buterin, the Augur oracle is designed specifically for "events," so it prioritizes security over speed.<sup>140</sup> In contrast, the Chainlink oracle emphasizes rapid data delivery.<sup>141</sup> For example, if a party chooses an automated oracle over a TTP oracle, the next step would be deciding which project to utilize for their transaction—one that prioritizes speed, security, or some other factor.<sup>142</sup>

In addressing force majeure clauses in smart contracts, Professor Tjong Tjin Tai suggests including a general force majeure exception, invocable by the debtor and operationalized with an expert oracle.<sup>143</sup> However, this approach may undermine the very benefits that make smart contracts attractive—namely, efficiency and cost-effectiveness. Furthermore, it raises complex questions: Who selects the expert? What happens if the expert provides a poor opinion? How are expert qualifications determined across different jurisdictions? What recourse exists for challenging expert determinations? One of the downsides of solely relying on an oracle to answer these questions is that it may introduce unexpected legal issues due to the novelty of the technology. For instance, instead of having a smart contract interpretation issue, it may spiral into an oracle third-party liability problem.

Professor Tjong Tjin Tai recognizes the complexity of smart contracts,

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134. *Id.* at 789.

135. *Id.*

136. *Id.*

137. *Id.*

138. *Id.*

139. LEX CLIPS, *Vitalik Buterin on Chainlink and Hybrid Smart Contracts* (YouTube, Jun. 4, 2021), <https://www.youtube.com/watch?v=IRba55HTK0Q> [<https://perma.cc/EK65-6GR3>].

140. *Id.*

141. *Id.*

142. *Id.*

143. Tjong Tjin Tai, *supra* note 133, at 800 ("Debtor" is a term of art used by Professor Tjong Tjin Tai to connote a party that seeks to be excused from performance of contractual obligations).

explaining that it is practically impossible to code for all foreseeable events and that, given the technology's novelty, defining foreseeability is itself challenging.<sup>144</sup> What may be foreseeable in the real world can be unexplainable in the DLT universe, and vice versa. Professor Tjong Tjin Tai suggests that parties face a choice between: (1) A simple default rule listing circumstances that qualify as force majeure, identified through automated or TTP oracles, with presumed causality within a relevant time frame; or (2) A simple reference to an expert oracle.<sup>145</sup> However, both approaches present significant drawbacks. Most notably, both parties must agree on the type of oracle to be used, and businesses focused on profit and efficiency may simply opt out of the transaction. Although these solutions may be workable for smaller transactions, they risk diminishing the benefits of smart contracts in more complex commercial agreements.

The following example illustrates how an oracle can operate within a smart contract transaction. In a cross-border wine sale between a buyer in the United States and a seller in Russia, the contract governs the sale of five cases of vintage wine to be shipped by cargo vessel on March 25, 2025, subject to a critical environmental condition: the wine must remain below 80 degrees Fahrenheit throughout transit.<sup>146</sup> To enforce this requirement, the seller integrates an IoT-enabled thermometer into the wine cases, creating a real-time data feed to the blockchain-based smart contract through a digital oracle.<sup>147</sup> The oracle continuously monitors the temperature as an automated and impartial verifier of contract compliance. If the temperature reaches 81 degrees at any point during transit, the smart contract automatically cancels the transaction and triggers the applicable insurance payment, thereby protecting both parties and allocating risk without the need for post hoc dispute resolution. This example shows how oracles can facilitate performance and risk management in relatively straightforward two-party contracts involving a single, objectively verifiable condition.

Oracles are essential for the function of smart contracts to interact with information from the outside world.<sup>148</sup> In more complex transactions, oracles face significantly greater challenges, such as data aggregation, conditional

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144. *Id.* at 799.

145. *Id.* at 801.

146. See BENEXT, *What are Smart Legal Contracts?* (YouTube, Sep. 14, 2021), <https://www.youtube.com/watch?v=o-6BnatkDRE&t=454s> [<https://perma.cc/V33D-Z9F9>].

147. *Id.*; see David, *The potential of temperature sensor applications in IoT*, DEEPSEA DEVS., <https://www.deepseadev.com/en/blog/temperature-sensor-applications/#:~:text=The%20potential%20of%20using%20temperature%20sensors%20in%20IoT&text=To%20use%20temperature%20sensors%2C%20they,for%20processing%20and%20appropriate%20actions/> [<https://perma.cc/Z6SP-2S8L>] (last visited Nov. 23, 2024) (explaining how IoT thermometers work).

148. See Siddhant Kejriwal, *Understanding The Role Of Oracles In Decentralized Finance*, COIN BUREAU (Nov. 19, 2024), <https://coinbureau.com/analysis/the-role-of-oracles-in-defi/> [<https://perma.cc/L62J-CVBQ>].

interdependency, and multiple jurisdiction compliance.<sup>149</sup> When disputes over oracle-enabled smart contracts reach courts, existing international frameworks such as the CISG provide limited guidance. While Professor Tjong Tjin Tai's proposed solutions may address force majeure in simple two-party contracts and serve as fail-safes in more complex transactions, they largely ignore or attempt to bypass the role of the judge.

Although oracles can enable smart contracts to self-execute and, in theory, reduce the need for judicial intervention, current technology has not yet realized this ideal. Rather than attempting to eliminate judicial oversight altogether, a more productive approach is to develop a legal environment that supports smart contracts when oracles fail or produce contested outcomes. As discussed in earlier sections, international courts and tribunals already struggle to apply Article 79(1) of the CISG consistently in the context of traditional paper contracts; it is therefore doubtful that the provision can govern smart contracts effectively without further doctrinal development. In the absence of a clear framework for their interpretation and dispute resolution, parties may be incentivized to retreat to traditional contracting methods rather than adopt smart contract technology.

One of the primary motivations for businesses, governments, and individuals to adopt smart contracts is the elimination of intermediaries. At the same time, commercial relationships are embedded in complex real-world conditions that cannot always be reduced to code *ex ante*. Oracles offer a mechanism for bridging this gap by allowing smart contracts to respond to external facts and events while preserving many of the efficiencies that make automated contracting attractive. Much of the debate surrounding oracles focuses on whether they reintroduce the very intermediaries that blockchain technology seeks to eliminate. This Note does not seek to reject the use of oracles in smart contracts; rather, it argues that oracles are essential to integrating smart contracts with the practical realities of commercial life. Nevertheless, the complexity and variability of external events mean that parties cannot yet rely exclusively on oracles to resolve all disputes. An international legal framework that extends beyond Article 79(1) of the CISG and provides consistent standards for invoking force majeure in smart contracts would supply necessary legal stability as the technology continues to evolve toward more autonomous solutions.

### *B. The Judicial Challenge of Smart Contract Interpretation*

As smart contracts become increasingly prevalent through the growth of blockchain and other distributed ledger technologies, a fundamental question remains: how will courts interpret these self-executing agreements, particularly

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149. See Mohamed Damak et al., *Utility at a cost: Assessing the risks of blockchain oracles*, S&P GLOBAL (Nov. 17, 2024), <https://www.spglobal.com/en/research-insights/special-reports/utility-at-a-cost-assessing-the-risks-of-blockchain-oracles> [<https://perma.cc/99SE-TBFY>].

in the context of international sales governed by the CISG? Although smart contracts operate through executable code—a series of binary instructions—this does not mean that questions of contractual interpretation will disappear.<sup>150</sup> In practice, smart contracts are unlikely to be bespoke programs drafted through direct interaction between contracting parties and programmers. Rather, their widespread adoption will depend on standardized, pre-coded templates that parties can adopt and complete in much the same way they currently use letters of credit, bills of lading, or insurance contracts. In this setting, interpretive challenges arise not from ambiguity in negotiated language, but from the potential mismatch between the parties' commercial expectations and the legal effects produced by the underlying code. Courts will therefore confront questions not of how to read code itself, but how to reconcile automated contractual performance with established doctrines of intent, risk allocation, and excuse under international sales law.

State and federal judges, who are accustomed to using traditional interpretive tools to resolve ambiguity in contracts, will need to adapt their approaches when dealing with smart contracts. Contract interpretation typically begins with the plain language, with the parties' intention controlling, but gathered from the four corners of the written instrument.<sup>151</sup> However, judges will find themselves confronting code rather than ambiguous legal language. The binary nature of programming languages and the execution of smart contract render traditional canons of construction largely inapplicable. When faced with a smart contract dispute, courts cannot simply parse ambiguous terms through *ejusdem generis* or *expressio unius*, nor seek refuge in plain and ordinary meaning. The image below is a very simple example of a sale of goods contract written in Solidity, the primary language of Ethereum smart contracts:

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150. Siegfried Fina & Irene Ng (Huang Ying), *Smart Contract 'Drafting' and the Homogenization of Languages*, in SMART LEGAL CONTRACTS: COMPUTABLE LAW IN THEORY AND PRACTICE 339, 350-51 (Jason G. Allen & Peter Hunn eds., 2022).

151. See 11 WILLISTON ON CONTRACTS § 32:5 (4th ed. 2025).

```

1  pragma solidity 0.6.11;
2
3  contract VendingMachine {
4
5      // Declare state variables of the contract
6      address public owner;
7      mapping (address => uint) public cupcakeBalances;
8
9      // When 'VendingMachine' contract is deployed:
10     // 1. set the deploying address as the owner of the contract
11     // 2. set the deployed smart contract's cupcake balance to 100
12     constructor() public {
13         owner = msg.sender;
14         cupcakeBalances[address(this)] = 100;
15     }
16
17     // Allow the owner to increase the smart contract's cupcake balance
18     function refill(uint amount) public {
19         require(msg.sender == owner, "Only the owner can refill.");
20         cupcakeBalances[address(this)] += amount;
21     }
22
23     // Allow anyone to purchase cupcakes
24     function purchase(uint amount) public payable {
25         require(msg.value >= amount * 1 ether, "You must pay at least 1
26         ETH per cupcake");
27         require(cupcakeBalances[address(this)] >= amount, "Not enough
28         cupcakes in stock to complete this purchase");
29         cupcakeBalances[address(this)] -= amount;
30         cupcakeBalances[msg.sender] += amount;
31     }
32 }

```

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Professor James Grimmelmann suggests that all smart contracts can be ambiguous “because technical facts depend on socially determined ones.”<sup>153</sup> To give meaning to a computer program, a community of programmers and users must agree on the semantics of the programming language in which it is written.<sup>154</sup> Professor Grimmelmann explains that ambiguity in smart contracts does not only come from the written code but also from the function of oracles because “the problem of observing the world is also a problem of ambiguity,” and the world is complex.<sup>155</sup> But there is no simple way to deal with this type of ambiguity.

The lack of effective interpretative tools may give rise to a new framework of construction tailored to smart contracts—perhaps the “digital canons of construction.” These digital canons would need to bridge the gap between computer code and contractual intent, focusing on elements such as protocol standards, code conventions, and digital ledger-specific industry practices. An

152. Benjamin Talin, *What are Smart Contracts? – Understanding contracts on the blockchain*, MORE THAN DIGITAL (Mar. 22, 2021), <https://morethandigital.info/en/what-are-smart-contracts-understanding-contracts-on-the-blockchain/> [https://perma.cc/S8P4-7N6C].

153. James Grimmelmann, *All Smart Contracts are Ambiguous*, 2 J.L. & INNOVATION 1, 1-3 (2019).

154. *Id.* at 1.

155. *Id.* at 15.

example of an industry standard would be the practice of “optimistic rollups” in Ethereum Layer 2 networks.<sup>156</sup> In these systems, transactions are initially considered valid by default and can be executed immediately, but there is a challenge period (typically seven days) where anyone can challenge the transaction’s validity.<sup>157</sup> This “innocent until proven guilty” approach with a built-in-dispute window has become a de facto industry standard. Potentially, this could resemble the hierarchy of implied terms found in UCC § 1-303(e).<sup>158</sup>

Traditionally, courts have several tools to determine ambiguities within a paper contract. Some considerations from the CISG and contract law principles include intent, good faith, and other established rules for interpreting written agreements. The Law Commission’s report and statement published by the United Kingdom Jurisdiction Taskforce suggest a “reasonable coder” standard for contractual interpretation in smart contracts.<sup>159</sup> Under this approach, smart contracts would rely heavily on a “reasonable coder” standard, meaning courts would consult expert testimony from programmers to understand the code.<sup>160</sup> The experts would explain “the effect of certain combinations of words, and give their reasoned opinion as to what the code appeared to instruct the computer to do.”<sup>161</sup> This approach is unlikely to find favor with the United States Supreme Court’s conservative majority, given their strong commitment to the plain text and ordinary meaning.<sup>162</sup>

Also, the traditional “reasonable person” test is likely inadequate for smart contracts because an ordinary reasonable person would not understand the

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156. See Mike Shin, *What is an Optimistic Rollup?*, THIRDWEB (Nov. 4, 2023), <https://blog.thirdweb.com/what-is-an-optimistic-rollup/> [<https://perma.cc/E3JU-CTP6>].

157. *Id.*

158. UCC § 1-303(e) (A.L.I. & UNIF. L. COMM’N 1977): Hierarchy of Implied Terms (e) The express terms of an agreement and any applicable course of performance, course of dealing, or usage of trade must be construed whenever reasonable as consistent with each other. If such a construction is unreasonable:

- (1) express term prevails over course of performance, court of dealing, and usage of trade;
- (2) course of performance prevails over course of dealing and usage of trade; and
- (3) court of dealing prevails over usage of trade.

159. See L. COMM’N, SMART LEGAL CONTRACTS ADVICE TO GOVERNMENT (2021) [hereinafter SMART LEGAL CONTRACTS ADVICE TO GOVERNMENT]; UK JURISDICTION TASKFORCE, LEGAL STATEMENT ON CRYPTO ASSETS AND SMART CONTRACTS 38 (2019); L. COMM’N, DIGITAL ASSETS CONSULTATION PAPER (2022).

160. See Nick Hsu & Jagjit S. Sahota, *Interpreting Smart Contracts: The Reasonable Coder and the need for a Stronger Contextual Approach*, 12 OXFORD U. UNDERGRADUATE L. J. 146, 165 (2023).

161. Harriet Jones-Fenleigh, Adam Sanitt & Jonathan Hawkins, *Smart legal contracts under English Law – Part 2: Formation and interpretation*, NORTON ROSE FULBRIGHT (Feb. 2, 2022), <https://www.nortonrosefulbright.com/en/inside-disputes/blog/202202-smart-legal-contracts-under-english-law-formation-and-interpretation> [<https://perma.cc/2T7D-5DBP>].

162. See generally William N. Eskridge, Jr., Brian G. Slocum & Kevin Tobia, *Textualism’s Defining Moment*, 123 COLUM. L. REV. 1611 (2023) (explaining the Court’s turn toward plain-text and ordinary-meaning interpretation).

meaning of the smart contract's code. A significant issue arises with the "reasonable coder" standard: it substantially shifts the role of adjudication away from the judge and toward the expert coders.<sup>163</sup> Smart contract scholars argue that because of this issue, there must be a "backshift towards a contextual approach to interpretation in the realm of smart contracts."<sup>164</sup> Therefore, the admissibility of "surrounding circumstances" (including pre-contractual negotiations) would restore the judges' role in determining the parties' agreement.<sup>165</sup> Some other scholars take a more extreme position with smart contracts, believing that code only has an effect, leaving no room for interpretation, essentially—"code is the law."<sup>166</sup>

While the UNCITRAL has not yet addressed whether a smart contract constitutes a valid contract under the CISG, extensive scholarship supports the view that smart contracts meet all of the requirements of acceptance and offer found under Article 14 of the CISG.<sup>167</sup> Therefore, it is easy to see how smart contracts raise challenges regarding the balance between judicial interpretation and the technical expertise of coders, particularly when disputes arise over the contract's term, execution, and intended functionality.

### C. The Lack of International Harmony

Scholars have characterized Article 79 of the CISG as "the Convention's least successful part of the half-century work," while also being one of the most complex and difficult provisions.<sup>168</sup> This provision, which governs force majeure in international sales contracts, presents courts with significant interpretative challenges and has led to inconsistent application across jurisdictions. The elements required for a party to satisfy Article 79(1) are: (1) an impediment to performance; (2) the impediment must have prevented performance; (3) the impediment was beyond the party's control; (4) the impediment could not have been reasonably foreseen when forming the

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163. Hsu & Sahota, *supra* note 160, at 147.

164. *Id.*

165. *Id.*

166. SMART LEGAL CONTRACTS ADVICE TO GOVERNMENT, *supra* note 159, paras. 4.8, 4.9, 4.10; see Michel Cannarsa, *Interpretation of Contracts and Smart Contracts: Smart Interpretation or Interpretation of Smart Contracts?*, 26 EUR. REV. PRIV. L. 773, 780 (2018).

167. Anna Duke, *What Does the CISG Have to Say About Smart Contracts? A Legal Analysis*, 20 CHI. J. INT'L L. 141 (2019); André Janssen, *The United Nations Convention on Contracts for the International Sale of Goods (CISG) and the Emergence of Smart Contracts and Cryptocurrencies: Should We Try to Teach an Old Dog Some New Tricks?*, 14 TSINGHUA CHINA L. REV. 1 (2022); Tharika Dishani Lamappulage Donn, *Smart Contract and International Trade: European Legal Strategies for Managing Challenges*, 4 J. DIGIT. TECH. & L. 1042 (2023).

168. Yasutoshi Ishida, *CISG Article 79: Exemption of Performance, and Adaptation of Contract Through Interpretation of Reasonableness – Full of Sound and Fury, but Signifying Something*, 30 PACE INT'L L. REV. 331 (2018); Harry M. Flechtner, *The Exemption Provisions of the Sales Convention, Including Comments on "Hardship" Doctrine and the 19 June 2009 Decision of the Belgian Cassation Court*, 59 BELGRADE L. REV. 84 (2011).

contract; and (5) the impediment could not have been avoided or overcome.<sup>169</sup> This section examines the divergent judicial interpretations of Article 79(1), revealing how international courts' and tribunals' persistent reliance on domestic legal frameworks undermines the CISG's harmonization goals and demonstrates why this provision's inherent inconsistency makes it fundamentally incompatible with governing smart contracts.

In *Scaфом International BV v. Lorraine Tubes S.A.S.*, the Belgian Court of Cassation confronted two parties that had entered into an agreement for the sale of steel tubes.<sup>170</sup> Subsequently, the cost of steel unexpectedly increased by more than 70%.<sup>171</sup> As a result, the seller sought to renegotiate a higher contract price, but the buyer refused.<sup>172</sup> The trial court held that the facts did not constitute an "impediment" under Article 79(1) of the CISG.<sup>173</sup> On appeal, the court held that the CISG did not govern the facts, applied French civil law, and overturned the trial court's decision.<sup>174</sup> The buyer appealed to the Supreme Court of Belgium, which held that the CISG did govern the facts under Article 79(1) and that the price increase did constitute an impediment.<sup>175</sup> However, the Belgian Supreme Court did not stop there; the court ordered the parties to renegotiate the contract price.<sup>176</sup>

On the other hand, in *Macromex SRL v. Globex Int'l Inc.*, a seller contracted to deliver chicken to a buyer in Romania, but an outbreak of bird flu led the Romanian government to ban imports.<sup>177</sup> During the contract period, the price of chicken rose substantially, and the seller, seeking to benefit from higher prices elsewhere, failed to deliver the contracts goods, claiming an Article 79(1) exemption.<sup>178</sup> The tribunal rejected the seller's claim, finding that the company's desire to capitalize on market changes for financial gain did not constitute an impediment under Article 79(1), particularly since alternative means of performance, such as shipping ports outside Romania, were available.<sup>179</sup> Similarly, the United States District Court for the Northern District of Illinois in *Raw Materials, Inc. v. Manfred Forberich GmbH & Co., KG* ("RMI") held that

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169. Brandon Nagy, *Unreliable Excuses: How Do Differing Persuasive Interpretations of CISG Article 79 Affect Its Goal of Harmony?*, 26 N.Y. INT'L L. REV. 61 (2013).

170. *Scaфом International BV v. Lorraine Tubes S.A.S.* (Neth. v. Fr.), Cass. [Court of Cassation], June 19, 2009, Case No. C.07.0289.N (English trans.), [https://ciscg-online.org/files/cases/7880/translationFile/1963\\_18923774.pdf](https://ciscg-online.org/files/cases/7880/translationFile/1963_18923774.pdf) [hereinafter *Steel Tubes*].

171. *Id.*

172. *Id.*

173. *Id.*

174. *Id.*

175. *Id.*

176. *Id.*

177. *Macromex Srl. v. Globex Int'l Inc.*, Case No. 50181T 0036406, Interim Award, at 9 (Am. Arb. Ass'n, Int'l Ct. for Disp. Resol., Oct. 23, 2007), [https://ciscg-online.org/files/cases/7564/fullTextFile/1645\\_53897288.pdf](https://ciscg-online.org/files/cases/7564/fullTextFile/1645_53897288.pdf) [<https://perma.cc/H3XG-3EF7>] (holding the Buyer's favor and award damages, as the weightier facts and more persuasive precedent/scholarly commentary support that result).

178. *Id.*

179. *Id.*

the CISG was the applicable substantive law, but in applying Article 79, the court used case law interpreting a similar provision in § 2-615 of the UCC [Uniform Commercial Code].<sup>180</sup> The court determined that there were two questions of fact unanswered: first, whether the port freezing over made it impossible for Forberich to meet its contractual deadline, and whether the St. Petersburg port freezing in December rather than in January was foreseeable.<sup>181</sup> Therefore, summary judgment was deemed inappropriate since there were unresolved questions of fact.<sup>182</sup>

Both *Steel Tubes* and *RMI* highlight the deficiencies in the CISG's harmonization of international transactions. In *Steel Tubes*, the court's decision to renegotiate contractual terms reflects a remedy for hardship commonly found in civil law jurisdictions, where courts have greater flexibility to adjust contracts based on changed circumstances.<sup>183</sup> In contrast, in common law jurisdictions such as the United States, courts rarely adjust contractual terms due to changed circumstances.<sup>184</sup> In *Macromex*, the tribunal not only denied contract renegotiation but also held that a rise in market price does not constitute an impediment.<sup>185</sup> The U.S. courts have further complicated the matter by applying domestic UCC principles to interpret the CISG, contributing to the fragmented understanding of Article 79.

The unifying thread across these divergent judicial decisions is that they all involve traditional paper contract relationships disrupted by conventional force majeure events—a stark contrast to the code-driven execution of smart contracts. Courts would have even less guidance interpreting smart contracts than they do with paper contracts. More importantly, these fragmented interpretations and applications pose a greater risk to smart contracts, potentially stunting the growth of the industry and forcing parties to rely on the inferior alternative of paper contracts. As Professor Frank Emmert explains, DLT requires a “predictable legal environment” for individuals, businesses, and

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180. *Raw Materials, Inc. v. Manfred Forberich GmbH & Co.*, No. 03 C 1154, 2004 U.S. Dist. LEXIS 12510 (N.D. Ill. July 6, 2004) [hereinafter *RMI*].

181. *Id.*

182. *Id.*

183. See Tian Dai, *A Case Analysis of Scafom International BV v. Lorraine Tubes S.A.S: the Application of Article 79 of the United Nations Convention on International Sale of Goods*, 1 *PERTH INT'L L.J.* 131, 132 (2016); see also Fredrick R. Fucci, *Hardship and Changed Circumstances as Grounds for Adjustment or Non-Performance of Contracts: Practical Considerations in International Infrastructure Investment and Finance*, *ARNOLD PORTER* (Apr. 2006), [https://www.arnoldporter.com/-/media/files/perspectives/publications/2006/04/hardship-and-changed-circumstances-as-grounds-fo\\_/files/publication/fileattachment/hardship\\_excuse\\_article.pdf?rev=c85b346bcc844d68a7e0eb17072bd719&sc\\_lang=en&hash=094DDAAAE5D10E7265B0C86EB70EB5EE](https://www.arnoldporter.com/-/media/files/perspectives/publications/2006/04/hardship-and-changed-circumstances-as-grounds-fo_/files/publication/fileattachment/hardship_excuse_article.pdf?rev=c85b346bcc844d68a7e0eb17072bd719&sc_lang=en&hash=094DDAAAE5D10E7265B0C86EB70EB5EE) [https://perma.cc/NJ4W-KH6Y].

184. *Id.*

185. *Macromex Srl. v. Globex Int'l Inc.*, Case No. 50181T 0036406, Interim Award, at 9 (Am. Arb. Ass'n, Int'l Ct. for Disp. Resol., Oct. 23, 2007), [https://ciscg-online.org/files/cases/7564/fullTextFile/1645\\_53897288.pdf](https://ciscg-online.org/files/cases/7564/fullTextFile/1645_53897288.pdf) [https://perma.cc/H3XG-3EF7].

investors to commit time and money to the industry.<sup>186</sup> Professor Emmert advocates for international treaties and conventions to regulate DLT and blockchain, noting that a treaty specifically designed for smart contracts would be ideal.<sup>187</sup> However, the CISG's lack of uniformity, exacerbated by domestic legal influences of Article 79 interpretations, falls short of these expectations.

Some scholars disagree with the view that Article 79(1) has been inconsistently applied, arguing instead for a concept of "functional uniformity," where courts may apply rules differently but achieve similar outcomes.<sup>188</sup> For instance, in the *Sunflower Seed* case, a seller's attempt to invoke Article 79(1) due to reduced production and escalating costs was rejected because the CISG does not excuse performance merely due to economic hardship.<sup>189</sup> Similarly, in the *Canned Oranges* case, a Chinese arbitral tribunal denied a seller's claim when unforeseen factors increased costs, holding that the seller did not meet the hardship standard under Article 79(1).<sup>190</sup> The divergence among scholars and courts often centers around the meaning of "impediment" in Article 79(1). The term "impediment" was deliberately chosen to bridge the gap between various excuse doctrines, ranging from strict impossibility to mere economic hardship.<sup>191</sup> But the flexibility of the term seems to have led courts to rely on national doctrines of excuse, increasing the risk of misapplication.

*Sunflower Seed* and *Canned Oranges*, while cited as an example of "functional uniformity," in fact underscore the inconsistency in applying Article 79(1). Both cases denied exemptions based on economic hardship, yet courts in other jurisdictions, such as in *Scafom*, have accepted similar economic disruptions as valid impediments. The CISG's reliance on broad terms like "impediment" leaves significant room for subjective judicial interpretation influenced by domestic legal principles. Another twist smart contracts will add to this inconsistency is the varying views of DLT across countries, courts, and tribunals. For example, the federal judiciary's treatment of smart contracts and digital assets may continue to evolve alongside shifting regulatory and policy approaches to DLT. In *Van Loon*, discussed earlier in Part I of this Note, the three-judge panel consisted of Judges Don R. Willett, James C. Ho, and Kurt D.

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186. Professor Frank Emmert is the John S. Grimes Professor of Law at the Indiana University Robert H. McKinney School of law. He is a widely known and highly regarded expert in the law of the European Union, international business transactions, international commercial arbitration, the World Trade Organization, international trade, and the Middle East. He co-founded the Council on International Law and Politics and the Blockchain Law Alliance. See Frank Emmert, *Blockchain and Law in Comparative Perspective*, 3 (Mar. 31, 2022), [https://mckinneylaw.iu.edu/events/\\_docs/EmmertBlockchainandNFTs.pdf](https://mckinneylaw.iu.edu/events/_docs/EmmertBlockchainandNFTs.pdf) [<https://perma.cc/X4E9-X8TV>].

187. *Id.* at 6-7.

188. David Kuster & Camilla Baasch Andersen, *Hardly Room for Hardship—A Functional Review of Article 79 of the CISG*, 35 J.L. & COM. 1, 11 (2016).

189. Epheteio Lamia [Ephet.] [Lamias Court of Appeals] 63/2006 (Greece).

190. *Canned Oranges Case II* (Ger. v. China), CISG/2006/06 (China Int'l Econ. & Trade Arb. Comm. (May 2006)).

191. See Kuster & Andersen, *supra* note 188, at 11.

Engelhardt, each appointed by President Trump.

Conversely, China's restrictive approach to DLT could affect its interpretation of Article 79 in similar contexts.<sup>192</sup> The European Union presents yet another approach, with its balanced regulatory framework under the Markets in Crypto-Assets ("MiCA") legislation, which could lead to a more measured interpretation of Article 79 that weighs both innovation and consumer protection.<sup>193</sup> Meanwhile, countries like El Salvador, which have adopted Bitcoin as legal tender, might develop particularly permissive interpretations of force majeure in blockchain-based transactions to encourage adoption and economic development.<sup>194</sup> Each CISG contracting state has a unique public policy consideration influenced by its cultural, political, and economic landscape, all of which will shape its approach to smart contracts and DLT.

Moreover, the infamous *Milk powder* case illustrates the challenges in applying Article 79 to smart contracts.<sup>195</sup> In this case, a buyer received spoiled powdered milk due to lipase contamination.<sup>196</sup> The seller sought an exemption under Article 79 because the seller proved that no available testing technique could have detected the inactive lipase.<sup>197</sup> However, the Bundesgerichtshof<sup>198</sup> ("BGH") rejected this defense, ruling that merely proving the inadequacy of current testing methods was insufficient for exemption.<sup>199</sup> The CISG AC Opinion No.7 provides further insight through a hypothetical example: "Assume a seller bound to deliver frozen goods which, due to a blackout occurring after the seller shipped them but before risk transferred to the buyer, arrive decomposed at the delivery place."<sup>200</sup> The Opinion states that "Article 79 may apply only if the seller proves that he neither knew of the blackout nor could

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192. *The Most (and Least) Crypto-Friendly Countries in the World*, NOMAD CAPITALIST (Nov. 11, 2024), <https://nomadcapitalist.com/finance/cryptocurrency/the-most-and-the-least-crypto-friendly-countries-in-the-world/> [<https://perma.cc/J7SY-QZA7>].

193. The Markets in Crypto-Assets Regulation (MiCA) institutes uniform EU market rules for crypto assets.

194. Rebecca Beyer, *El Salvador Adopted Bitcoin as an Official Currency; Salvadorans Mostly Shrugged*, YALE INSIGHTS (Jan. 29, 2024), <https://insights.som.yale.edu/insights/el-salvador-adopted-bitcoin-as-an-official-currency-salvadorans-mostly-shrugged#:~:text=El%20Salvador%20took%20a%20different,Bitcoin%20as%20a%20legal%20tender> [<https://perma.cc/9XH9-HV9K>].

195. See *Milk Powder Case* (Neth. v. Ger.), Bundesgerichtshof [BGH] [Federal Court of Justice] Jan. 9, 2002, VIII ZR 304/00, [https://cisg-online.org/files/cases/6594/translationFile/651\\_52762818.pdf](https://cisg-online.org/files/cases/6594/translationFile/651_52762818.pdf) [<https://perma.cc/LB2H-5MMH>].

196. *Id.*

197. *Id.*

198. The Federal Court of Justice is the highest court of civil and criminal jurisdiction in Germany. Its primary responsibility is the final appellate review of decision by lower courts for errors of law.

199. *Id.*

200. CISG-AC Opinion No. 7, Exemption of Liability for Damages under Article 79 of the CISG, Rapporteur: Professor Alejandro M. Garro, Columbia University School of Law, New York, N.Y., USA. Adopted by the CISG-AC at its 11th meeting in Wuhan, People's Republic of China, on 12 October 2007.

have controlled it,” and therefore, the “seller would not be exempted if he reasonably could have expected to anticipate a possible power failure when concluding the contract.”<sup>201</sup>

These interpretations raise serious concerns for smart contract implementation. The *Milk powder* case demonstrates how Article 79 requires complex and subjective assessments of what constitutes “reasonable foreseeability” and adequate preventive measures—judgments that are incompatible with the deterministic nature of smart contracts. “In smart contracts, the parties write their wills with the codes such as ‘do this if the following condition occurs.’”<sup>202</sup> “Therefore, since each input will have an output, it is quite difficult to foresee force majeure and include it to the code.”<sup>203</sup> A programmer can code recognized force majeure events—such as floods, tsunamis, epidemics, and earthquakes—based on historical experience; however, the program’s ability to determine whether a novel future event qualifies as force majeure is far more limited. For example, courts must consider whether the malfunctioning of a smart contract, issues transferring cryptocurrencies, or a party’s access to the blockchain being compromised are events that fall within the sphere of force majeure events under Article 79(1) of the CISG.

In 2017, CryptoKitties, a digital cat game, overwhelmed the Ethereum network, causing congestion, delayed transactions, and increased gas fees.<sup>204</sup> Courts and tribunals will face scenarios where smart contract malfunctions or network congestion led to unintended consequences, potentially affecting millions of users and transactions worldwide within minutes. Eventually, the court will be faced with interpreting the smart contract alongside the CISG to determine whether this CryptoKitties event meets Article 79. In the future, artificial intelligence will likely be better equipped to foresee these smart contract force majeure events and provide its own interpretations that are now made by lawyers and judges while balancing the interests of the parties. The technology simply is not at this point yet.

It remains unclear how contracting states of the CISG will approach force majeure in the context of smart contracts. The existing jurisprudence provides little hope that Article 79 can effectively govern smart contracts, as courts have yet to establish a consistent interpretation of Article 79(1) even for traditional paper contracts. The uncertainty is even greater regarding whether courts will view coding errors, blockchain disruption, or technical malfunction as

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201. *Id.*

202. Miran Legal, *Legal Assessment On Smart Contracts And Force Majeure*, MIRAN LEGAL (Nov. 14, 2022), [https://miranlegal.com.tr/en/publications/legal-assessment-on-smart-contracts-and-force-majeure?utm\\_source=mondaq&utm\\_medium=syndication&utm\\_content=article original&utm\\_campaign=article](https://miranlegal.com.tr/en/publications/legal-assessment-on-smart-contracts-and-force-majeure?utm_source=mondaq&utm_medium=syndication&utm_content=article%20original&utm_campaign=article) [<https://perma.cc/RH7Y-FZTF>].

203. *Id.*

204. *The Inside Story of the CryptoKitties Congestion Crisis*, CONSENSYS (Feb. 20, 2018), <https://consensys.io/blog/the-inside-story-of-the-cryptokitties-congestion-crisis> [<https://perma.cc/EU3N-B4EE>].

impediments under the CISG, or simply treat them as inherent risks that parties assume when choosing DLT. Consequently, sellers and buyers entering into smart contracts must take proactive measures to protect themselves against the potential for inconsistent judicial outcomes across different jurisdictions.

## V. RECOMMENDATION

### *A. Suggestions for International Parties Contracting for the Sale of Goods*

The CISG's Article 79(1) has failed to fully achieve its fundamental purpose of harmonizing international trade law in matters of contractual excuse. Courts and tribunals, viewing Article 79 through their domestic legal lenses, have created a fragmented landscape of interpretations—ranging from force majeure to impossibility, *eccessiva onerosità* to impracticability, and *Wegfall/Störung der Geschäftsgrundlage* to economic hardship. This interpretive discord becomes even more pronounced in the context of smart contracts, where novel technological challenges strain the CISG's existing framework. Although a specialized international convention addressing smart contracts and distributed ledger technology would be desirable, such an instrument would be difficult to draft and even more difficult to secure ratification from a broad range of countries in the foreseeable future. Given these limitations, parties entering smart contracts for the international sale of goods need practical solutions now. This section provides essential recommendations for contracting parties engaging in smart contract transactions, including a proposed force majeure clause tailored to possible smart contract events.

First, parties should maintain a dual-contract system: the original paper contract and the smart contract. The paper contract serves as the foundation for a computer programmer to convert into code. Parties may want to include a clause within the paper contract stating, “in case of dispute between parties, the paper contract will govern for interpretation purposes.” Maintaining the original paper contract proves advantageous when disputes arise due to coding errors that did not represent the original drafter's intent. Additionally, parties should address programmer liability, as programmers will likely seek protection against any potential claims for their services.

Second, parties should prioritize hiring professionals who understand both contract drafting principles and coding to accurately express the full intent of both parties. Law schools like Stanford University and New York University are now producing graduates with training in both law and computer programming, creating a new class of professionals who can bridge this critical gap.<sup>205</sup> As smart contracts are written in programming languages, it is essential

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205. See *Law & Computer Science – Joint Degree (JD/MS)*, DEPAUL U., <https://catalog.depaul.edu/programs/law-computer-science-joint-degree-jd/#:~:text=Graduates%20with%20the%20joint%20degree,or%20reusing%20computer%20software%2C%20expressive%2C/>

to rely on skilled programmers well-versed in languages such as Solidity, Vyper, Python, and JavaScript.<sup>206</sup>

Third, parties must carefully select the appropriate oracle type—automated, trusted third party (“TTP”), or expert—based on their specific transaction needs.<sup>207</sup> Each international transaction may require a different oracle depending on the complexity of the transaction and the parties’ priorities regarding speed, security, efficiency, and cost.

Simple transactions can typically utilize automated oracles. Consider a US-based retailer purchasing 1,000 units of standard electronic components from South Korean manufacturer for \$50,000.00. This straightforward transaction involves a single buyer and seller, standard goods with clear specifications, fixed price and quantity, delivery to a single destination, and payment upon delivery verification. A programmer can likely write sufficient code to address potential force majeure events in this scenario.

Complex transactions, however, often require TTP or expert oracles. For instance, a German pharmaceutical company entering into a supply chain agreement with multiple ingredient suppliers across Asia, contract manufacturers in Eastern Europe, and distributors across three continents presents numerous complexities: multiple parties, temperature-sensitive perishable goods, varying regulatory requirements across jurisdictions, complex pricing tiers, and profit-sharing arrangements. Such intricate arrangements exceed a programmer’s ability to predict and code for all contingencies. Additionally, when selecting an oracle provider, parties should evaluate which project aligns with their specific needs, as some providers prioritize security while others focus on transaction speed or data volume. These considerations, along with cost, liability, and the need for human judgment in exceptional circumstances, should guide the selection process.

Fourth, parties may want to have clear dispute resolution mechanism specifically tailored to smart contract issues like designating a specific forum or arbitration body familiar with smart contracts and DLT. For example, Professor Frank Emmert is a member of the Silicon Valley Arbitration and Mediation Center (“SVAMC”) and has industry-specific experience in DeFi and Blockchain contracts.<sup>208</sup> Also, JAMS, the world’s largest private alternative dispute resolution (“ADR”) provider, created a Model Dispute Resolution

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[<https://perma.cc/9PP8-NPBZ>] (last visited Feb. 17, 2026); *Law and Computer Science: JD MS*, STANFORD L. SCH., <https://law.stanford.edu/education/degrees/joint-degrees-within-stanford-university/law-and-computer-science/> [<https://perma.cc/PAT8-2K6H>] (last visited Feb. 17, 2026); *Exploring the Intersection of Computer Science and Law*, NORTHWESTERN (Sep. 13, 2022), <https://www.mccormick.northwestern.edu/computer-science/news-events/news/articles/2022/exploring-the-intersection-of-computer-science-and-law.html> [<https://perma.cc/9FMS-7535>].

206. *Top 6 Smart Contract Languages in 2024*, CHAINLINK (Jan. 2, 2024), <https://chain.link/education-hub/smart-contract-programming-languages> [<https://perma.cc/ZFN6-XXU4>].

207. Tjong Tjin Tai, *supra* note 133, at 800.

208. See Frank Emmert, *Commercial Law and Arbitration Experience*, FRANK EMMERT, <https://www.frankemmert.com/arbitration> [<https://perma.cc/Z9PT-N22D>] (last visited Feb. 17, 2026).

Clause specifically for smart contracts that parties may utilize.<sup>209</sup>

Finally, this section proposes a new model for force majeure clauses in smart contract agreements that bridges the divide between conventional contract law and digital asset transactions. The model addresses three fundamental objectives: accounting for the automated and irreversible nature of smart contract execution, addressing international cross-jurisdictional complexity of blockchain transactions, and maintaining flexibility to accommodate evolving technological threats while providing consistency in international sales.<sup>210</sup> The force majeure clause follows:

A party shall not be liable for failure to perform any of its obligations under this smart contract if it proves that such failure was due to an unforeseen event, hardship, impossibility, or impediment beyond its control and that it could not reasonably have been expected to take such impediment into account at the time of the code's deployment or to have avoided or overcome its consequences. Such impediments shall include, but are not limited to:

- (1) critical blockchain network failures, or consensus mechanism disruptions;
- (2) widespread validator node outages, smart contract vulnerabilities discovered post-deployment, or oracle malfunctions resulting in incorrect data feeds;
- (3) severe network congestion resulting in sustained inability to execute transactions, or cryptographic failures affecting contract security, network attacks, or exploits that compromise contract functionality;
- (4) unforeseen flaws in the smart contract code that materially impact its intended function;
- (5) Acts of God, natural disasters, or extreme weather events;
- (6) War, hostilities, terrorism, or civil unrest; or
- (7) Government actions, laws, or regulations.

The party failing to perform must provide cryptographically signed notice of the impediment and its effect on performance to the other party within a reasonable time after the failing party knew or should have known of the impediment. The exemption provided herein shall have effect only for the period during which the impediment exists. If the

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209. See Daniel B. Garrie & Gail A. Andler, *Arbitrating Smart Contract Disputes: A Comprehensive Approach*, DAILY J. (Dec. 20, 2024), <https://www.jamsadr.com/insight/2024/arbitrating-smart-contract-disputes> [https://perma.cc/3SY2-7MZ4]; *JAMS Model Dispute Resolution Clause for Smart Contracts*, JAMS, <https://www.jamsadr.com/rules-clauses/clauses-smart-contracts> [https://perma.cc/GMZ8-XSEK] (last visited Feb. 17, 2026).

210. See Siegfried Fina & Irene Ng, *Smart Contract 'Drafting' and the Homogenization of Languages*, in SMART LEGAL CONTRACTS: COMPUTABLE LAW THEORY AND PRACTICE 339 (Jason G. Allen & Peter Hunn eds., 2022).

impediment lasts for more than [X] consecutive blocks, either party may terminate the contract through the designated termination function, with all parties returned to their pre-contractual positions to the extent technically feasible.

The model clause is intended to adapt traditional force majeure principles to the realities of smart contract transactions. It preserves the core idea of Article 79—excusing performance when an unforeseen impediment beyond a party's control occurs—while expressly addressing risks unique to blockchain systems, such as oracle failures, network disruptions, and post-deployment code defects. The notice requirement, time limits, and termination mechanism provide clear procedural safeguards and give courts and arbitral tribunals a workable standard for review. Taken together, the clause offers parties a practical way to allocate risk and manage disruption in smart contract sales, while promoting greater consistency in dispute resolution until broader international agreement on smart contract governance emerges.

## VI. CONCLUSION

The emergence of smart contracts represents a pivotal moment in the evolution of international commercial law, challenging traditional legal frameworks in ways that demand both immediate practical solutions and long-term systematic reform. As this Note has demonstrated, the current interpretation and application of Article 79(1) of the CISG—already fraught with inconsistencies across jurisdictions for traditional contracts—proves particularly inadequate when confronting the technological challenges posed by smart contracts and DLT.

The fundamental tension lies in reconciling the deterministic, code-based nature of smart contracts with the inherently flexible and jurisdiction-dependent interpretation of force majeure under Article 79(1). While traditional force majeure provisions effectively address conventional disruptions like natural disasters or government actions, they fail to contemplate the novel impediments inherent in smart contracts—from oracle failures and consensus attacks to code vulnerabilities and network congestion. This gap in coverage, combined with courts' persistent reliance on domestic legal frameworks when interpreting Article 79(1), creates significant uncertainty for parties engaging in international smart contract transactions.

The proposed solutions in this Note operate on two levels. In the immediate term, parties must adopt practical safeguards, including implementing dual-contract systems, carefully selecting appropriate oracles, and incorporating comprehensive force majeure clauses specifically tailored to smart contract vulnerabilities. The recommended force majeure clause provided in this Note serves as a bridge between traditional contract law and the emerging realities of digital commerce, addressing both conventional and technological impediments

while maintaining the flexibility necessary for cross-jurisdictional application.

However, these stopgap measures, while necessary, highlight the broader need for international legal reform. The inconsistent application of Article 79(1) across jurisdictions—evident in cases like *Scaфом International*, *Macromex*, and *Raw Materials*—underscores the CISG’s limitations in providing the predictable legal environment necessary for smart contract adoption and growth. As DLT continues to evolve and smart contracts become more prevalent in international commerce, the development of a specialized convention addressing smart contracts and their challenges becomes increasingly crucial.

Until such comprehensive reform materializes, the success of smart contracts in international commerce will depend largely on careful drafting, expertise, and proactive risk management by contracting parties. The recommendations provided in this Note offer a framework for navigating this complex landscape, balancing the efficiency and automation benefits of smart contracts with the need for legal certainty and protection against both traditional and technological force majeure events.

Ultimately, the integration of smart contracts into international commerce marks not merely a technological leap but a profound reimagining of how human promises transcend borders through code. As we venture deeper into this digital frontier, the law must evolve beyond its earthbound origins—where force majeure once spoke only of storms and wars—to embrace a new realm where impediments travel at the speed of light and contracts execute themselves in the blink of an eye. In this borderless realm of digital commerce, our legal frameworks must learn to dance with both the predictable precision of code and the unpredictable chaos of a world that refuses to be contained within binary bounds.