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BLOCKCHAIN BILLS OF LADING AND THEIR FUTURE REGULATION

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Blockchain bills of lading and their future regulation

Dr Wang Feng[*]

The advent of blockchain bills of lading has attracted the attention of both industry participants and maritime scholars. Concerns are growing about the development of blockchain bills of lading and the construction of a future regulatory framework. This paper will argue that, rather than relying on reform or implementation of positive law instruments regarding blockchain bills of lading, the other layer of regulation in the shipping industry, which consists of relevant self-regulation instruments, should be considered to provide a basis for filling the regulatory gap between the fast evolution of blockchain bills of lading and the inherent conservatism of maritime law.

Keywords: Bills of lading, blockchain, regulation, carriage of goods by sea, maritime law.

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1 Introduction

Maritime transport is one of the essential industries that drive the world's economy. Over 90% of the world's trade is transported by sea, and it is the most cost-effective way to move a large volume of cargo and material around the world.[1] At the same time, shipping law can be described as conservative and an area that is known for its notoriously slow response to technological change and shipping practice.[2] Cornerstones of the current legal regime governing the carriage of goods by sea can be traced back to the late 19th century or even further back, to late medieval times.[3]

Unsurprisingly, technology is often ahead of its time, and legal responses are always lagging.[4] In recent years, several digital technologies have arisen in the maritime sector. For instance, it is said that artificial intelligence (AI) and autonomous vessel initiatives will significantly reduce human error and maintenance issues, whilst improving the safety of navigation.[5] It has also been claimed that the rewards of a digital transformation can be significant, and that the shipping industry must therefore adapt to such digital transformation if it is to restore its prosperity in the modern world.[6] The idea of applying digital technology has been well received by the maritime industry this year, since the Covid-19 crisis has painfully demonstrated the vulnerability of the shipping industry by, to a large extent, restraining personal interaction and paper-based transactions.[7] It has been commonly agreed that the digitalisation of maritime commerce should be accelerated in order better to adapt to the new

1 See https://business.un.org/en/entities/13 (accessed 3 March 2021).

2 Martin Davies, 'When Was the Last Time You Were Restrained by a Prince? Conservatism and the Development of Maritime Law', in PK Mukherjee (ed), *Maritime Law in Motion* (Springer 2020) 153; Paul Myburgh, 'Uniformity or Unilateralism in the Law of Carriage of Goods by Sea?' (2000) 31 *VUWLR* 355.

3 For the development of bill of lading, see Sir R Aikens, R Lord and M Bools, *Bill of Lading*, (3rd edn Informa Law from Routledge 2020), ch 1.

4 R Brownsword, E Scotford and K Yeung, 'Law, Regulation, and Technology: The Field, Frame, and Focal Questions', in R Brownsword, E Scotford and K Yeung (eds), *The Oxford Handbook of Law, Regulation and Technology*' (OUP 2017) 8–9.

5 For discussion on unmanned vessels, see L Carey, 'All Hands Off Deck? The Legal Barriers to Autonomous Ships' (2017) 23 *JIML* 202; and R Veal and M Tsimplis, 'The Integration of Unmanned Ships into the Lex Maritima' [2017] *LMCLQ* 303.

6 On maritime technologies that are changing the industry in 2019 and beyond, see https://www.lloydsmaritimeacademy.com/page/Maritime-technologies-that-are-changing-the-industry-in-2019-and-beyond (accessed 3 March 2021).

7 See https://www.hellenicshippingnews.com/covid-19-a-catalyst-for-change-in-shipping/ (accessed 3 March 2021).

normal.[8] Among these digital technologies, the application of blockchain technology[9] with regard to bills of lading has attracted much attention.

The operation of blockchain bills of lading has developed rapidly.[10] Throughout the pandemic period, there has been no pause in their development. Both Indian and Israeli ports have successfully tested systems involving blockchain bills of lading this year,[11] whilst China's State-owned container line, COSCO, will also work with the digital giant Alibaba to construct its own blockchain platform to track goods.[12]

The emergence and subsequent development of blockchain-based bills of lading has attracted the attention of maritime scholars.[13] It has been commonly agreed that blockchain technology has the potential to surmount the disadvantages of paper bills of lading (pBLs) [14] and surpass the insufficiencies which have prohibited the adoption of electronic bills of lading (eBLs)[15] and, finally, that it will 'in future, usher in a long-awaited shift away from paper bills of lading'.[16] The lack of a proper regulatory regime has been seen as an obstacle to the fast application of this technology.[17] Therefore, as argued by some scholars,[18] there is an immense demand for evolution of the current maritime law

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8 For the promotion of the benefits of the digitalisation of shipping industry, especially during the pandemic period, see https://www.hellenicshippingnews.com/associations-call-for-accelerating-digitalisation-of-maritime-trade-and-logistics/ and https://www.hellenicshippingnews.com/covid-19-a-catalyst-for-change-in-shipping/ (accessed 3 March 2021).

9 Blockchain is a decentralised database based upon distributed ledger technology. For more information about this technology, see Part 2 below.

10 For a brief introduction to the most recent developments of blockchain bills of lading and relevant platforms, see https://www.ukpandi.com/news-and-resources/club-articles/electronic-bills-of-lading--an-update-part-i/ (accessed 3 March 2021).

11 See https://www.maritime-executive.com/article/israel-ports-company-tests-blockchain-bill-of-lading-technology and https://tokenpost.com/India-successfully-tests-blockchain-based-bills-of-lading-processing-5562 (accessed 3 March 2021).

12 See https://www.hellenicshippingnews.com/cosco-strikes-blockchain-pact-for-ocean-cargo-with-alibaba-ant/ (accessed 3 March 2021).

13 For recent research on blockchain bills of lading, see P Todd, 'Electronic Bills of Lading, Blockchains and Smart Contracts' (2019) 27 *International J of Law & Information Technology* 339; N Chetrit, M Danor, A Shavit, B Yona and D Greenbaum, 'Not Just for Illicit Trade in Contraband anymore: Using Blockchain to Solve a Millennial-long Problem with Bills of Lading' (2018) 22 *Virginia J of Law & Technology* 59; C Albrecht, 'Blockchain bills of Lading: The End of History: Overcoming Paper-Based Transport Documents in Sea Carriage through New Technologies' (2019) 43 *Tul Mar LJ* 251; E Ong, 'Blockchain bills of lading and the UNCITRAL Model Law on Electronic Transferable Records' [2020] *JBL* 202; H Liu, 'Blockchain and Bills of Lading: Legal Issues in Perspective', in P K Mukherjee, M Q Mejia Jr and J Xu (eds), *Maritime Law in Motion* (Springer 2020) 413; K Takahashi, 'Blockchain Technology and Electronic Bills of Lading' (2016) 22 *JIML* 202.

14 Such as slow transactions and fraud issues.

15 Such as the closed system issue. See M Goldby, 'Electronic Bills of Lading and Central Registries: What is Holding Back Progress?' (2008) 17 *Information & Communication Technology Law* 125.

16 Ong (n 13) 202.

17 Albrecht (n 13) 271; Takahashi (n 13) 206.

18 See the articles cited at n 13.

regime. Viewing the matter from the perspective of positive law, some scholars have alleged that a functional regulatory regime could be constructed, either by exercising a legislative approach or by relying upon functional equivalence and technological neutrality[19] to fit blockchain bills of lading into existing regulatory frameworks. They argue that positive law instruments such as the UNCITRAL Model Law on Electronic Transferable Records (the MLETR)[20] or the Rotterdam Rules[21] could provide significant guidance for the future development of blockchain bills of lading.[22]

However, the author will propose in this paper that the disruptive effects that would be introduced into the current bill of lading regulatory regime and the shipping industry by blockchain technology have been neglected. The use of blockchain bills of lading will produce a series of legal and ethical challenges that are beyond the consideration of legislators and to which the current maritime law regime may find hard to adjust. The author will argue that, rather than relying on reform or implementation of positive law instruments regarding blockchain bills of lading that will not happen anytime soon,[23] the other layer of regulation in the shipping industry, which consists of relevant self-regulation instruments,[24] should be considered to provide a basis for filling the regulatory gap between the fast evolution of blockchain bills of lading and the inherent conservatism of maritime law.

This paper is in six parts. Part 2 will briefly introduce blockchain technology, its merits, and its application to bills of lading. Part 3 will outline the disruptive effects and the potential risks of blockchain bills of lading which, if implemented, would pose substantial challenges to the existing regulatory regime. Part 4 will discuss the limitation of the current positive law regime to regulate these

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19 Functional equivalence generally means that 'services that are functionally alike, or that serve the same purpose ought to be regulated alike'. See A Savin, 'Rule Making in the Digital Economy: Overcoming Functional Equivalence as a Regulatory Principle in the EU' (2019) 22 *J of Internet Law* 4. The principle of technological neutrality aims to reduce the risk that the application of positive law will be limited to specifically defined technology and, instead, ensures that positive law will remain applicable as technology continues to advance. See UNCITRAL, *UNCITRAL Model Law on Electronic Transferable Records* (United Nations 2018), 23. For the interaction between these two principles, see part 4.

20 See https://uncitral.un.org/en/texts/ecommerce/modellaw/electronic_transferable_records (accessed 3 March 2021).

21 United Nations Convention on Contracts for the International Carriage of Goods Wholly or Partly by Sea (2008) (Rotterdam Rules).

22 This is a common argument which has been advanced in the articles cited at n13. In particular, see Ong (n 13) 202 for the function of the MLETR and Takahashi (n 13) for general information.

23 See also Todd (n 13) 341. For more detailed discussion on the slow reaction of positive law instruments, see also part 4. The author acknowledges the legislative activities regarding blockchain in several countries such as in the USA: see https://www.ncsl.org/research/financial-services-and-commerce/blockchain-2019-legislation.aspx (accessed 3 March 2021). The most recent legislative activity in relation to eBL is Singapore's Electronic Transactions (Amendment) Act 2021 that came into effect on 19 March 2021: see https://sso.agc.gov.sg/Acts-Supp/5-2021/Published/20210312?DocDate=20210312 (accessed 30 March 2021). However, as will be seen in part 4, several reasons may impede the development of positive law regarding blockchain bills of lading within a short time.

24 Such as standard contracts and industrial standards. See part 5.

challenges. Part 5 will argue that, should the application of blockchain bills of lading be feasible in the future, positive law regulations should not be the only choice. In contrast, self-regulatory entities and instruments of the maritime industry should play a more active and constructive role in the regulation of blockchain bills of lading. From the perspective of long-term development, the construction of a positive interaction mechanism between positive law and self-regulation instruments is the key to success.

2 Blockchain technology and blockchain bills of lading: an overview

Given the abundance of material available regarding blockchain technology,[25] this Part will concentrate on the following headings that are necessary to facilitate the discussion below: (a) categories and specialties of blockchain technology; (b) smart contracts; and (c) current projects on blockchain bills of lading.

2.1 Categories and specialties of blockchain technology

Blockchain is a decentralised database based upon distributed ledger technology.[26] The advent of this technology did not occur recently, as the concept of blockchain first emerged in 2008.[27] The primary purpose of this technology was not for recording or transfer of documents but for usage and transaction of the cryptocurrency known as 'Bitcoin'.[28] The function and application of blockchain have been widely recognised over the past few years; however, there is no uniformly accepted definition of it.[29] Although the wording of the definition of blockchain can differ, the consensus is that blockchain can be viewed as a series of stable blocks, each of which stores a series of previously confirmed transaction records.[30] These blocks are interconnected and protected by encrypted

25 For more information on blockchain technology and relevant issues, see P Hacker, I Lianos, G Dimitropoulos and S Eich, *Regulating Blockchain: Techno-social and Legal Challenges* (OUP 2019); P De Filippi and A Wright, *Blockchain and the Law: The Rule of Code* (Harvard University Press 2018); D Kraus, T Obrist and O Hari (eds), *Blockchains, Smart Contracts, Decentralised Autonomous Organisations and the Law* (Edward Elgar 2019).

26 Ong (n 13) 207.

27 See KFK Low and E Mik, 'Pause the Blockchain Legal Revolution' (2019) 69 *ICLQ* 135.

28 For a general introduction to blockchain and bitcoin, see G Vidan and V Lehdonvirta, 'Mine the Gap: Bitcoin and the Maintenance of Trustlessness' (2019) 21 *New Media & Society* 42.

29 See Low and Mik (n 27) 137.

30 E Ganne, *Can Blockchain Revolutionize International Trade?* (WTO 2018) 5.

certificates (ie hashing)[31] into chains.[32] Since countless computers jointly maintain the blockchain network, its primary function is as a decentralised ledger which can record data. In other words, each participant computer (ie node) in the blockchain maintains a copy of the blockchain data.[33] Therefore, in theory, blockchain transactions occur in a borderless, peer-to-peer global network environment.[34] To generate new blocks, participants in the network need to perform expensive and intensive computing activities, a process called mining, which relies on the hash algorithm.[35] The job of miners is to verify transactions and group these transactions into newly generated blocks, which, if the relevant conditions are met, are then added to the blockchain.[36] Miners will also be responsible for introducing new tokens into the system, that is, tokens issued as work rewards. Whenever a block is mined, miners will announce the new block information to other miners in the entire network so that other miners can then confirm whether the block is valid. Thereafter, they will add the valid block information themselves, whereupon the transaction is completed. However, miners still need to add the hash value of the previous block to the new block so that all blocks can be linked together. This is called a blockchain.[37] This process is generally known as Proof of Work (PoW), which commonly exists in permissionless blockchains such as those involving Bitcoin.[38] Another widely adopted blockchain validation algorithm is Proof of Stake (PoS).[39] PoS algorithms aim to overcome the disadvantages of PoW, especially with respect to energy inefficiency and consumption.[40] Under PoS, the system will choose some nodes to validate transactions rather than to have these nodes compete with each other and mine blocks. The selection of these nodes will depend on the stake offered by these nodes. Therefore, the larger the stake offered by a node, the more likely that the node will become a validator. Thus, to validate transactions, validators must hold a certain percentage of the network's total value. In this way, it is logical to conclude that blockchain systems which adopt PoS are not as decentralised as those systems that adopt PoW.[41]

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31 Hashing is a cryptographic technique. Blockchain bills of lading system can use a kind of hashing algorithm, such as Secure Hash Algorithm 256, to generate hash values. See Ong (n 13) 214.

32 Ganne (n 30) 5.

33 Ibid.

34 Ibid. This borderless feature normally occurs in the scenarios of permissionless blockchains. For more information of the categories of blockchain, see Ganne (n 30) 8–13.

35 Low and Mik (n 27) 139.

36 Ganne (n 30) 6.

37 Ibid.

38 Ibid.

39 European Parliamentary Research Service, *Blockchain for Supply Chains and International Trade: Report on Key Features, Impact and Policy Options* (2020) 7.

40 Ibid 8.

41 Ibid.

There are two types of blockchains, permissionless (or public) and permissioned (or private). The permissionless blockchain covers the majority of distributed ledgers that exist today.[42] Permissionless means that anyone can join and view the transactions that take place anonymously; all that is required is that they download the necessary software.[43] Theoretically, every node on this network has the same right to 'access, use and edit the given blockchain'.[44] Therefore, it may be a challenge to push through changes to the network while maintaining an undivided system, since not all participants are likely to agree to a proposal at the same time.[45]

Permissioned blockchains, by contrast, usually have established access rules stipulating who can view and write to the blockchain.[46] Therefore, a permissioned blockchain is not open to everyone to join. Permissioned blockchains, by their nature, are not decentralised systems, due to there being a clear hierarchy in terms of control.[47] However, they are distributed, and many nodes still maintain copies of the blockchain on their computers. Permissioned blockchains are more suitable for corporate maintenance,[48] because companies hope to enjoy the advantages of blockchains without allowing external network access. In permissioned blockchains, under the background of a security model, PoW is redundant, given the fact that the identity of each participant is known and managed manually. In this case, a more effective consensus mechanism is to use designated verification procedures, which are nodes that are chosen to undertake specific functions to perform transaction verification.[49] Therefore, permissioned blockchains still rely on 'good old-fashioned trust',[50] namely, the trust among members rather than trust according to a code.[51] Although it is commonly alleged that permissioned blockchain is the future for commercial usage,[52] there are still some participants claiming themselves

42 World Bank Group, *Distributed Ledger Technology (DLT) and Blockchain' Fintech Note No 1* (2017) 13.

43 Low and Mik (n 27) 138.

44 Ibid.

45 For instance, the decentralised autonomous organisation (DAO) attack that occurred on Ethereum in 2016 resulted in the hard fork of this platform since some participants of the platform refused to upgrade to another, more secure, platform after this attack. See A Walch, 'In Code(rs) We Trust: Software Developers as Fiduciaries in Public Blockchains', in *Regulating Blockchain* (n 25) 62–64**.**

46 Ganne (n 30) 10–11.

47 De Filippi and Wright (n 25) 31.

48 Low and Mik (n 27) 138.

49 Sir M Walport, *Distributed Ledger Technology Beyond Blockchain: A Report by the UK Government Chief Scientific Adviser*, Government Office for Science (2016) (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf (accessed 2 March 2021) 17.

50 Low and Mik (n 27) 140.

51 Therefore, to this extent, the permissioned blockchains are enclosed systems that are analogous to the eBL systems. This point will be explained below in part 3.1.a.

52 Ganne (n 30) 11.

to be a permissionless blockchain system.[53] Therefore, in this paper, both permissionless and permissioned blockchains will be considered.

The merits of blockchain technology that have been most loudly proclaimed are, first, that it has an open and decentralised nature; this essentially means that no central authority is in charge of the system, and intermediaries can be eliminated.[54] The second alleged merit is the immutability of the blockchain; this means that, because of the cryptography technology (including hashing and both the public and private key) adopted by the blockchain, the transactions that are recorded in the chain are time-stamped and almost impossible to modify.[55] The third merit, also based upon the cryptography technology, is the transparency of the transactions. Once transactions are made, they are open to anyone who has access to the blockchain platform.[56] This is why blockchain has been promulgated as a 'trust machine' by some proponents.[57] However, one issue worthy of note is that the abovementioned merits of blockchain mainly relate to permissionless blockchains. As will be stated later, these merits will be weakened to a certain extent by the different governance models adopted by various permissioned blockchain platforms.

2.2 Smart contracts

The emergence of smart contracts predated blockchain technology and was proposed by Nick Szabo in the 1990s.[58] A smart contract is a set of commitments specified in computer language, including an agreement in which the parties execute these commitments, which are then automatically executed by a computer system.[59] It has been suggested by some scholars that smart contracts only mean those codes that are stored, triggered on a blockchain.[60] Sharing the same feature as other computer programmes, smart contracts follow the 'if-then' pattern.[61] A typical example of a smart contract in the maritime scenario could be 'if the goods are unloaded at the port of X, then funds will be

53 For instance, CargoX and Wave, which will be discussed below in part 2.3.

54 K Yeung, 'Regulation by Blockchain: The Emerging Battle for Supremacy between the Code of Law and Code as Law' (2019) 82 *MLR* 207, 212.

55 Low and Mik (n 27) 143.

56 Liu (n 13) 418.

57 See https://www.economist.com/leaders/2015/10/31/the-trust-machine (accessed 2 March 2021).

58 Yeung (n 54) 223.

59 See Walport (n 49) 18.

60 A Savelyev, 'Contract Law 2.0: 'Smart contracts as the Beginning of the End of Classic Contract Law' (2017) 26 *Information & Communications Technology Law* 121, 127; Nataliia Fulatova, 'Smart Contracts from the Contract Law Perspective: Outlining New Regulative Strategies' (2020) 28 *International J of L & Information Technology* 221.

61 Fulatova (n 60) 221.

transferred'.[62] Although it has been recognised by some scholars that a smart contract is neither smart nor a contract,[63] it indeed has the characteristics of a self-executing and self-enforcing transaction and is, therefore, 'smart' to this extent.[64] In addition, with the assistance of blockchain technology, smart contracts also possess features such as immutability, efficiency and pseudonymity.[65] Both permissionless and permissioned blockchain bill of lading platforms, therefore, have adopted smart contracts into their systems,[66] and the application of smart contracts in the trade scenario has also proved feasible.[67]

2.3 Blockchain bills of lading

The proposition to apply blockchain technology to bills of lading can be attributed to the drawbacks of the mechanism of pBLs and the failure of previous attempts to deal with these flaws by way of eBLs.[68] Among the various disadvantages of pBLs, the most criticised weakness is that they slow down transactions.[69] On the one hand, due to the increase in the speed of vessels, it is now more common than ever that a vessel will beat the transfer of a pBL in arriving at the discharging port.[70] On the other hand, rigid maritime law still requires the release of goods against the original pBL.[71] This can result in significant problems, and the release of cargo without the presentation of the original bill of lading will generally expose the carrier to liability for any loss. By adopting letters of indemnity, the shipping industry has remedied this issue to some extent; however, it is still commonly considered to be an unsatisfactory situation.[72] Electronic bills of lading systems have previously been implemented to attempt to resolve this issue and make the transfer of bills of lading smoother.[73] Although the eBL system has received some recognition and attention in recent years,[74] there are three main factors

62 Ganne (n 30) 13.
63 Todd (n 13) 363; Also see Chamber of Digital Commerce 'Smart Contracts: Is the Law Ready'? https://digitalchamber.org/smart-contracts-paper-press/ (accessed 2 March 2021).
64 Fulatova (n 60) 222.
65 Ibid.
66 For information about permissionless blockchain platform see https://cargox.io/platform/; for information about permissioned blockchain platform see https://www.tradelens.com/post/automating-global-logistics-starts-with-digital-documents (accessed on 2 March 2021).
67 Fulatova (n 60) 222.
68 Albrecht (n 13) 261.
69 See Ong (n 13) 203; Todd (n 13) 342–343.
70 Todd (n 13) 342.
71 Ibid 345.
72 Ibid 355.
73 Clyde & Co, *The Legal Status of Electronic Bills of Lading: A Report for the ICC Banking Commission* (2018) 5–7. See also Goldby (n 15).
74 Todd (n 13) 340.

hindering its development.[75] First, the membership requirement will result in eBL members having difficulty in trading with non-members; secondly, the lack of legal certainty has resulted in eBLs developing without protection; and, thirdly, not all parties involved in international trade, such as port authorities and customs, can cope with electronic data.[76]

In light of blockchain technology, several platforms claiming to use blockchain bills of lading have emerged, such as TradeLens, CargoSmart (GSBN), Wave and CargoX.[77] Both TradeLens and CargoSmart are built upon a permissioned blockchain platform, namely Hyperledger Fabric, which was developed by IBM. They all have membership requirements and, before using the platform, companies need to agree with their terms of use.[78] Both CargoX and Wave claim to be based upon the permissionless blockchain Ethereum. However, given the paucity of commercial details disclosed by the two companies, there is no guarantee that the two blockchain systems have all the benefits of a permissionless blockchain. A recent development is that International Group (IG) P&I Clubs have approved both Wave and CargoX.[79]

From the perspective of those optimistic about blockchain bills of lading, the complicated issues relating to pBLs/eBLs could be resolved by the deployment of blockchain technology. The transfer of blockchain-based bills of lading is obviously faster than the transfer of pBLs.[80] It is also claimed by the supporters of blockchain bills of lading that the cost of transfer has been significantly reduced.[81] Cryptographic techniques, such as 'hashing', could enable the security of transfer and the possession of bills of lading which, as alleged by its proponents, would maintain the uniqueness of blockchain bills of lading and make them, to the extent of uniqueness, the same as pBLs.[82] The decentralised nature of blockchain will distinguish blockchain bills of lading from former eBL systems such as Bolero.[83] As to the corresponding regulatory regime, it is suggested that, by relying upon rationales such as functional equivalence and technological neutrality, blockchain bills of lading can be brought under

75 M Goldby, *Electronic Documents in Maritime Trade: Law and Practice* (OUP 2019) paras 11.06–11.09.

76 Ibid paras 11.09–11.10.

77 For information on these platforms, see https://www.tradelens.com/; https://www.cargosmart.ai/en/solutions/blockchain-for-shipment-documentation/; https://wavebl.com/; and https://cargox.io/ (accessed 2 March 2021).

78 Ibid.

79 See https://cargox.io/press-releases/full/cargox-becomes-first-public-blockchain-ethereum-bill-lading-provider-approved-international-group-pi-clubs/; https://www.nepia.com/circulars/electronic-paperless-trading-wave/ (accessed 2 March 2021).

80 As alleged by CargoX, the transfer of bills of lading can be accomplished within 20 seconds: https://www.freightwaves.com/news/blockchain/cargoxs-blockchain-based-smart-bill-of-lading-solution-is-now-on-dexfreights-platform (accessed 2 March 2021).

81 See https://www.nortonrosefulbright.com/en/knowledge/publications/b20094b6/e-bills-of-lading (accessed 2 March 2021).

82 Ong (n 13) 209–212; Albrecht (n 13) 264.

83 Albrecht (n 13) 262.

the MLETR or even the Rotterdam Rules.[84] With the expansion of the blockchain bills of lading system[85] and the increasing maturity of blockchain technology, the substitution of traditional pBLs with blockchain bills of lading seems promising.

3 The disruptive effects and drawbacks of blockchain bills of lading

New technologies always come with disruptive effects, and blockchain technology is no exception. This Part will discuss the disruptive effects of blockchain bills of lading that have not been dealt with by other researchers, and the extent to which the shipping industry would be challenged by their adoption. A thorough examination of these disruptive effects, or even drawbacks, is vital since, as will be discussed, blockchain technology, which is seemingly perfect, may nevertheless pose unexpected challenges to existing maritime industrial practice, business models, and legal regimes.

3.1 Disruptive effects and challenges of blockchain bills of lading

3.1.a Centralisation

One recently recognised counterintuitive fact of blockchain technology is that, although the mechanism of the storage of data may be decentralised or distributed, the operation and regulation of blockchain platforms (whether permissionless or permissioned) are centralised. In addition, this centralisation is inevitable, as economists have found that there is a positive correlation between the centralisation of the blockchain platform and its efficiency.[86]

This finding is not a surprise when considering the permissioned blockchain scenario since, as stated in the previous Part, permissioned blockchains are more centralised than those in the permissionless form. This is due to the following features of permissioned blockchains: first, only identified participants who have agreed to the rules of the system set by a central authority can join;[87] secondly, the system is owned and maintained by one or more entities;[88] and, thirdly, for commercial privacy

84 For more information, see the articles cited above at n 13.

85 See https://www.maersk.com/news/articles/2020/10/15/cma-msc-complete-tradelens-integration-to-improve-data-sharing-across-industry (accessed 2 March 2021).

86 J Abadi and M Brunnermeier, 'Blockchain Economics' https://scholar.princeton.edu/sites/default/files/markus/files/blockchain_paper_v3g.pdf (accessed 2 March 2021).

87 Low and Mik (n 27) 140. For instance, to join TradeLens, users need first to agree with the Terms of Use. See also https://www.tradelens.com/platform (accessed 3 March 2021).

88 GTD Solution Inc and IBM (together the 'TradeLens Collaboration') jointly own and develop the TradeLens solution. See https://www.tradelens.com/legal-notice (accessed 14 September 2020). The TradeLens

purposes, not all data is open for all members to view.[89] Therefore, a permissioned blockchain is, in essence, a centralised or partially centralised,[90] member-only system which relies upon the old-fashioned notion of trust. In addition, there is a hierarchy in permissioned blockchains, as the rights and obligations between the founders of the system and the later participants are not the same.[91]

Therefore, these features of the permissioned blockchain platform remind us of the eBL system, such as Bolero. They all have a membership requirement, and they all require members of the system to accept terms of use or Rulebooks.[92] Also, like an eBL system, a permissioned blockchain is a closed entity, and traders will only be able to trade with other participants who join the system.[93] For example, take the most widely accepted platform, TradeLens. The transaction of blockchain bills of lading will require that all the parties involved are transacting on the TradeLens platform, with an established business partnership and an entitlement to participate in the transaction of bills of lading.[94]

Therefore, to this extent, the permissioned blockchain bill of lading platforms fail to remove the previous disadvantages brought by the adoption of eBLs. In the early stage of the development of these platforms, one noticeable side effect is that, because of this centralised framework, these blockchain bills of lading platforms may become relatively closed systems, the practicality of permissioned blockchain bills of lading will be greatly reduced, making it difficult to support the massive volume of international trade. For instance, TradeLens currently only supports non-negotiable ie straight bills of lading.[95] Only 12 customs authorities have become members, and there is no participation by any significant trading countries.[96] In addition, similarly to eBLs, TradeLens also faces legal uncertainty. What is worse is that platforms such as TradeLens do not have a detailed Rulebook

platform is jointly owned and operated by IBM and A.P. Moller-Maersk A/S, cl 1 of TradeLens Platform Network Member; see https://www-03.ibm.com/software/sla/sladb.nsf/8bd55c6b9fa8039c86256c6800578854/d03a01ba301908ab8625833000722d37/$FILE/i126-8226-01_10-2018_en_US.pdf (accessed 3 March 2021).

89 For instance, in TradeLens, because of the channel in Hyperledger Fabric, only relevant parties to a transaction can view and share their data: https://docs.tradelens.com/reference/data_sharing_specification/ (accessed 3 March 2021).

90 This will depend upon the wording of the Terms of Use.

91 For instance, platform provider can control the distribution of data and members have several obligations to fulfil. See TradeLens Network Member Agreement, ss 3 and 4.

92 Goldby (n 15) 126–127.

93 Todd (n 13) 361.

94 The entitlement will be determined by an onboarding team. See https://docs.tradelens.com/how_to/ebol/ (accessed 3 March 2021).

95 Ibid.

96 See https://s3.us.cloud-object-storage.appdomain.cloud/tradelens-web-assets/TradeLens-Ecosystem.pdf (accessed 3 March 2021).

similar to that adopted by Bolero.[97] Thus, it is clear from the status of TradeLens that it still shares the significant disadvantages of eBL systems such as Bolero.[98] Therefore, if the eBL system has not already successfully persuaded traders and legislators to change, why would the shipping industry put faith in a permissioned blockchain system that fails to show the potential to remove any of the abovementioned hindrances?[99]

It could, therefore, be suggested that we rather use CargoX and Wave, which are both built upon a permissionless blockchain. This permissionless model is open to everyone to join and enables them to interact with other members or parties on the network. Given the large volume of international trade and daily interaction between traders, an open system is more desirable. However, it should also be noted that even a public blockchain is not actually a decentralised system. Given the limited number of developers and limited resources, a centralised decision-making mechanism always exists in this so-called decentralised system.[100] Even the most decentralised blockchain systems, such as Bitcoin, are governed by ad hoc processes and controlled by a handful of software developers.[101] In light of the PoW consensus, nodes with significant computer processing power will inevitably control the mining process and therefore be very influential in regulating the system.[102] An extreme example is commonly known as the 51% attack. In general, a 51% attack is an attack on a blockchain by a group of miners who control more than 50% of the network's mining hash rate.[103] Therefore, the control of a permissionless blockchain platform by an individual with more than 51% of computer power is a real threat, since similar situations have happened at least twice on the Bitcoin platform.[104] In the circumstance of PoS consensus, concentration of power is also inevitable.[105] In open-source software, there will usually be a group of core developers who have 'commit access' and can make actual

97 For the details of the Rule Book, see http://www.bolero.net/wpcontent/uploads/2020/04/Bolero-Insights-The-Bolero-Rulebook-NW.pdf (accessed 3 March 2021).

98 Another similar project, Global Shipping Business Network (GSBN), which is run by CargoSmart, also shares the same problems, as Hyperledger Fabric is also the underpinning technology of this network. See https://www.wto.org/english/res_e/booksp_e/blockchainrev19_e.pdf, 28 and 31 (accessed 3 March 2021).

99 Although TradeLens has been accepted by some liner carriers, it should be noted that the construction of a global blockchain bills of lading system also requires support from other parties, such as shippers and governments.

100 Walch (n 45) 60–64.

101 These developers were appointed by the chief developer. See Walport Report (n 49) 45. See also Vidan and Lehdonvirta (n 28) 49.

102 Ibid 43.

103 Ganne (n 30) 7

104 Vidan and Lehdonvirta (n 28) 51–53.

105 M Saad, Z Qin, K Ren, D Nyang and D Mohaisen, 'e-PoS: Making Proof-of-Stake Decentralized and Fair', IEEE Transactions on Parallel and Distributed Systems https://arxiv.org/pdf/2101.00330.pdf (accessed 3 March 2021).

changes to the software code.[106] Only those skilled in designing, reading, evaluating, and crafting software code can perform these services.[107]

Thus, contrary to the idea of a harmonious Utopia, the permissionless blockchain follows the law of the jungle.[108] Even worse, permissionless blockchains cloak all of the above issues under the name of decentralisation. Therefore, theoretically, there is no central authority that is in charge of the creation and maintenance of the system, or is responsible for maintaining and updating the software operating on the computers.[109] This normally results in three issues: first, there would be no entity to accept liability if anything were to go wrong with the system; secondly, there would be no-one to take responsibility to maintain such a platform, with no-one being in charge of the upgrading or bug-fixing work; and, thirdly, the decision-making process would be slow and inefficient.[110] This is because, in order to obtain a consensus, for instance, to upgrade the platform, it would need most of the nodes on the blockchain to agree and update their software accordingly; otherwise, the system could face a split.[111]

Therefore, the core issue is that no matter which kind of blockchain is implemented, a platform that is running by one or multiple operators would need to be constructed. In this way, the original, relatively decentralised bill of lading transaction mechanism would need to be centralised. This centralisation would pose significant problems: in the permissioned blockchains scenario, a collusion between the controller of the system could easily arise;[112] in permissionless blockchains, the liability of the real controllers of the platform is a challenge to the conventional legal regime. In addition, given the transnational nature of the transaction of bills of lading, having a centralised network adopted by all traders around the world within a short period of time is also unrealistic.[113]

3.1.b Smart contracts

As mentioned earlier, a smart contract as a self-executing instrument, plus the immutable nature of blockchain, could guarantee the performance of some contractual obligations and therefore eliminate

106 Walch (n 45) 61.
107 Ibid 65.
108 To the extent that blockchain code and protocols govern the network on an exclusive basis, see Yeung (n 54) 234.
109 Walch (n 45) 60.
110 Vidan and Lehdonvirta (n 28) 49.
111 Low and Mik (n 27) 164.
112 T Schrepel, 'Collusion by Blockchain and Smart Contracts' (2019) 33 *Harvard J of L & Technology* 117. See also Ganne (n 30) 89-90.
113 Standard-setting activities, which will be discussed later, could be helpful to overcome this interoperability issue. However, undoubtably, they would also be time-consuming.

reliance on other institutions.[114] However, conspicuous drawbacks and disruptive effects exist in its application. Thus, any advantages would be offset.

The first issue is that, by applying such a self-executing 'contract', the legitimate rights of contractual parties under contract law would be restricted. Commercial activities in real life are very complicated. Not only can parties subjectively agree to modify or terminate the contract, if there are objective circumstances such as force majeure or changes in circumstances, they can also claim contract modification, termination or exemption from liability for breach of contract. For instance, before the transfer of a bill of lading by the seller and before the buyer pays the seller to receive the bill of lading, they both enjoy the right to suspend the transfer. The seller may suspend the transfer of cargo because the buyer is involved in bankruptcy proceedings and is unable to pay for the cargo. The buyer may suspend the payment because it may find fraudulent actions on the part of the seller and want to carry out further inspection.[115] For smart contracts, the automatic execution of the contract cannot be prevented when the abovementioned situations occur;[116] this may infringe the legitimate rights and interests of the parties and may even violate the autonomy of the parties. It may be suggested by some authors that, through the implementation of a smarter and more rigorous algorithm, the abovementioned risks can be avoided. However, the reality is that it is both economically unfeasible and technologically inadvisable to devise a smart contract based upon complex codes.[117]

Secondly, smart contracts are programmed by coders and exist in the form of code. They, therefore, require a high level of expertise and are difficult for amateurs to understand. In this case, the parties need to transfer their trust from written words to third-party coders. However, there is no guarantee that those coders are immune to mistakes. Sometimes, even the most straightforward algorithm could go wrong and result in a significant loss.[118] For instance, in the recent Singaporean case *Quoine Pte Ltd v B2C2 Ltd*,[119] Quoine's oversight in making certain minor changes resulted in a loss of 2000 bitcoins in one night. What can make matters worse is that, even if errors in smart contracts or the backdoors of platforms can be found, the immutability of the blockchain system will make it hard to change them.

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114 Low and Mik (n 27) 165.

115 For the general information of the choices of both sellers and buyers under bills of lading and documentary credit, see P Todd, *Bills of Lading and Bankers Documentary Credits* (4th edn, Informa London 2007) ch 6.

116 This is due to the immutability of blockchain. See Fulatova (n 60) 240.

117 Low and Mik (n 27) 172–174.

118 Ibid 169.

119 [2020] SGCA (I) 02. For a case summary, see https://www.supremecourt.gov.sg/news/case-summaries/quoine-pte-ltd-v-b2c2-ltd-2020-sgcai-02 (accessed 3 March 2021).

The third issue is commonly known as the 'oracle problem'. Although blockchain can store and trace data effectively, it cannot take in external data by itself.[120] Similarly, for a smart contract to be functional, it needs to rely upon the information provided by third parties or sensors in order to trigger execution. These third parties are commonly known as 'oracles', which retrieve and verify external data for blockchains and smart contracts through methods such as web APIs or market data feeds.[121] For instance, if a smart contract provides that, 'if the vessel arrives then transfer funds', it will rely upon relevant information about the ship that is provided by other instruments, such as the Internet of Things (IoT), in order to be functional.[122] Therefore, these data feeds from third-party sources give that data substantial influence over the execution of a smart contract, diminishing the trustworthy nature of smart contracts. In this circumstance, the users of blockchain bill of lading platforms will not only need to put their trust in these platforms but also in the third-party oracles with which they will not have a contractual relationship or of which they have even heard. Even worse, at the moment, there is no satisfactory way to ensure the security and authenticity of the data obtained from the oracles.[123] A reliable connection between blockchains and external data feeds should be constructed. However, this would be costly.[124]

3.1.c Security concerns

The third hindrance that would be brought by blockchain bills of lading are concerns regarding security. Those in favour have argued that the immutability and transparency feature of blockchains would be very helpful in dealing with the issue of fraudulently issued documents.[125] However, the reality is that, by deploying blockchain bills of lading, especially those which are built upon permissioned blockchains, numerous security issues may emerge that would be harmful to the stability of maritime commerce.

The first issue is the system's vulnerabilities. In both permissionless and permissioned blockchains, the human factor will not be eliminated, as we still need humans to design and maintain software and platforms. Since humans can, and do, make mistakes, no matter how secure proponents claim these platforms to be, they are only as strong as their weakest link. From the perspective of permissionless blockchains, given their open-source nature, they may face the so-called 51% attack or a split of the

120 *Blockchain for Supply Chains* (n 39) 10.
121 Ganne (n 30) 13.
122 For general information to use IoT to supply information to blockchain systems, see https://www2.deloitte.com/content/dam/Deloitte/lu/Documents/technology/lu-blockchain-internet-things-supply-chain-traceability.pdf (accessed 3 March 2021).
123 Ganne (n 30) 81.
124 Ibid.
125 Albrecht (n 13) 258; Ong (n 13) 203.

platform.[126] Although this is not a frequent occurrence, when it does happen, it would fundamentally undermine the stability of the system. In addition, permissioned blockchain systems, although not necessarily facing risks such as a split of the system or a 51% attack, are more vulnerable in the face of cyber-attacks. This is because there is a potential point of failure with all the nodes that have the right to edit data.[127] If other nodes on the network are able to detect the failure of a single node, then all is fine. However, if it is a so-called Byzantine failure, namely, the faulty node cannot be detected, or it pretends to be normal on purpose, then it is more harmful to the whole system.[128] A successful cyber-attack on a blockchain bill of lading system will be catastrophic, since it may harm not only the parties who transfer bills of lading using this platform, but also third parties, such as banks, and may even threaten the stability of the whole maritime commercial world, given the importance, unique nature, and common usage of bills of lading. Given that maritime cyber-attacks have increased by 900% in three years,[129] it would pose new regulatory challenges to the shipping industry to digitalise bills of lading since they are an essential document for trade.

The second security concern comes from the fact that blockchains can only verify data that has been stored online.[130] Similar to the oracle problem regarding smart contracts, blockchain systems cannot ensure that data has not been tampered with or corrupted before being validated in the network. The first potential risk is whether, if false information has been recorded in blocks, it is possible for this inaccurate information to be corrected. From the perspective of permissionless blockchains, the flawed data or records would be immutable for practical purposes; it is very difficult to change this inaccurate information and, therefore, this information may be stored online forever.[131] Users operating on the blockchain would then unknowingly rely on misleading or false information and losses may arise.[132] In the case of permissioned blockchains and, as previously discussed, in light of the operator's power, data is not immutable and can therefore be changed; as a result errors may be more easily corrected. However, the trade-off is that the other correct data may also run the risk of being altered.[133] These vulnerabilities may provide opportunities for fraud. The second potential risk relates to the Public Key Infrastructure (PKI), which has been commonly used for digital signatures and

126 For instance, the 2013 bitcoin hard fork and the 2016 Ethereum hard fork. For more information of these two attacks, see Walch (n 45) 62–63.

127 Low and Mik (n 27) 158.

128 Ibid 157.

129 See https://www.hellenicshippingnews.com/maritime-cyber-attacks-increase-by-900-in-three-years/ (accessed 3 March 2021).

130 See Ganne (n 30) xv.

131 Ibid.

132 Low and Mik (n 27) 143–145.

133 For instance, Hyperledger has long been criticised for its lack of transparency and security and can be vulnerable to data fraud. See *Blockchain for Supply Chains* (n 39) 16.

which has been promulgated as essential in order to ensure that blockchain bills of lading have been transferred to the right person.[134] Without efficient interaction between the online and offline world, it cannot be guaranteed that the private key is in the hands of the rightful holder. This is because, unlike the relationship between the public and private key, there is no mathematical link between the private key and its user.[135] Therefore, although the PKI mechanism can be used to ensure safe transaction of blockchain bills of lading,[136] it is difficult to guarantee that they have been transferred to the rightful holders of the bills of lading.

3.1.d The fragmentation of platforms

Compared with other industries, the most significant feature of the shipping industry and of maritime law is its relative uniformity.[137] However, given the numerous branches and platforms of blockchain technology and its risk of forking, if this technology is adopted in its current form, the shipping industry will face division due to various carriers and traders possibly choosing to develop their platforms to further their business;[138] this could result in there being a considerable difference between various platforms. Therefore, the current, relatively unified custom and usage governing the flow of bills of lading would be significantly undermined. This would be extremely harmful to the development of maritime commerce.

The first issue to note is that even the projects that initiated the transfer of bills of lading are different and incompatible. For instance, TradeLens, which built upon Hyperledger Fabric, will not talk to CargoX, which relies upon the Ethereum blockchain.[139] The GSBN run by CargoSmart, although also built upon Hyperledger Fabric, will not share data with TradeLens. Although some practical solutions have been implemented regarding this issue,[140] given the diversity of blockchain platforms, fragmentation regarding solutions and their approach to interoperability is pervasive.

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134 Ong (n 13) 210.

135 Law Commission, *Electronic Execution of Documents* (LCCP 237, 21 August 2018) 17–18, 20.

136 Ong (n 13) 215.

137 For the general idea of the uniformity of maritime law, see E Van Hooydonk, 'Towards a Worldwide Restatement of the General Principles of Maritime Law' (2014) 20 *JIML* 170; GW Paulsen, 'An historical Overview of the Development of Uniformity in International Maritime Law' (1983) 57 *Tul L Rev* 1065; W Tetley 'The General Maritime Law: The Lex Maritima' [1996] *ETL* 469; Myburgh (n 2) 355-383.

138 Obviously, the shipping industry is making efforts to achieve interoperability. For instance, the Digital Container Shipping Association (DCSA) has published a standard for eBLs. The eBL standard is the first DCSA standard to be eligible for self-certification under a new DCSA Compliance Programme, which was published in January 2021. See https://dcsa.org/dcsa-publishes-standards-for-the-bill-of-lading/ (accessed 3 March 2021). For the general discussion of standard-setting activities, see part 5 below.

139 See also Bolero, which is partnering with R3 Corda, another blockchain platform, to redesign its eBL system using blockchain: Goldby (n 75) para 11.43.

140 Such as the Overledger, which aims to resolve the interoperability issue in blockchain. See https://www.quant.network/technology/overledger-os/ (accessed 3 March 2021).

The second issue is that, outside the small scope of blockchain bills of lading, other blockchain systems are designed for other industries, such as Everledger for supply chains and R3 Corda for banks.[141] Interoperability between these systems and blockchain bills of lading is essential, since the smooth transfer of bills of lading is only a small part of international trade. For its application on a larger scale, and for the smooth running of international trade, blockchain bills of lading systems also need to resolve the interoperability issue with other participating parties in international trade.[142]

Finally, for the import and export of goods, blockchain bills of lading platforms also need to be compatible with government systems, such as customs authorities. Without interoperability, all these blockchain bills of lading platforms will be like digital islands. However, currently, there is no practical way in which to resolve the abovementioned issues.[143]

Furthermore, even if it is technologically possible to resolve the interoperability issue, due to competition and political concerns, it would be very difficult to have a unified system just for the transfer of bills of lading. From the perspective of concerns regarding competition, it would be hard to persuade companies to join systems that have been developed by their competitors. This is why we have both TradeLens and GSBN, and why only a handful of shippers have joined these two platforms. It is also why the International Port Community Systems Association (IPCSA) is going to develop its own blockchain bills of lading platforms.

The political concern is also real. Recently, due to the clash between the USA and China, we have seen that technology and related applications could become the battlefield between the two countries. Therefore, to those countries for whom a maritime industry is important, they may want to have their own systems available. For example, Alibaba, Ant Finance, and COSCO are developing a blockchain platform for the digital transformation of the shipping industry that includes blockchain bills of lading. Therefore, by implementing permissioned blockchain bills of lading that are designed for members only and that lack interoperability, these platform providers are not tearing down trade barriers; by contrast, they are building walls. It might be possible for large shipping companies to become members of different platforms and run many nodes at the same time in order to expand their business. However, it is impractical for sellers or buyers to copy this model.[144] It is also possible to use pBLs and blockchain bills of lading simultaneously.[145] However, this hybrid approach will not allow the full potential advantages of blockchain to be exploited. In contrast, this approach may put an

141 See Ganne (n 30) 95.

142 Ibid.

143 Although some solutions have been proposed, they are time-consuming and complex. See ibid 44.

144 See ibid 96.

145 All the major platforms offer the switching of eBL to paper BLs: https://www.ukpandi.com/news-and-resources/club-articles/electronic-bills-of-lading--an-update-part-i/ (accessed 3 March 2021).

additional burden on players, since they need to maintain both the traditional transaction of bills of lading and the new infrastructure.[146] Additionally, one question is, since it is still possible to issue a pBL while eBLs are not a necessity, why should the industry give up the regime of more than 300 years of legal precedent that supports pBLs, and embrace a more legally uncertain regime?

3.2 What are the challenges?

The above discussion does not fully enumerate the shortcomings of blockchain technology. The adoption of blockchain bills of lading would also pose other challenges, such as the widely discussed jurisdictional issue that mainly relates to permissionless blockchains,[147] and collusion concerns that will arise due to the adoption of permissioned blockchains.[148]

Given these disruptive effects, what are the challenges? First, by using blockchain technology, transfers of bills of lading would occur in this borderless digital space which will, primarily, be subject to the computer code and operators of the system rather than conventional law. It has been suggested by some scholars that this cyberspace is subject to lex cryptographica rather than positive law.[149] Although this argument is not without criticism,[150] it is non-negligible that via the blockchain technology some governance rules and procedures can be inserted into code.[151] Therefore, the adoption of blockchain technology will mean that industrial associations and relevant technology institutions will share regulatory responsibilities with the shipping industry. Due to the immutable nature of blockchain and the high threshold to make a change to such governance infrastructure,[152] to some extent, the regulatory responsibility has been transferred to the designer, coder and provider of the platform. Although providers and coders of platforms are still subject to certain conventional law requirements and ethical standards, there is still a great opportunity for coders and developers who can access software design to manipulate it and code to their advantage.[153] What adds to the weight of the platforms' coders' regulatory role is that coding has become 'as important as nature for

146 *Blockchain for Supply Chains* (n 39) 47.
147 Ganne (n 30) 100–101.
148 LW Cong, *Blockchain Disruption and Smart Contracts* (NBER Working Paper, March 2018) http://www.nber.org/papers/w24399 (accessed 3 March 2021).
149 De Filippi and Wright (n 25) 136.
150 Yeung (n 54) 207.
151 J Rohr and A Wright, 'Blockchains, Private Ordering, and the Future of Governance', in *Regulating Blockchain* (n 25) 47.
152 V Mignon, 'Blockchains — Perspectives and Challenges', in Kraus, Obrist and Hari (n 25) 14.
153 M Leiser and A Murray, 'The Role of Non-State Actors and Institutions in the Governance of New and Emerging Digital Technologies', in Brownsword, Scotford and Yeung (n 4) 675.

providing the material grounds of our existence'.[154] Therefore, another regulation dimension which is outside of maritime practitioners' control has been added.

The second change would involve a shift of trust. In the existing maritime commerce system, commercial activities are based upon trust between people, trust in contract autonomy, trust in a legal system guaranteed by authorities, and trust in industry customs and practices. Blockchain technology aims to build a 'trustless trust' system, which means that the traditional trust that relies upon institutions such as courts and banks will be replaced with reliance on code (or technology).[155] Therefore, what blockchain does is to shift some of the trust in people and institutions[156] to trust in technology. However, as has been mentioned above, no matter how sophisticated they may be, the computer codes are still created, maintained, and altered by people. Thus, traditional trust in humans has not changed. What has changed is that the people in whom we place our trust can make decisions on our behalf and it is difficult to hold them accountable for their actions. Therefore, a significant challenge faced by the shipping industry is to construct an effective regulatory framework which should be based upon mutual trust that originates from the close engagement between not only regulators and regulatees in the shipping industry, but also participants from both maritime and technology industries.[157]

Finally, given the potential risks of adopting blockchain bills of lading, the next question is in regard to cases where the malfunction of the platform causes loss. In this instance, who should bear the cost and compensate the users? In the scenario of permissionless blockchains, it would appear that no-one will. This is because they claim themselves to be decentralised, meaning that no-one would be responsible for any losses.[158] In the scenario of permissioned blockchains, both TradeLens and GSBN argue that they will not be responsible for losses that may occur on their platforms.[159] P&I Clubs will also not cover losses that arise from cyber-attacks or systems failures, since they are considered as

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154 Lord Sales, 'Algorithms, Artificial Intelligence and the Law' (2020) 25 *JR* 57.

155 Low and Mik (n 27) 139. See also Walch (n 45) 59.

156 Such as banks and letters of credit.

157 A proposal to enhance trust through standard-setting will be introduced later.

158 Or, as CargoX claims, that its limitation of liability is €3 million: https://www.skuld.com/contentassets/9570cd183e8d4cdca6a52bced54f8002/cargox_special_terms_conditions_v1_10_february_2020.pdf (accessed 3 March 2021). Clearly, this is an allocation of risk issue. Losses might be covered by insurance. For instance, Lloyd's has launched an insurance policy to protect cryptocurrency held in online wallets against theft or other malicious hacks. However, no mature insurance policies have been launched to protect the systematic failure of blockchain platforms. See https://www.insurancejournal.com/news/international/2020/03/02/559855.html (accessed 3 March 2021).

159 For GSBN, see https://www.cargosmart.com/en/company/tou.htm; for TradeLens, see https://www.tradelens.com/legal-notice (accessed 3 March 2021.

business risks rather than marine risks, which are traditionally covered by P&I Clubs.[160] The product liability regime is also unlikely to provide sufficient protection for users of blockchain bills of lading platforms as: first, although the platforms may be a product under this regime, the maintenance of them is usually not;[161] and, secondly, it would be extremely difficult to prove that losses have arisen due to the fault of the platform provider.[162]

With these phenomena, the potential obstacle which might impede the wide adoption of blockchain bills of lading is the shipping industry's lack of confidence and consensus for utilisation of this technology. The core challenge for the shipping industry is that in the blockchain bills of lading world there is still a lack of standard-setting activities regarding construction of the platform, addressing the potential vulnerabilities of the platform, and securing the transactions of bills of lading. Moreover, the absence of both a corresponding accountability system and an adaptive risk allocation instrument would further enhance the distrust between the different groups of actors.

Nevertheless, it is noteworthy that a discussion of the disruptive effects and challenges of blockchain technology does not mean that the technology should be rejected. The use of blockchain will significantly improve the efficiency, reliability, and security of bills of lading. However, whether blockchain bills of lading can be used on a large scale depends not only on the advantages of blockchain, but also on whether the existing legal or regulatory system can effectively deal with the challenges and uncertainties caused by the disruptive effects. Therefore, recognising the potential risks of blockchain technology and exploring methods to deal with them from a legal and regulatory perspective is more crucial for the application of blockchain bills of lading.

4 The limits of positive law instruments as the sole source of regulation

As demonstrated in the previous Part, blockchain bills of lading can be disruptive and change established industry practice and trade patterns. Inevitably, those changes will pose new challenges to the shipping industry. The question is whether current legal systems can deal with the challenges raised by the abovementioned disruptive effects. Given that the MLETR and the Rotterdam Rules are the relevant existing instruments, this Part will draw a distinction between them and other instruments which might come in the form of positive law. This Part will first briefly introduce the MLETR and Rotterdam Rules that have been commonly referred to by scholars as the potential

160 See https://www.ukpandi.com/news-and-resources/articles/2020/electronic-bills-of-lading---an-update-part-ii/ (accessed 3 March 2021).

161 Walch (n 45) 65.

162 Ibid 75.

regulatory framework.[163] It will then consider the insufficiencies of these two instruments as blueprints for the future regulation of blockchain bills of lading. Finally, it will consider the limits of positive law instruments as the sole source of regulation.

4.1 The MLETR and the Rotterdam Rules

As stated in Part 2, a blockchain bill of lading is, in essence, a kind of eBL. The advent of eBLs can be dated back to the 1980s. They have been well developed since then.[164] Maritime industry regulators and maritime law legislators have carefully come up with various propositions to facilitate the utilisation of eBLs and their regulation. As has been mentioned above, in the view of the proponents of eBLs, the main obstacle to their wide adoption is the lack of legal rules; thus, the propositions regarding the regulation of eBLs mainly exist in the form of positive law. In addition, given the international nature of maritime trade, an international instrument is the preferred way of maintaining uniformity in application of law.

The most recent instrument which has been most frequently referred to by scholars is the Rotterdam Rules. The aim of the Rotterdam Rules is to achieve uniformity of law in the field of maritime carriage. Although the Rules are not solely designed for eBLs, several of the Rules set out fundamental principles regarding the use of electronic transport records which clearly cover eBLs. For instance, arts 8–10 in Chapter 3 of the Rotterdam Rules, which are entitled 'Electronic transport records', entail the use of electronic transport records which are functional equivalents to conventional transport documents such as bills of lading.[165]

The MLETR is a uniform model law that was adopted by the UNCITRAL in 2017. The MLETR can be seen as a set of principles that are intended to provide a basic legal framework for electronic transferable records, with the focus upon what is needed to facilitate these kinds of records rather than to regulate them. The scope of the MLETR is to allow the use of transferable documents and instruments which include bills of lading in electronic form. Thus, as recommended by practitioners, the MLETR can be used to facilitate the use of eBLs.[166] Although the MLETR sets out a legal framework

163 See the articles cited at n 13.
164 Todd (n 13) 340.
165 See Rotterdam Rules, art 8(a). Articles concerning electronic transport records can also be found in chapters 8, 9, 10 and 11.
166 Clyde & Co (n 73) 10–11.

for the validation of electronic transferable records,[167] it is not in its nature a law. Its application is subject to individual States' decision on whether to adopt it into their own law.

4.2 The shortcomings of the MLETR and the Rotterdam Rules

When facing technological changes, the typical response from legal scholars is to fit the new, arising legal issues brought on by new technology into existing legal categories.[168] It is logical for maritime scholars to suggest that the MLETR and the Rotterdam Rules should be called upon as legal frameworks to deal with the abovementioned disruptive effects and challenges, and therefore to assist in shaping blockchain technology so as better to boost maritime commercial activities. The two rationales which underlie these two instruments are 'functional equivalence' and 'technological neutrality'. However, both these two instruments and their rationales have their respective drawbacks and the propositions that have been mentioned above are, consequently, ill-founded.

The first noticeable obstacle impeding the application of the MLETR and the Rotterdam Rules is that both of these instruments currently have no legal force. The MLETR is 'soft law' in nature. It is only binding on States if enacted into their domestic laws. Such an implementation approach will have two consequences: first, even States that choose to implement the MLETR may implement it differently into their enacting legislation; secondly, the implementation process can be time-consuming. Currently only the Kingdom of Bahrain and Singapore have officially enacted laws based on, or influenced by, the MLETR.[169] The Rotterdam Rules have been ratified by only a handful of countries and far from the number required in order to come into force. It has been suggested that the chance of its coming into force is slim, if not completely unlikely.[170] Therefore, even if certain articles in these two instruments could provide guidance for the future regulation of blockchain bills of lading, due to the inapplicability of these two instruments, they are of limited future use.

Secondly, neither the MLETR nor the Rotterdam Rules was designed with the disruptive effects and challenges of blockchain bills of lading in mind. In fact, if the arguments in Part 3 are accepted, it is clear that it should not be up to these two instruments to deal with the potential systematic challenges

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167 HD Gabriel, 'The UNCITRAL Model Law on Electronic Transferable Records' (2019) 24 *Uniform L Rev* 261, 279.

168 GN Mandel, 'Legal Evolution in Response to Technological Change', in Brownsword, Scotford and Yeung (n 4) 228.

169 *Blockchain for Supply Chains* (n 39) 128. Singapore's Electronic Transactions (Amendment) Act, which came into effect on 19 March 2021, also adopts the MLETR with modifications. The Bill makes consequential and related amendments to the Bills of Lading Act (Cap 384). Therefore, this Bill may have an impact on the use of blockchain bills of lading. See above n 23.

170 Davies (n 2) 156.

brought about by blockchain bills of lading. Therefore, although these two instruments can be used to resolve some basic issues, such as how to make sure that a blockchain bill of lading exists as a document of title,[171] they are of limited use to boost consensus in utilisation of blockchain bills of lading and to enhance mutual trust among the various industry actors.

Thirdly, the technological neutrality and functional equivalence principles which have been relied upon by these two instruments also have drawbacks. As can be seen from the definition of functional equivalence and technological neutrality,[172] these two principles are intrinsically linked, and the application of functional equivalence should function with the principle of technological neutrality in mind.[173] However, the application of these two principles has shortcomings. The first drawback, and also a paradox of adopting these two principles together, is that, if the particular technology which underlies the commercial activities that the MLETR and the Rotterdam Rules intend to facilitate and regulate cannot be specified, how functional equivalence be ascertained. Under this circumstance, equivalence is hard to define.[174] Clearly, the equivalence of words does not equal to functional equivalence. A real functional equivalence, as argued by scholars, can only be achieved if the interests which are balanced by the offline rules can also be identified and balanced by the rules for online activities.[175] However, this result can only be achieved if the technology is specified.[176] The second drawback relates to the vague language that would be adopted with the application of these two principles. There are two reasons for the adoption of vague language. The first is to achieve technological neutrality, whereupon vague language would be used and the definition of target technology would be given a broad meaning.[177] Secondly, the construction of international frameworks that aim to regulate the cross-border use of electronic transferable records would normally mean that a compromise between different nations or international entities is inevitable, and the adoption of vague language is usually the measure to achieve such a compromise.[178] However,

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171 See generally Ong (n 13).

172 See the definitions at n 20 above.

173 See UN General Assembly, *Legal Issues Relating to the Use of Electronic Transferable Records, Report of United Nations Commission on International Trade Law Working Group IV (Electronic Commerce)* (Forty-fifth session, Vienna, 10–14 October 2011) 10.

174 Todd (n 13) 370.

175 C Reed, 'Online and Offline Equivalence: Aspiration and Achievement' (2010) 18 *International J of L & Information Technology* 270.

176 E Mik, 'Evaluating the Impact of the UN Convention on the use of Electronic Communications in International Contracts on Domestic Contract Law: The Singapore Example' https://ink.library.smu.edu.sg/cgi/viewcontent.cgi?article=3022&context=sol_research (accessed 3 March 2021) 6-8.

177 Reed (n 175) 270. This is to ensure that the law will neither require nor assume the adoption of a particular technology.

178 For example, the Hamburg Rules are a good example of how the use of ambiguous language to achieve compromise may bear significant problems. See DC Frederick, 'Political Participation and Legal Reform in

vague language is a huge challenge for regulators, and a broad definition would provide an expansive opportunity for courts subsequently to interpret terms widely.[179] A wide interpretation would make the enforcement and compliance of a technology-neutral instrument problematic.[180] All of these factors would reduce the certainty of the law as well as its applicability. Ultimately, they would also diminish the enforceability of the law.[181] The third drawback of deploying functional equivalence methodology to change the current regulatory regime is that the advantages of new technology could be exaggerated by the promoters of such technology, and relevant defects could be hidden.[182] For instance, the proposition that containerisation could reduce risk and thus reduce insurance costs was subsequently proved to be unrealistic.[183] However, legislators and scholars may not be aware of the full extent of emerging technologies.[184] Therefore, the construction of a legal rule which may seem appropriate at the time could be proved to be adverse at a later date.[185]

Unquestionably, both the MLETR and the Rotterdam Rules still present the potential to promote use of blockchain bills of lading and harmonisation of law. However, the effectiveness of both the Rotterdam Rules and the MLETR depends on whether there will be a mature business model which has the industry's support to construct and maintain an open eBL system.[186]

4.3 The limitations of positive law instruments as the sole source of regulation

Except for the discussion related to the above mentioned two instruments, the next noticeable issue is that, although regulation in the form of positive law may still be feasible to regulate blockchain bills of lading, positive law instruments as a whole should not be taken as the only source of regulation.

First, positive laws enacted by individual states may be incompetent to regulate blockchain bills of lading. Following the advent of blockchain bills of lading, as has been discussed above, another regulatory layer has been created which exists in cyberspace. This is, to certain extents, a sphere which

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the International Maritime Rulemaking Process: From the Hague Rules to the Hamburg Rules' (1991) 22 *JMLC* 81, 105–106.

179 See F Berlingieri, 'Unification and Harmonisation of Maritime Law Revisited' (2006) 59 *RHDI* 613–616.

180 JG Allen and RM Lastra, 'Border Problems: Mapping the Third Border' (2020) 83 *MLR* 532.

181 The current status of both the MLETR and the Rotterdam Rules is a good example of these issues.

182 For example, there has been major touting of blockchain technology in the maritime transport sphere, but the serious consequences that could follow the application of blockchain technology have not been sufficiently studied and discussed.

183 E Schmeltzer and RA Peavy, 'Prospects and Problems of the Container Revolution' (1970) 1 *JMLC* 203, 209.

184 Lord Sales (n 154) 58.

185 Mandel (n 168) 238. For more criticisms about functional equivalence and technological neutrality in other UNCITRAL instruments, see Mik (n 176).

186 Gabriel (2019) 24 Uniform L Rev 261, 280.

State-oriented law has constantly been proven to be incompetent to regulate by itself alone.[187] Such incompetence largely derives from the fact that cyberspace activities are always transnational and difficult to subject to an individual nation's domestic law since no single State should have the overriding authority to legislate for particular cyberspace activities.[188] Therefore, given the strengthened transnational nature of blockchain bills of lading, it would be inappropriate to place its regulation under the legislation of individual countries, for this approach would aggravate its fragmentation. It would be tempting to suggest that, following the reception of the MLETR by individual countries, the fragmentation issue could be mitigated. However, a close examination will reveal that the enactment of the MLETR is still subject to each individual country's adjustments to the text to accommodate local requirements which vary from one country to another. Therefore, eventually, on this approach, blockchain bills of lading will still be subject to each nation's domestic law. After all, a model law only provides for a legislative text that is recommended to States.[189]

Secondly, although both the transnational nature of blockchain platforms and the internationality of bills of lading require the international harmonisation of rules, the enactment of international legal instruments is time-consuming and may never be able to keep pace with the innovation of technology. Therefore, by the time that those laws are ready, technology will have moved on to the next phase. Until now, the process of harmonisation has been driven by international agencies such as the IMO, CMI and UNCITRAL. The main technique is international Conventions. Unquestionably, this process achieves good results.[190] The Hague/Hague-Visby Rules are still the dominant rules governing the international transfer of bills of lading. However, the recent harmonisation processes in the maritime industry through the technique of international Conventions have been proven to be unsatisfactory.[191] The most significant criticism of this process is that it can be only a long-term process, since both the ratification of Conventions by States and the implementation of them into domestic legal systems are time-consuming. In addition, a global top-down harmonisation process will normally require a level of political consensus, which also takes time. Thus, unsurprisingly, given the speed of technology innovation, the construction of a new international conventional legal instrument governing blockchain bills of lading can quickly become out of touch with market practice.

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187 See generally C Reed, 'How to Make Bad Law: Lessons from Cyberspace' (2010) 73 *MLR* 903; C Reed and A Murray, *Rethinking the Jurisprudence of Cyberspace* (Edward Elgar 2018) ch 2.

188 C Reed and A Murray, *Rethinking the Jurisprudence of Cyberspace* (Edward Elgar 2018) ch 2.

189 See https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/12-57491-guide-to-uncitral-e.pdf (accessed 3 March 2021) 14.

190 With the work done by the IMO and CMI, many international maritime Conventions have been widely adopted, eg, the Collision Convention 1910, the Salvage Convention 1989 and SOLAS 1974.

191 Van Hooydonk (n 137) 171.

Thirdly, although it is always possible to design and introduce positive law rules to encourage the use of new technology by removing potential legal uncertainty, one particular point which should not be neglected by positive lawmakers is that law is not designed to regulate technology itself. Law is designed to regulate, shape and guide human activities.[192] Therefore, before the implementation of any positive law to deal with the challenges brought by blockchain bills of lading, three fundamental questions must be answered by maritime regulators and scholars. First, why is regulation by positive law still necessary? Given the very limited use of blockchain technology and the previous failed experience with eBLs, legislators may argue that there is no need to legislate for blockchain bills of lading at this time, given the lack of a mature technology and a mature market.[193] Secondly, since new legal disputes that would be brought by new technology are normally unforeseeable, how should positive law regulate blockchain bills of lading? In the early stage in the development of technology, any information and knowledge about disruptive technology would be limited. Such knowledge would be limited to scholars, legislators and regulators, given that most of the technology is developed by companies who, for commercial reasons, would like to conceal the developing technology. Therefore, how would legislators provide clear-cut rules without having a clear understanding of what would be changed by the disruptive effects and kinds of new legal disputes would arise from new technology? Thus, as a result, positive law may lose its target. Finally, even if it is necessary and feasible to regulate blockchain bills of lading by positive law, the next question is, who should make these laws? Considering the transnational nature of maritime commerce and the highly globalised blockchain bills of lading platforms, positive law on a national basis could only play a limited role. For the reasons given at the beginning of this Part, the role of international organisations in the development of international conventions will also be limited.

Finally, the international maritime law community seldomly responds to technological changes in a timely and effective fashion.[194] Historically, the development of maritime law has been motivated by the necessity of balancing the interests of shipowners and cargo owners.[195] Technological advancements may shatter this delicate balance and result in changes to certain rules.[196] However,

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192 Julia Black, 'Critical Reflections on Regulation' (2002) 27 *Australian J of Legal Philosophy* 25.

193 It should be noted that the lack of positive law regarding blockchain technology will not impede its innovation. For instance, various international organisations and governments have implemented a mechanism called the sandbox, which is an isolated, but fully functional testing environment where software, applications, and programs can be tested. This mechanism will enable innovative experiments within a well-defined space and duration. See https://www.icao.int/about-icao/partnerships/Pages/Blockchain-Sandbox.aspx and https://www.mas.gov.sg/development/fintech/regulatory-sandbox (accessed 3 March 2021). See also Yeung (n 54) 233.

194 Myburgh (n 2) 365.

195 See generally Frederick (n 178) 82–86.

196 The background of the development of the Visby Rules clearly reflects this trend. See L Zhao, 'Uniform Seaborne Cargo Regimes — A Historical Review' (2015) 46 *JMLC* 145, 155–157.

maritime law, at least in its commercial sphere, rarely answers directly to technological developments in the form of positive law.

The implication of this Part is not to denounce the role of institutional regulators such as UNCITRAL and positive law instruments in the regulation of blockchain bills of lading. Clearly, institutional regulators can impose laws on end-users and blockchain-based systems.[197] However, the insufficiencies of the positive law instruments are also significant.

5 Self-regulation by the maritime industry

Given the rapid development of blockchain bills of lading platforms and the maturity of blockchain technology, the advent of a world where the utilisation of blockchain technology could efficiently promote international trade and maritime commerce is still possible. However, given the abovementioned disruptive effects and the incompetence of positive law instruments, the salient issue is how we could regulate the development of blockchain bills of lading in the absence of positive law.

5.1 The rationale for self-regulation

Although this paper does not intend to provide a comprehensive introduction of self-regulation theories,[198] this section will still briefly introduce the rationale for self-regulation.

There is no universally accepted definition of self-regulation.[199] However, the commonly agreed major features of self-regulation are as follows. First, the rule-making power shifts from States to private actors. Secondly, self-regulation is a response to the weakness of conventional law regulation and the emergence of new technologies.[200] Thirdly, participation in self-regulation regime is voluntary. Fourthly, self-regulation regimes are not self-contained — they rely on the existence of international and domestic institutions. In other words, they are not fully independent and autonomous regimes.[201]

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197 De Filippi and Wright (n 25) 175–176.

198 For the general theory of self-regulation, see J Black, 'Constitutionalising Self-Regulation' (1996) 59 *MLR* 24.

199 C Coglianese and E Mendelson, 'Meta-Regulation and Self-Regulation', in R Baldwin, M Cave and M Lodge (eds), *The Oxford Handbook of Regulation* (OUP 2010) 147–148.

200 F Cafaggi, 'New Foundations of Transnational Private Regulation' (2001) 38 *J of Law & Soc* 20, 28–29.

201 F Cafaggi, 'The Many Features of Transnational Private Rule-Making: Unexplored Relationships between Custom, Jura Mercatorum and Global Private Regulation' (2015) 36 *U of Pennsylvania J of International Law* 105.

Private actors work in collaboration with public entities rather than in competition with them.[202] Finally, self-regulation can be effective to increase efficiency, reduce transaction costs and enhance mutual trust between industrial participants.[203] There are of course, other important theoretical discussions concerning the self-regulation regime, such as the legitimacy, models and enforcement mechanisms of this regime.[204] However, for the purpose of this paper, it is enough to understand the existence and significance of this form of regulation to fill the regulatory gap left by the State-oriented instruments.

There are two factors underlying the need for self-regulation in the blockchain bills of lading scenario. The first is that self-regulation has been vital in cyberspace since the development of the internet. Regulation by positive law never claims to be the sole appropriate method for dealing with emerging technology. As Lawrence Lessig has argued, an effective management mechanism should be an interaction between State legislation, technological architecture, market forces, and social norms.[205] The functions of non-State actors in the regulation of cyberspace and emerging new technology have also been commonly accepted.[206] In addition, the transnational nature of digital technologies also calls for the international co-operation (from both public and private spheres) to set both technological and legal standards.[207]

Secondly, self-regulation should not be a surprise to the maritime industry, since it has long been proved that self-regulation measures, such as customs and usage or standard forms of contracts, play an essential role in the regulation of maritime commercial activity.[208] The formation of the modern regulatory regime governing bills of lading is a process that has been bottom-up rather than top-down.[209] For instance, both the Hague/Hague-Visby Rules were first drafted by private entities before being submitted to diplomatic conferences for ratification.[210] Both of these sets of Rules reflected the consensus and compromise that had been reached by practitioners and the commercial practices at that time.[211] It is crucial to note that, without solid, well-received commercial practices and commercial needs, the longevity and widespread acceptance of these Rules could not be achieved.[212]

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202 Ibid 113.
203 Coglianese and Mendelson (n 199) 153.
204 For a general discussion of these issues, see *The Oxford Handbook of Regulation* (2010).
205 L Lessig, *Code and Other Laws of Cyberspace* (Basic Books 1990) 5. See also P Tasca and R Piselli, 'The Blockchain Paradox', in *Regulating Blockchain* (n 25) 28.
206 See Brownsword, Scotford and Yeung (n 4) 21–22.
207 Lord Sales (n 154) 57–58.
208 See Van Hooydonk (n 137); Tetley (n 137).
209 Tetley (n 137).
210 Zhao (n 196).
211 Frederick (n 178) 88.
212 See Frederick (n 178) and Zhao (n 196).

Although these two sets of Rules have long been criticised as being outdated and deficient,[213] the failure of both the Hamburg Rules and the Rotterdam Rules to replace them proves that commercial interest-oriented instruments are still preferable.

Therefore, in the absence of positive laws, a self-regulatory regime that is based upon the positive interaction between industry practitioners could still stimulate the development of the maritime industry.

5.2 The self-regulation actors

A self-regulatory regime consists of various non-State actors. In the sphere of maritime commerce, given the historical tradition of self-regulation and its transnational nature, a wide range of private actors should participate in the regulation of blockchain bills of lading. This section will consider the role of these actors.

5.1.a Business companies

As mentioned earlier in the paper, the existing blockchain platforms, especially permissioned blockchains, can impose regulation on the users of the platform by restricting membership and transactions or by compelling the users to agree with the terms of use. In addition, the algorithms used by these companies will restrain users' choice in cyberspace even further. Therefore, it has been suggested by some scholars that the era of technological management has arrived.[214]

The prominent leaders in this technological transformation are the many companies adopting the new blockchain technology. This will include companies that are in charge of the design, development, and maintenance of the blockchain bills of lading platforms and shipping companies who will use the systems. However, it is worth noting that the tech companies responsible for the development of blockchain platforms currently hold more advantages. This is because these companies can design, develop, and programme the platform to protect their interests. Therefore, although some blockchain bills of lading platforms exist in the form of correlation between technology and shipping companies, such as TradeLens and GSBN, shipping companies are the customers of these platforms rather than their controllers. This is because neither Hyperledger nor R3 was designed or maintained for shipping companies and international trade only. The reliance of traders on these dominant platforms will give

213 See MF Sturley, 'Bringing Carriage of Goods into the Twenty-First Century', NUS Centre for Maritime Law Working Paper 18/01, 12.

214 R Brownsword, 'Technological management and the Rule of Law' (2016) 8 *Law, Innovation & Technology* 100. For the arguments about regulation by blockchain, see Yeung (n 54) 209; and Rohr and Wright (n 151) 43–45.

these tech companies considerable market power. Although in some cases traders may be able to influence the design of the platform by working with the platform providers, the traders' position remains that of a regulatee rather than a regulator, as opposed to a dominant platform provider. One might suggest that the maritime industry could develop its own blockchain system in order to avoid the risk of being regulated by other companies. However, given the lack of expertise and the cost of construction in the field of blockchain technology,[215] it would be both uneconomical and unfeasible for the shipping industry to develop a blockchain platform solely to transfer bills of lading. The challenge for shipping companies is, therefore, what to do if it is later found that the existing systems do not fulfil the needs of international trade.

5.1.b International private actors

Other than business companies, international private actors in the maritime sphere, such as BIMCO, CMI, and IG P&I Clubs should participate in the regulation of blockchain bills of lading. BIMCO, as the largest international shipping association representing shipowners, aims to promote fair business practices, while facilitating the harmonisation and standardisation of commercial shipping practices and contracts.[216] Therefore, in the emergence of blockchain technology, BIMCO could function as a facilitator by bringing together the key stakeholders, gathering their concerns and sharing information between them.[217] BIMCO, in this perspective, could at least try to obtain a consensus among shipowners regarding the adoption of blockchain bills of lading. BIMCO could also play a role in drafting standard contracts and clauses that could be used across the shipping industry and establishing and setting international trade standards.[218] However, this will not happen until there is more widespread use of blockchain bills of lading.

Until blockchain bills of lading are more widely adopted, the role of the CMI, being an international maritime law association, would be relatively limited. However, again it could play a significant role in gathering legal and regulatory concerns from its members and passing those concerns to the designers and providers of blockchain platforms for the better use of blockchain technology.

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215 Although the cost of transfer of documents may be reduced by the use of blockchain technology, the cost of the construction and maintenance of a blockchain platform is costly. see Ganne (n 30) 21.

216 See https://www.bimco.org/about-us-and-our-members (accessed 3 March 2021).

217 See https://www.bimco.org/news/priority-news/20170928-bimco-president (accessed 3 March 2021).

218 For information of one of the most recent consortiums with which BIMCO has been involved in the promotion of blockchain and smart contract in the bunker industry, see https://ibia.net/2018/07/26/bloc-announces-industry-led-demonstrator-consortium-for-blockchain-use-in-bunkering-with-lloyds-register-bimco-precious-shipping-bostomar-ibia-and-goodfuels/ (accessed 3 March 2021).

The third private maritime association which could also exert influence on blockchain bills of lading, although indirectly, is the IG P&I Clubs. By approving the adoption of blockchain bills of lading platforms, liabilities arising in respect of the carriage of cargo under eBLs created on these systems would be covered by the IG P&I Clubs.[219] This is vital for the development of these platforms since, in the absence of this most fundamental assurance, carriers and traders would be reluctant to adopt this technology. Therefore, in this regard, the IG P&I Clubs will at least influence people's choice. Furthermore, by issuing documents such as industry guidelines on new emerging issues, the IG P&I Clubs could further boost the development and deployment of blockchain bills of lading or enhance their security.[220] However, given the experience of eBLs, what should not be ignored is that the approval by the IG P&I Clubs does not mean the wide acceptance of blockchain bills of lading by the shipping industry.

In addition to the private actors from the maritime sphere, another private entity which has been increasingly active in the adoption and regulation of blockchain technology is the International Chamber of Commerce (ICC). As a world business organisation led by entrepreneurs, the ICC aims to ensure the free flow of goods across the world and to streamline global business.[221] With the worldwide adoption of various editions of self-regulatory instruments, such as Incoterms and the ICC's Uniform Customs and Practice for Documentary Credits (UCP), a set of rules governing the interpretation of the most commonly used trade terms and documentary credits, have brought great certainty to international trade. Therefore, it has been suggested by some scholars that both Incoterms and the UCP are the codification of the lex mercatoria,[222] a set of unwritten rules followed by international traders.[223]

Unsurprisingly, the ICC has already joined the flow of application of blockchain technology. Co-operation between the ICC, the Singapore government, and other key industry players, has resulted in the launch of TradeTrust, a platform that allows for interoperability across different trade platforms for the exchange of trade documents on a public blockchain.[224] The primary purpose of this platform is not only transaction of blockchain bills of lading. However, the advantage of the ICC is that, as an

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219 See https://www.ukpandi.com/news-and-resources/club-articles/electronic-bills-of-lading--an-update-part-i/ (accessed 3 March 2021).

220 See https://www.igpandi.org/article/maritime-global-security (accessed 3 March 2021).

221 For general information on the ICC, see https://iccwbo.org/about-us/who-we-are/ (accessed 3 March 2021).

222 VM Johnson, 'Codification of the Lex Mercatoria: Friend or Foe?' (2015) 21 *Law & Business Review of the Americas* 161.

223 For the definition of, and a comprehensive introduction to the lex mercatoria, see R Goode, 'Usage and Its Reception in Transnational Commercial Law' (1997) 46 *ICLQ* 1.

224 See https://iccwbo.org/media-wall/news-speeches/icc-digital-initiatives-that-will-equip-business-for-the-next-century-of-global-trade/ (accessed 3 March 2021).

international organisation with 45 million members, the existing interoperability issue could, to some extent, be alleviated. However, it is still too early to ascertain whether TradeTrust would be as successful as the other international instruments that have been initiated by ICC thus far. Given the significant drawbacks of permissionless blockchains, it remains unclear how TradeTrust can become a network that supports the vast volume of international trade.

5.2 Foundations for self-regulation

Perhaps the most significant foundation for the self-regulation of blockchain bills of lading is the reaching of consensus. Reaching consensus is vital for the operation of blockchain systems. In permissionless blockchain platforms, transactions will be validated by consensus mechanisms such as PoW. In permissioned blockchains, controlled consensus process will ensure the efficiency of the platform.[225] In addition, consensus between private actors is also required for the adoption of transnational private regulatory instruments.

Given the disruptive effects that have been mentioned above, perhaps, besides the implementation of any self-regulatory instruments, one of the most important cornerstones is for the shipping industry to reach a consensus on the necessity for blockchain bills of lading. This consensus is vital in order to achieve their wide adoption, since there is no point in saying that blockchain bills of lading should be regulated before their use becomes a common practice of maritime commerce.

One of the obstacles to reaching consensus is that blockchain is clearly not suitable for every circumstance. Blockchain (especially permissionless blockchain) is a technology that creates and enhances trust between strangers, in the absence of regulators, intermediaries and laws. Its adoption makes sense in the cryptocurrency scenario since, until now, this world has not been effectively regulated by any conventional legal regime or any instruments of dispute resolution. Therefore, in this 'Wild West world', a high level of trust and transparency between the members in the system is required. However, in the scenario of international carriage of goods by sea, a sound legal system and relatively uniform industry practices already exist. There is, therefore, no need for traders to put their trust in unfamiliar counterparties and invest money to secure such trust if they know that they can already trust in institutions to protect their legitimate interests. As discussed above, all the proposed advantages of blockchain technology (permissionless or permissioned) have their drawbacks and limitations. What is worse is that, by distorting the permissionless blockchain technology that was

[225] P Delimatsis, 'When Disruptive Meets Streamline: International Standardisation in Blockchain', in Kraus, Obrist and Hari (n 25) 86.

originally designed for the transfer of cryptocurrency and turning it into an old-fashioned eBL system, a platform that is offering blockchain bills of lading is neither a genuinely immutable nor a decentralised system. Indisputably, blockchain bills of lading would increase transaction security, minimise fraud, and bring efficiency into the maritime industry. However, the abovementioned disruptive effects are also significant. Therefore, if the result of solving a problem is to bring more conundrums, how is it possible to justify its application? Unquestionably, every solution comes with some necessary evils, and we should not be too harsh on emerging technologies. However, if immaturity and all the disruptive effects are necessary evils that we need to bear in order to chase the faster transaction of bills of lading, why can we not accept the slow circulation of pBLs as a necessary evil in order to maintain the certainty of the shipping industry? These are the key questions that industrial actors and maritime scholars should answer and reach consensus upon before the wide adoption of blockchain bills of lading.

To facilitate the achievement of consensus in the maritime industry that blockchain bills of lading are needed, the industry must devise and issue minimum and unified standards for the design and construction of blockchain bills of lading platforms and also for the safe transaction of bills of lading.[226] An industrial, widely accepted standard is the key to overcoming the interoperability issue and ensuring the worldwide application of the blockchain bill of lading.[227] It is also the key to enhance trust among different commercial actors.[228] For now, given the immaturity of blockchain technology, most of the research on standard setting is carried out by private entities such as ISO. Under its project ISO/TC 307, there are currently 10 blockchain-related ISO standards under development,[229] and all these standards intend to cover crucial issues such as terminology and concept, security risks and vulnerabilities, and architecture.[230] The legitimacy of such standard setting by private actors, as suggested by scholars, largely depends on the technical grounds of their superiority in achieving the regulation task.[231] The technical standard setting by relevant organisations can also be useful to enhance both the quality and legitimacy of future regulation.[232]

The standard-setting entities in the shipping industry, such as BIMCO, the IG P&I Clubs, the International Association of Classification Societies (IACS), and the ICC should also participate in this

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226 Given the diversity of the maritime industry, the responses to setting standards for blockchain technology have been inconsistent between different sectors. For instance, with the help of industrial associations such as DCSA, container shipping is moving towards the adoption of unified standards. However, whether such standardisation will extent to the other sectors such as bulk shipping is still unknown.

227 *Blockchain for Supply Chains* (n 39) 137.

228 Cafaggi (n 200) 104.

229 Delimatsis (n 225) 97–98.

230 Ibid 93.

231 C Scott, 'Standard-Setting in Regulatory Regimes', in *The Oxford Handbook of Regulation* (2010) 113.

232 Ibid 114.

standard-setting process and express their specific concerns from the perspective of the shipping industry on the use of blockchain platforms. Co-operation between the shipping industry and the ISO should not be a surprise, given the success of the ISO/TC8 committee.[233] Although possessing a transnational nature, standards and other regulatory instruments initiated by these private actors are not subject to international law and it is therefore relatively easy to reach a consensus between various industry actors who have different interests. However, this does not mean that these standards will be available any time soon or will be available in a unified form. It seems that the standard-setting initiative that aims to resolve the interoperability issue is also facing the risk of fragmentation. For instance, at least six working groups from various international organisations are now developing international standards for blockchains. In addition, much work is coming from industry and community organisations.[234] However, whether these standards will be compatible in future is still unknown. As a result, the maritime industry will now face a new round of painful consensus-reaching processes. However, a spill-over effect may be helpful in this process in the sense that, if standards were harmonised between two major industry actors, these standards could be adopted by other industry players who still wish to remain in the market.[235] In addition, as will be discussed later, the implementation of standards can also be promoted by the utilisation of standard contracts that are issued by industry associations.

The normative effect of these private setting standards may be seen from the following aspects. First, private standards, despite their 'soft' status, are not necessarily voluntary in practice. In practice, the market may demand compliance, and failure to comply will result in exclusion by other market participants. Secondly, these private standards may gain normative effect, in the sense that they can be given judicial recognition or can be incorporated into national legal systems. Thirdly, standards developed by trade associations, in particular, may not be limited to their members. These standards may be disseminated more widely in the market by the organization, or submitted for adoption by the public sector as an alternative to regulatory intervention. Finally, if a significant number of participants in the market choose to operate according to a trade association code or a standard, this may have important implications for the outside world.[236]

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233 A Chircop, 'The Quest for Universality and Uniformity: Theory and Practice of International Maritime Regulation', in J Chuah (ed), *Research Handbook on Maritime Law and Regulation* (Edward Elgar 2019) 130.

234 *Blockchain for Supply Chains* (n 39) 138–139.

235 T Cottier, 'Technology and the Law of International Trade Regulation', in Brownsword, Scotford and Yeung (n 4) 1028.

236 J Black and D Rouch, 'The Development of the Global Markets as the Rule-Makers: Engagement and Legitimacy' (2008) *2 Law & Financial Markets Rev* 223.

In addition to standard-setting activities, another instrument which can be helpful to lay the foundation of self-regulation in an emerging new market is the standard form contracts that are issued by the industry associations.[237] Traditionally, the standard form contract has been seen as an important instrument in the construction of the lex mercatoria, which is allegedly an anational, autonomous and unified legal system.[238] Although this argument has recently been criticised by scholars, one non-negligible fact is that standard form contracts have been an important element in the transnational regulatory toolbox. Standard form contracts can be deployed: first, to ensure compliance with standards, since, for those standards which have been incorporated in the contracts, compliance with them is ensured by both contractual and regulatory sanctions;[239] secondly, to construct a preliminary risk allocation framework between the regulator and the regulatee, or between the regulatee and third parties; and, finally, to promote harmonisation of regulation, since the new participants have the incentive to adopt the mature standard contracts which have been adopted by the majority of actors in the industry.[240] As has been stated above, in the shipping industry, the driving force for issuance and use of standard contracts is BIMCO. BIMCO standard contracts have been developed not only to facilitate compliance with international standards, but also to promote uniformity of private law amongst users.[241] Therefore, the development and utilisation of standard form contracts are clearly vital for the future of blockchain bills of lading.

Finally, the necessity of private ordering does not mean that regulation through positive law should be abandoned. State authorities should still monitor the application of blockchain bills of lading. As mentioned earlier, States still have relevant interests to protect. For instance, for TradeLens to practise in the USA, it still needs to obtain the US antitrust exemption from the Federal Maritime Commission (FMC) and follow the restrictions that have been set in this exemption.[242] In addition, blockchain platforms may also need to follow relevant data protection requirements such as the European Union's General Data Protection Regulation (GDPR).[243] However, the mechanism should be principle-based rather than rule-based. State authorities should focus on identifying the interests that need to be protected and the values that should be preserved. An interactive and balanced relationship between State-oriented and market-based rules is the key to success.

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237 Cafaggi (n 201) 133.

238 See generally CM Schmitthoff, 'The Unification or Harmonisation of Law by Means of Standard Contract and General Conditions' (1968) 17 *ICLQ* 551.

239 Cafaggi (n 201) 134.

240 Ibid.

241 Chircop (n 233) 119, 130.

242 For the details of the TradeLens agreement and relevant issues, see https://www2.fmc.gov/FMC.Agreements.Web/Public/AgreementHistory/26452 (accessed 30 March 2021).

243 *Blockchain for Supply Chains* (n 39) 53. The transfer of public key and the protection of data privacy are also issues that would fall under the regulation of the GDPR.

6 Conclusion

Blockchain is not manna that drops from heaven.[244] In the maritime scenario, although it may seem tempting and possible to use blockchain to remedy to a certain degree the slow flow of pBLs, in general, in terms of the disruptive effects of blockchain technology, its use to reform bills of lading may require a high level of consensus and mutual trust within the shipping industry.

An essential element of a sound international commercial transaction is the existence of a single, clear, simple, and workable document acceptable to various industry practitioners. In the shipping industry, this document is the bill of lading. As a document which was invented by merchants back in the 14th century,[245] the bill of lading has survived the change in the shipping industry from its sailing era to containerisation. The rationale which underlies the endurable existence of bills of lading is the fact that, following centuries of development in regard to customs, usages and law relating to them, a delicate balance has been established. The smooth operation of the shipping industry and international trade largely depends upon such a delicate balance. The traditional pBL is not immune to drawbacks. However, following centuries of evolution, it also offers carriers and traders certainty, predictability, and the absence of unbearable costs. Even in the new era of technology, this balance should be carefully and patiently maintained. History has proved that the evolution of technology never succeeds in being an excuse for a radical change of maritime regulatory regime. The gradual progress of a maritime regulatory regime that is promoted by private actors has superseded traditional, time-consuming, and insufficiently positive law regimes, such as international Conventions, which would take years to reach the diplomatic conference and subsequent ratification stages. Therefore, the challenge is to explore a functional mechanism to maintain the interactive and balanced relationship between the self-regulation of the industry in the cyberspace that will be created by blockchain technology and the physical world that is still under the governance of conventional law.

Before we enter into the brave new world of blockchain bills of lading, the primary question that should be considered by participants in the maritime industry is whether it is economically desirable and functionally reliable to transfer hundreds of years of practice of pBLs to the blockchain platform. If the blockchain bill of lading is finally realised and popularised, such a result can be achieved only

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244 As recognised by Low and Mik (n 27) 164, 'the use of the blockchain technology creates fundamentally different problems, for which the existing law has no solutions'. Given the current restricted knowledge of blockchain technology, this statement may be too exaggerated; nevertheless, it still shows the struggle of the positive law to keep up with the pace of innovative technologies.

245 WP Bennett, *The History and Present Position of the Bill of Lading as a Document of Title to Goods* (CUP 1914) 4.

through the maritime industry's choosing it. Technological advances will be accompanied by contradictions and conflicts of interest. In this process, a re-examination of business ethics and order will be the basis for future legal regulation. Therefore, in this process, the role of positive law is restricted.

There is no risk-free system in the world. The choice will always be the lesser of two evils. The question that should therefore be asked before the implementation of any system is how much risk the shipping industry is willing to take.