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Blockchain Technology and the Development of African Economies: Promises, Opportunities, and the Legal Issues at Stake

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Abstract

The blockchain technology–or more generally, the technology of distributed ledgers (DLT)–has been heralded as a 'game changer' for the development of African economies. Whilst the private sector is already blazing ahead with a multitude of applications, lawyers are still struggling with the legal implications and potential pitfalls of the new technology. The following paper outlines the promises and opportunities of DLT for developing countries in particular and offers an analysis of the most pressing legal issues that African lawmakers need to address. To that end, the author draws from his experience as a German lawyer and provides a synopsis of regulatory approaches that have been taken across the world. The goal is to suggest solutions that may be suitable for jurisdictions in Africa, hopefully inspiring African lawmakers to develop their own tailor-made regulatory approach.

A. Introduction

In June 2015, the London-based newspaper *The Economist* published an article entitled 'African energy: The leapfrog continent', analysing Africa's prospects to bypass carbon-intensive power generation and move directly into the age of renewable energy.[1] Indeed, African nations have repeatedly demonstrated their ability to leapfrog many 'first-world'

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1 Available at <https://www.economist.com/middle-east-and-africa/2015/06/06/the-leapfrog-continent>.

countries in technological concerns, the most prominent case being mobile phone usage which soared from about 3% in the early 2000s to more than 80% in 2015.[2]

The next big thing could be the Blockchain. The blockchain technology–or more generally, the technology of distributed ledgers (DLT)–has attracted the attention of a broader public as the database underlying Bitcoin, i.e. as the platform on which this so-called 'cryptocurrency' is created, stored and circulated among its users. With the Bitcoin price skyrocketing from about 800 Euros in January to more than 16,000 Euros in December 2017, both the currency itself and the technology supporting it have been praised as the heralds of a 'Fourth Industrial Revolution', stressing their disruptive impact on many sectors of the world's economy.[3] Although the Bitcoin craze seems to have subsided to some extent as of summer 2019,[4] the debate on the potential of DLT is far from over, contemplating a multitude of use cases for developing countries in particular.[5]

In Africa, more and more governments are actively investigating potential fields of application, with countries like South Africa, Ghana or Kenya taking the lead. Ahead of South Africa's election in May 2019, President *Ramaphosa* confirmed the ruling African National Congress (ANC)'s commitment to the new technology, stressing the need for respective skill development and announcing the establishment of a 'digital industrial revolution commission' in partnership with the private sector.[6] Moreover, blockchain and cryptocurrency conferences are regularly held in South Africa since 2015, exploring how DLT could mod-

2 Cf. J. Stolp et al., 'Blockchain and Cryptocurrency in Africa', *Baker McKenzie*, November 2018 (<http://blockchain.bakermckenzie.com/2019/02/12/blockchain-and-cryptocurrency-in-africa>), Preface.

3 D.L. Kuo Chuen, 'Fintech Tsunami: Blockchain as the Driver of the Fourth Industrial Revolution', 6 July 2017 (<https://ssrn.com/abstract=2998093>); European Parliament Research Service (EPRS), 'How blockchain technology could change our lives', February 2017 (available at <http://www.europarl.europa.eu/thinktank>);
M. Swan, *Blockchain: Blueprint for a new economy* (O'Reilly Media, 2015), Preface viii ('world-changing potential of the blockchain'; 'dawn of a new revolution'); *Frankfurter Allgemeine Woche*, Issue 34 of 19 August 2016, 15ff. ('Neuvermessung der Welt').

4 By July 2019, the Bitcoin price seems to have levelled out (perhaps temporarily) at about 10,000 EUR; J.O. McGinnis & K. Roche, 'Bitcoin: Order Without Law in the Digital Age', 94 (2019) *Ind. L.J.* 1, 44–46.

5 For an overview see K. Schmidt & P. Sandner, 'Solving Challenges in Developing Countries with Blockchain Technology', FSBC Working Paper, October 2017 (<https://medium.com/@philippsandner/solving-challenges-in-developing-countries-with-blockchain-technology-78ec9b01bae3>). Further N. Kshetri, 'Much more than bitcoin: how blockchain can help the world's poorest people', *World Economic Forum*, 5 May 2017; T. Koffman, 'Blockchain–Africa Rising', *Forbes Magazine*, 4 April 2019; F. De Senneville, 'Blockchain: The "Trust Machine" that Africa needs?', *fieldfisher*, 1 February 2017 (all available online).

6 C. Ramaphosa, Speech of 12 January 2019 (<https://www.iol.co.za/news/politics/ancmanifesto-read-cyril-ramaphosas-full-speech-18792716>); same, State of the Nation Address of 16 February 2018 (<https://www.gov.za/speeches/president-cyril-ramaphosa-2018-state-nation-address-16-feb-2018-0000>).

ernize systems and processes across various industries.[7] Aside from digital currencies which may offer payment solutions to people without access to traditional banking services,[8] prominent use cases include the introduction of blockchain-based digital land registries in order to tackle the problems of insecure land ownership,[9] but also a growing number of civic services such as registries for life events,[10] the administration of development aid,[11] or electronic voting facilities that prevent election fraud.[12]

From a legal perspective, the implications of DLT are largely unexplored. Many countries still struggle with issues such as the dogmatic status of cryptocurrencies, namely their precise classification as a commodity, a money equivalent or some other form of legal tender, but also with rather general questions such as the acceptance of blockchain-based information as evidence in a court of law.[13] Moreover, the Bitcoin craze soon prompted policymakers to highlight the dangers of potential side-effects, most notably as regards money laundering or terrorist financing.[14] In fact, it seems likely that legal rather than technical problems, if at all, could hamper the success of blockchain-based solutions both in Africa and globally.[15]

Against this backdrop, the present article offers an analysis of the most pressing legal issues that African nations need to address in order to benefit from distributed ledgers, arguing that the widespread enthusiasm is justified in principle, but warrants critical reflection in detail. For this purpose, the article first provides an indispensable overview of the relevant technological features (section B. below) which serves as the basis for a closer examination of the technology's promises on the African continent (section C.). Based on the findings of the legal analysis (which will be specified in section D.), the article concludes with some final recommendations and an outlook (section E.).

7 See <https://blockchainafrica.co>.

8 For a first overview see S. Murray, 'How developing nations use tech to reach the underbanked', *Financial Times*, 24 April 2019 (<https://www.ft.com/content/0c6ddd3c-4b36-11e9-bde6-79eaea5acb64>); Stolp et al. (n. 2), Preface.

9 E.g. D. Olewe, 'Why Kenya hopes blockchain can end land grabbing', *BBC News*, 5 May 2018 (<https://www.bbc.com/news/world-africa-43640885>); Schmidt & Sandner (n. 5), 5–7.

10 OECD, *Digital Economy Outlook 2017* (OECD Publishing, 2017), 313–314; Schmidt & Sandner (n. 5), 7–8.

11 See A. Zwitter & M. Boisse-Despiaux, 'Blockchain for humanitarian action and development aid', 3:16 (2018) *J. Int. Humanit. Action* (<https://doi.org/10.1186/s41018-018-0044-5>).

12 T. Jackson, 'Blockchain At The Polls?', *Forbes Africa*, 22 November 2018 (<https://www.forbesafrica.com/technology/2018/11/22/blockchain-at-the-polls>).

13 See L.J. Trautman, 'Bitcoin, Virtual Currencies, and the Struggle of Law and Regulation to Keep Pace', 102 (2018) *Marquette Law Rev.* 447 (<https://dx.doi.org/10.2139/ssrn.3182867>).

14 For a first overview of the policy issues concerned see OECD (n. 10), 317; W. Blocher, 'The next big thing: Blockchain, Bitcoin, Smart Contracts', 21 (2016) *AnwBl.* 612, 618. In detail *infra*, section D.VI.

15 On a similar note A. Didenko, 'Regulating FinTech: Lessons from Africa', 19 (2018) *San Diego Int'l L.J.* 311 (<https://digital.sandiego.edu/ilj/vol19/iss2/5>), 313–314.

B. The Technology in a Nutshell[16]

I. Distributed Ledgers and the Blockchain: A Technology of Trust

To illustrate the concept of distributed ledgers, it is helpful to first examine the features of their traditional counterparts, the so-called 'centralized ledgers'. In a centralized ledger, which can be likened to a classical business journal or a checkbook, data is essentially processed and maintained by a trusted administrator (or intermediary) acting on behalf of certain external participants (or customers).[17] This concept underpins the conventional land or commercial registries administered by a government agency, for instance, but also certain private databases such as the accounting systems of a bank or a stock exchange.[18]

A distributed ledger, by contrast, is a storage system that operates without any central administrator or intermediary. Rather than relying on a single database, it is basically a digital register that is shared–or 'distributed'–in a network of independent participants, each of which holds a constantly updated copy of the relevant data on his or her computer (usually referred to as 'nodes').[19] The data in question may theoretically be of any kind, including a participant's personal information, a record of his or her tangible or intangible assets, financial status, or transactions on a specific market.

Although there are different types of distributed ledgers, the most important is certainly the Blockchain.[20] As its name suggests, a blockchain is a distributed ledger in which a specific type of data is set out and built up in a sequence of successive 'blocks', each of which contains a specific piece of information (so-called 'hash code') that connects it with the

16 It has been commented to me that only few people truly understand the technology of distributed ledgers, and that even fewer are able to write about it in a credible manner. I respect these concerns and humbly hope that the following description is sufficiently accurate to allow the subsequent legal analysis to be useful.

17 J. Condos et al., 'Blockchain Technology: Opportunities and Risks', Vermont Legislative Report, 15 January 2016 (<https://legislature.vermont.gov/assets/Legislative-Reports/blockchain-technology-report-final.pdf>), 4; D.A. Zetzsche, R.P. Buckley & D.W. Arner, 'The Distributed Liability of Distributed Ledgers: Legal Risks of Blockchain', UNSW Law Research Paper No. 17–52, July 2018 (<https://ssrn.com/abstract=3018214>), 10.

18 EPRS (n. 3), 5; Condos et al. (n. 17), 6; R. Benbunan-Fich & A. Castellanos, 'Digitalization of Land Records: From Paper to Blockchain', 2018 (available at <https://www.researchgate.net>), 3; Y. Le, 'The State of the Art in Cryptocurrencies', 2:3 (2017) *Junior Management Science* 1, 3.

19 E.g. Zetzsche, Buckley & Arner (n. 17), 8. H.Y. Jabotinsky, 'The Regulation of Cryptocurrencies–between a Currency and a Financial Product', 13 February 2018 (<https://ssrn.com/abstract=3119591>), 11, likens blockchains 'to a common Excel page shared by an entire community of users.'

20 M. Finck, *Blockchain Regulation and Governance in Europe* (Cambridge University Press, 2019), 1ff. Others include so-called block directed acyclic graphs ('blockDAG') and transaction-based directed acyclic graphs ('TDAG'); I. Bashir, *Mastering Blockchain* (Packt Publishing, 2nd edn., 2018), 37.

content of the following block,[21] thereby creating a 'chain' of data in chronological order.[22] Given the absence of a centralized authority, adding new data always depends on some form of consensus between the participants at large, the modalities of which may differ according to the system's design and configuration. While some blockchains essentially require participants–or rather their computers–to solve mathematical equations in order to validate data and create additional blocks (so-called 'proof-of-work' protocol), others will select a number of users as validators based on their economic stake in the network ('proof-of-stake').[23]

In any event, the major advantage of blockchains over centralized ledgers is their virtual immunity to manipulation. Whilst a centralized ledger may be destroyed, hacked or otherwise compromised rather easily, be it by external attackers or by the trusted authority (intermediary) itself, data bundled on a blockchain is essentially unerasable and can only be tempered with if the attacker not only targets a specific block, but manipulates the entire chain connected to it. This, however, requires a simultaneous attack on every single copy, i.e. on all participating nodes of the ledger, which is extremely difficult.[24] As a consequence, aside from the fact that there is no 'middleman' to be remunerated for his (or her) services, information such as a transfer of money or assets recorded on the blockchain can neither be deleted nor amended, thereby providing a maximum of authenticity, transparency and trustworthiness.[25]

II. Governance Mechanisms: Public or Private?

Another important distinction can be made in terms of a blockchain's governance. In principle, blockchains can be situated on a spectrum ranging from entirely public and permissionless to fully private and permissioned.[26] A permissioned system, on the one end, is basically a private network that limits the number of parties who may participate, i.e. access, check and add transactions to the ledger. On this basis, it is possible for 'mainstream' actors such

21 Pretty much like a fingerprint; cf. Le (n. 18), 2; A. Berentsen & F. Schär, 'A Short Introduction to the World of Cryptocurrencies', *Fed. Reserve Bank of St. Louis Rev.*, First Quarter 2018, 100(1), 13.

22 OECD (n. 10), 307; EPRS (n. 3), 5; Condos et al. (n. 17), 5ff.

23 For details (also on alternative types of protocols) Bashir (n. 20), 37–39; OECD (n. 10), 308–309; T. Schrepel, 'Collusion by Blockchain and Smart Contracts', 14 January 2019 (<https://ssrn.com/abstract=3315182>), 6.

24 EPRS (n. 3), 5; OECD (n. 10), 307. But see also *infra*, section D.VIII. in respect of residual risks.

25 OECD (n. 10), 308; Condos et al. (n. 17), 4–5; M.J. Casey & P. Vigna, *The Truth Machine: The Blockchain and the Future of Everything* (St. Martin's Press, 2018), 21ff.; *The Economist*, 'The Trust Machine', 31 October 2015 (<https://www.economist.com/leaders/2015/10/31/the-trust-machine>).

26 OECD (n. 10), 310; Zetzsche, Buckley & Arner (n. 17), 11–12; D. Bryson et al., 'Blockchain Technology for Government', MITRE Research Paper of December 2017, 8 (available at <https://www.mitre.org>).

as banks or governments to maintain substantial control over a specific network, for instance by subjecting applicants to certain vetting procedures before accepting them.[27]

A permissionless blockchain, by contrast, is open to the general public and allows anyone who downloads and runs its software from the Internet to participate. Such systems are generally anonymous (or more precisely: pseudonymous) and permit their participants to conceal their real-world identity, essentially by using an encrypted account (or 'wallet').[28] As a corollary, the total number of nodes participating at a given time is uncertain, making the system even more resilient to potential cyberattacks.[29] The most prominent public blockchain is the one underlying Bitcoin.[30]

III. Weak Spots

Notwithstanding its merits, the blockchain technology also has its flaws. Most importantly, while the decentralized storage of data virtually guarantees that all information is *authentic* (i.e. untampered), this does not necessarily imply that it is also *accurate*. For instance, if a participant wishes to add a piece of data such as his or her (alleged) birth date to the ledger, the system will accept it as long as the technical requirements are complied with–even if the person was actually born on another day.[31] A blockchain is thus not automatically prepared to prevent the inaccuracy of data, but may have to be supplemented with external mechanisms to ensure its veracity.[32]

In addition, many DLT solutions face the problem of incentivization. If a proof-of-work protocol is chosen (which is usually done in public blockchains[33]), participants may have to invest substantial time and computing power to solve the mathematical equations, especially since the latter become increasingly complicated as the chain of data is prolonged.[34] In the case of Bitcoin, it has been reported that the annual electricity consumption of the net-

27 EPRS (n. 3), 5; F. Glatz, 'Blockchain–Ein Paradigmenwechsel?' in S. Breidenbach & F. Glatz (eds.), *Rechtshandbuch Legal Tech* (C.H. Beck, 2018), Ch. 4.1 para. 36.

28 See Schrepel (n. 23), 6–7; Bryson et al. (n. 26), 8; EPRS (n. 3), 17; Trautman (n. 13), 455.

29 Zetzsche, Buckley & Arner (n. 17), 12 (at n. 44: 'security through obscurity').

30 OECD (n. 10), 310; Zetzsche, Buckley & Arner (n. 17), 12; Bryson et al. (n. 26), 8–9.

31 So-called 'garbage in, garbage out' phenomenon; see Zetzsche, Buckley & Arner (n. 17), 13, 16; A. Killeen & R. Chan, 'Global Financial Institutions 2.0' in D.L. Kuo Chuen & R. Deng (eds.), *Handbook of Blockchain, Digital Finance, and Inclusion, Vol. 2* (Academic Press, 2018), Ch. 10, 232; with a view to Africa also C. Lee & J. Mueller, 'Can Blockchain Unlock the Investment Africa Needs?', 12(3–4) *Innovations* 80 (2018) (<https://www.mitpressjournals.org/doi/abs/10.1162/inov_a_00277>), 85–86.

32 EPRS (n. 3), 19; Zetzsche, Buckley & Arner (n. 17), 16. Cf. *infra*, section D.V. in particular.

33 K. Raj, *Foundations of Blockchain* (Packt Publishing, 2019), 16.

34 OECD (n. 10), 309, 311–312; C. Sillaber & B. Waltl, 'Life Cycle of Smart Contracts in Blockchain Ecosystems', 41 (2017) *DuD* 497, 498 (<https://link.springer.com/article/10.1007/s11623-017-0819-7>).

work now exceeds that of the entire population of countries like Nigeria or Serbia.[35] Not to mention environmental issues,[36] it is obvious that users will expect some form of consideration for their efforts, which is why the Bitcoin system awards a certain amount of its assets–newly generated Bitcoins–to validators of transactions; quite aptly, this process is therefore known as 'mining'.[37] Yet even if such remuneration is provided, public blockchains may find it increasingly difficult to handle an ever-growing amount of data.[38]

IV. Icing on the Cake: Smart Contracts and the Internet of Things

One step further, advanced DLT solutions are also capable of hosting programmes which are commonly referred to as 'smart contracts'. A smart contract is essentially a software that executes a real-life contract which the parties have transformed into a blockchain-based computer code.[39] For instance, if the parties of a sales contract have successfully negotiated the terms of their agreement, it is not only possible to store the latter safely on the ledger, but also to have the system automatically fulfil all or some of the parties' obligations, e.g. by disbursing digital money (such as Bitcoins) from the buyer's account as soon as the payment deadline has expired.[40] This concept is particularly disruptive in combination with the so-called 'Internet of Things', i.e. if the blockchain is connected with the web-enabled hardware of certain external objects, including consumer goods: In the case of a car rental, the network could automatically deactivate the car's engine until the rental fees have been paid, which, in turn, could also be monitored on the blockchain.[41] As a consequence, the blockchain may prevent otherwise necessary lawsuits and/or relieve the respective parties from appointing a third person as trustee, thereby keeping transaction costs to a minimum.[42]

35 EPRS (n. 3), 22; OECD (n. 10), 311–312; McGinnis & Roche (n. 4), 47–48.

36 B. Palmer, 'Klimakiller Kryptowährung', *FAZ*, Issue 13 of 16 January 2018, 13; C. Mora et al., 'Bitcoin emissions alone could push global warming above 2°C' (<https://doi.org/10.1038/s41558-018-0321-8>).

37 Zetzsche, Buckley & Arner (n. 17), 12; Bryson et al. (n. 26), 4; EPRS (n. 3), 5.

38 On this so-called 'scalability problem' see OECD (n. 10), 311; De Senneville (n. 5); Le (n. 18), 4.

39 This definition goes back to N. Szabo, *Smart Contracts*, 1994 (<http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart.contracts.html>). Cf. Schrepel (n. 23), 6; M. Raskin, 'The Law and Legality of Smart Contracts', 1 (2017) *Geo. L. Tech. Rev.* 305, 309–310, 320.

40 See Sillaber & Waltl (n. 34), 498–499; OECD (n. 10), 314ff.

41 J. Cieplak & S. Leefatt, 'Smart Contracts: A Smart Way to Automate Performance' 1 (2017) *Geo. L. Tech Rev.* 417, 418. See also Raskin (n. 39), 329ff.; L.J. Trautman, 'Is Disruptive Blockchain Technology the Future of Financial Services?', 69 (2016) *Consumer Fin. L.Q. Rep.* 232, 238; F. Möslein, 'Smart Contracts im Zivil- und Handelsrecht', 183 (2019) *ZHR* 254, 262, 264, 271, 280.

42 Sillaber & Waltl (n. 34), 498; McGinnis & Roche (n. 4), 35; F. Glatz, 'Smart Contracts' in S. Breidenbach & F. Glatz (eds.), *Rechtshandbuch Legal Tech* (C.H. Beck, 2018), Ch. 5.3 para. 14.

C. Promises and Opportunities: An African Perspective

I. Cryptocurrencies

Perhaps most importantly, African Nations might benefit from the global advent of cryptocurrencies. Albeit the latter term is usually associated with Bitcoin as the ubiquitous market leader, there are now more than 2,000 cryptocurrencies worldwide, also including competitors ('altcoins') such as Ether, XRP/Ripple, or Litecoin.[43]

Whilst the features of cryptocurrencies may vary in terms of their functionality, e.g. as regards the underlying system's capability to host smart contracts,[44] the general applications are always more or less the same. At the outset, each participant of the network (which is usually public and permissionless) is assigned an encrypted 'wallet' that can be thought of as some kind of virtual bank account,[45] enabling him or her to send and receive currency units (or fractions thereof[46]) within the system.[47] If such units are not acquired by mining, they are usually traded in exchange for conventional Fiat money such as Euros or US-Dollars, for instance through one of the various cryptocurrency exchange websites that have sprung up in recent years.[48] In addition, there is a small but growing number of stationary 'Crypto-ATMs', allowing users to buy and sell cryptocurrencies using cash or credit cards or by directly charging a conventional bank account.[49]

At the same time, the adoption of cryptocurrencies within the real economy is also on the rise. Although companies were initially reluctant to accept Bitcoin and the like in exchange for goods or services, more and more businesses worldwide are starting to adapt their policies; this goes in particular for many start-up entities which embrace cryptocurrencies as a part of their business strategy, not least in order to display a certain innovative culture.[50]

The reasons for this are numerous. Firstly, aside from the fact that the underlying DLT may reduce transaction costs in comparison to conventional, intermediary-controlled pay-

43 Cf. G. Hileman & M. Rauchs, '2017 Global Cryptocurrency Benchmark Study', 6 April 2017 (<https://ssrn.com/abstract=2965436>), 13ff.; G. Atici, 'Bitcoin and Blockchain: A Threat or Opportunity for the Financial System', 4 (2018) *Eur. J. Econ. Bus. Stud.* 103, 104.

44 In this respect, the Ether network ('Ethereum') is currently considered to be market leader; Berentsen & Schär (n. 21), 13; Trautman (n. 13), 466.

45 Cf. already *supra*, section B.II.

46 In the Bitcoin universe, the smallest fraction is called a 'Satoshi' and corresponds to one hundred millionth of a Bitcoin; see Blocher (n. 14), 617.

47 Cf. Trautman (n. 13), 455; McGinnis & Roche (n. 4), 22ff.

48 As of February 2019, there were reportedly more than 200 cryptocurrency exchanges worldwide; R. Gutmann et al., 'Buying Bitcoin', 28 March 2019 (<https://ssrn.com/abstract=3346668>), 3.

49 'ATM' stands for 'Automated Teller Machine'. There is now a reported total of more than 3,000 'Bitcoin-ATMs' worldwide; V. Cermak, 'Can Bitcoin Become a Viable Alternative to Fiat Currencies?', 2 May 2017 (<https://ssrn.com/abstract=2961405>).

50 Cf. N. Jonker, 'What Drives bitcoin adoption by retailers?', De Nederlandsche Bank Working Paper No. 585, 6 March 2018 (<https://ssrn.com/abstract=3134404>).

ment methods,[51] the irreversibility of blockchain-based transactions appeals to participants on the receiving end, relieving them from the risk of 'chargebacks' which are possible in credit card and similar payment systems such as PayPal.[52] Secondly, blockchain-based cryptocurrencies may eliminate the problem of 'double spending' which arose with earlier digital solutions such as e-cash, namely the danger that a particular coin is copied and then spent more than once in conflicting transactions.[53] In the case of Bitcoin, the proof-of-work mechanism generally ensures that only the first of two or more conflicting transactions is validated, making it extremely difficult to spend the same currency unit twice.[54] Finally, given the system's pseudonymity and the lack of a controlling intermediary, it is hard to exclude certain participants for political reasons[55] as was recently the case at PayPal.[56] In fact, it has been suggested that the decentralized 'bottom-up' approach of blockchain-based cryptocurrencies may entail nothing short of a democratisation and a denationalisation of the entire monetary system.[57]

From an African perspective, the most important promise of cryptocurrencies lies in their capacity to 'bank the unbanked', namely to offer payment solutions to people without access to traditional banking services. In Sub-Saharan Africa alone, the number of unbanked adults is estimated at about 350 million people, amounting to 17% of the global total.[58] Cryptocurrencies could not only relieve the latter from the costs of mediation services such as check clearing, but also provide access to affordable credit as a number of companies have already started offering Bitcoin loans.[59] Cryptocurrencies may thus alleviate the notorious cash shortages that have plagued countries like Zimbabwe, making people and businesses more independent from the availability of bank notes.[60] Similar results could be achieved in regions suffering from political crises or military conflicts, given that cryptocurrencies are considered immune to the monetary disruptions triggered by such

51 Such as credit cards; McGinnis & Roche (n. 4), 26; OECD (n. 10), 312; EPRS (n. 3), 6.

52 C. Sorge & A. Kroh-Grimberghe, 'Bitcoin: Eine erste Einordnung', 36 (2012) *DuD* 479, 482; D.E. Sorkin, 'Payment Methods for Consumer-to-Consumer Online Transactions', 35 (2001) *Akron L. Rev.* 1, 8–9, 13, 19–20.

53 Cf. U.W. Chohan, 'The Double Spending Problem and Cryptocurrencies', 23 December 2017 (<https://ssrn.com/abstract=3090174>), 1; Raskin (n. 39), 317.

54 Trautman (n. 13), 455–456; OECD (n. 10), 309; A. Schlund & H. Pongratz, 'Distributed-Ledger-Technologie und Kryptowährungen–eine rechtliche Betrachtung', 56 (2018) *DStR* 598–599.

55 McGinnis & Roche (n. 4), 19 ('Bitcoin is censorship-resistant and not controlled by any government').

56 See Sorge & Krohn-Grimberghe (n. 52), 482.

57 Cf. N. Firth, 'Bitcoin tech to restore democracy', 235 (2017) *New Scientist* 8.

58 Stolp et al. (n. 2), Preface; McGinnis & Roche (n. 4), 33; Murray (n. 8).

59 McGinnis & Roche (n. 4), 34; P. Rizzo, 'Bitcoin Wallet Startup Now Extending Credit to Users', 5 April 2016 (<https://www.coindesk.com/bitpagos-bitcoin-wallet-credit>).

60 See M. Ncube, 'Zimbabwe's attempt to tackle "bad" currency deepens economic woes', *Financial Times*, 14 October 2018 (available at <https://www.ft.com>); Stolp et al. (n. 2), 14–15.

events.[61] And finally, cryptocurrencies may present an affordable alternative for the remittances of migrant workers on which so many African economies rely, with countries like Lesotho attributing almost a third of their gross domestic product (GDP) to remittances from abroad.[62]

Against this background, it is unsurprising that cryptocurrencies are already gaining track in many African countries, for instance in Kenya and Uganda where Bitcoins are frequently used for money transfers.[63] More and more private businesses are also adapting to the situation, including a medical clinic in Botswana as one of the most prominent examples,[64] whilst a variety of cryptocurrency exchanges have been launched in countries like Kenya, the Seychelles, or South Africa.[65] The latter are even being supplemented with a growing number of Crypto-ATMs, e.g. in Kenya or Botswana.[66]

Moreover, it has been suggested that national governments might forge ahead of the private sector, following a number of precedents from outside the African continent.[67] In February 2017, for instance, the government of Venezuela introduced a blockchain-based digital currency named 'Petro' as a countermeasure to the country's galloping inflation.[68] Similar projects include the Catalonian plan to establish a digital currency as a means of separation from the Spanish central state,[69] which became sidetracked after the failed independence referendum of October 2017. However, a true pioneer seems to be the African state of Tunisia which launched a blockchain-based digital currency in 2015,[70] although it

61 P. Rao, 'Africa could be the next frontier for cryptocurrency', *AfricaRenewal*, 11 June 2018 (<https://doi.org/10.18356/f6b3e553-en>); C. Tozzi, 'Is Africa the Next Hub for Blockchain Development?', 15 June 2017 (<https://www.nasdaq.com/article/is-africa-the-next-hub-for-blockchain-development-cm803927>).

62 Stolp et al. (n. 2), Preface; Schmidt & Sandner (n. 5), 15; D. Folkinshteyn, M. Lennon & T. Reilly, 'The Bitcoin Mirage: An Oasis of Financial Remittance', 10 (2015) *JSIS* 118, 121; R. Zambrano, *Blockchain: Unpacking the disruptive potential of blockchain technology for human development*, 2017 (<http://hdl.handle.net/10625/56662>), 42.

63 De Senneville (n. 5); Zambrano (n. 62), 40–41; E. Ahishakiye et al., 'Developing Countries and Blockchain Technology: Uganda's Perspective', 4 (2018) *IJLRET* 94, 97–98.

64 Stolp et al. (n. 2), 3; W. Ayugi, 'A Private Clinic in Botswana Has Started Accepting Bitcoin Payments', 5 May 2017 (<https://bitcoinafrica.io/2017/05/05/clinic-in-botswana-has-started-accepting-bitcoin-payments>).

65 Stolp et al. (n. 2), 3.

66 V. Kiprop, 'Kenya's first bitcoin ATM up, offers instant cash purchases', *The East African*, 18 June 2018; T. Odingo, 'Botswana Receives its First Bitcoin ATM', *Bitcoin Africa*, 6 March 2019.

67 E.g. P. Rao (n. 61); O. Kesa & V. Mahoro, 'Rwandacoin: Prospects and challenges of developing a cryptocurrency for transactions in Rwanda' (<https://arxiv.org/ftp/arxiv/papers/1901/1901.06249.pdf>).

68 See U.W. Chohan, 'Cryptocurrencies as Asset-Backed Instruments: The Venezuelan Petro', 7 February 2018 (<https://ssrn.com/abstract_id=3119606>).

69 J. Buck, 'Catalonia Considering Cryptocurrency Post-Independence', *Cointelegraph*, 28 October 2017 (available at <https://cointelegraph.com>).

70 So-called 'eDinar'; Kesa & Mahoro (n. 67), 3; Stolp et al. (n. 2), 16.

is not entirely clear whether the latter–operated through the Tunisian Postal Service–is currently in use.

II. Digital Land Registries

Another use case is the introduction of digital land registries. In Africa, the lack of trustworthy land and property registries is considered an obstacle to economic development, given that in a majority of countries more than 90% of the rural areas are unregistered and/or lack official title deeds, with most land being held on the basis of oral agreements or incomplete paperwork.[71] The sale of land is thus encumbered with a substantial degree of uncertainty and corruption, nepotism, and land title fraud, which seems particularly bad in Nigeria.[72] In addition, insecure property rights may weaken landowners' incentives to make land-related investments and undermine their ability to use a property as collateral to secure credit, leading to what Peruvian economist *de Soto* famously called 'dead capital'.[73]

Against this backdrop, it has been suggested that land titles in Africa (and elsewhere) could be registered on a distributed ledger to make property rights more transparent, trustworthy, and immutable, thereby leapfrogging the traditional paper-based and intermediary-controlled ledgers of many Western jurisdictions.[74] The relevant information could be stored together with GPS coordinates, property descriptions, and satellite photos, allowing potential purchasers to review the title history of a piece of land before acquisition. In comparison to the existing structures, this would also improve the position of a loan applicant as a bank is of course much more likely to grant affordable credit if the collateral is secure.[75]

On the global stage, digital land registries have reportedly been initiated in Honduras where land title fraud was particularly common,[76] but are also discussed in countries like Georgia or Haiti[77] and even in European Union (EU) member states such as Greece or Swe-

71 De Senneville (n. 5); Stolp et al. (n. 2), 4 and 5 (with respect to Ghana and Kenya); R. Aitken, 'Bitland's African Blockchain Initiative Putting Land on the Ledger', *Forbes Magazine*, 5 April 2016.

72 Ahishakiye et al. (n. 63), 98; M. Zimmer, 'Die Blockchain im deutschen Immobiliarsachenrecht: Keine Konkurrenz fürs Grundbuch', *Legal Tribune Online*, 15 January 2018; Aitken (n. 71).

73 H. de Soto, *The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else* (Basic Books, 2000), 35, 218. See also G. Feder & A. Nishio, 'The benefits of land registration and titling: economic and social perspectives', 15 (1999) *Land Use Policy* 25, 26–29; Schmidt & Sandner (n. 5), 5–7.

74 Benbunan-Fich & Castellanos (n. 18), 3ff.; Koffman (n. 5); M. Barbieri & D. Gassen, 'Blockchain–can this new technology really revolutionize the land registry system?', 21 March 2017 (<http://www.notaries-of-europe.eu/index.php?pageID=15101>), 2ff.

75 De Senneville (n. 5); Le (n. 18), 8.

76 See Benbunan-Fich & Castellanos (n. 18), 15, 17; Zambrano (n. 62), 35.

77 Benbunan-Fich & Castellanos (n. 18), 6–7; N.N. Peiró & E.J.M. García, 'Blockchain and Land Registration Systems', 6 (2017) *EPLJ* 296, 316–318 (<https://doi.org/10.1515/eplj-2017-0017>).

den.[78] In Africa, the state of Ghana is considered to be a forerunner, with a non-profit organization named 'Bitland' leading the way since 2016.[79] Additional centres include Rwanda where a public-private partnership for a digital land registry was sealed in November 2018, or Kenya where the National Land Commission expressed its intention to embrace distributed ledgers in creating transparency over land ownership.[80] Depending on the specific blockchain's protocol,[81] some initiatives even combine the projected land registry with cryptocurrency solutions by awarding currency units as an incentive for participation.[82]

III. eGovernance and Public Services

Beyond land registries, DLT could also be applied to a number of similar civic services, implementing what is commonly known as 'eGovernance'. The idea is to eliminate bottlenecks such as poor public infrastructures, corruption, or mismanagement through the blockchain technology, making government operations more efficient and improving the delivery of public services.[83]

The most prominent use case is e-voting. All over the world, public elections are vulnerable to fraud and manipulation–especially in the case of a paper ballot, but also if technical tools such as voting machines are employed.[84] The advent of DLT hence prompted the idea of a blockchain-based electoral system, capitalizing on the technology's authenticity and transparency[85] with a focus on developing countries in particular. To that end, African nations were among the first to embrace the concept, with Sierra Leone reportedly running its 2018 presidential elections on a private blockchain network. Albeit the latter was in fact

78 In respect of Greece see M. Themistocleous, 'Blockchain Technology and Land Registry', 30 (2018) *The Cyprus Rev.* 195, 196; in respect of Sweden see *Landmäteriet*, 'The Land Registry in the blockchain', July 2016 (<http://ica-it.org/pdf/Blockchain_Landregistry_Report.pdf>); further Schmidt & Sandner (n. 5), 7.

79 See <http://landing.bitland.world>. Further Aitken (n. 71); Stolp et al. (n. 2), 4; Zambrano (n. 62), 35.

80 P.H. Madore, 'Overstock's Medici Ventures & Rwanda Government Partner for Blockchain Property Rights Platform', *CCN*, 3 November 2018 (available at <https://www.ccn.com>); Stolp et al. (n. 2), 5.

81 *Supra*, section B.I.

82 Aitken (n. 71); K. Mwanza & H. Wilkins, 'African startups bet on blockchain to tackle land fraud', *Reuters*, 16 February 2018 (available at <https://www.reuters.com>).

83 EY Global, 'How blockchain can help create better public services', 29 March 2018 (available at <https://www.ey.com>); EPRS (n. 3), 18–19; Kshetri (n. 5); Zambrano (n. 62), 34.

84 Cf. EPRS (n. 3), 12–13; D. Pollock, 'Africa's Blockchain Potential Untapped, But How Can It Be Implemented?', *Forbes Magazine*, 23 October 2018; Schmidt & Sandner (n. 5), 17.

85 *Supra*, sections B.I./III.

little more than a test run,[86] it contributed to Sierra Leone's reputation as the continent's first 'smart country',[87] motivating nations such as Kenya to pursue a similar approach.[88]

Furthermore, blockchains could provide a solution to population issues such as identity management and public health. As many states lack the necessary infrastructure to record life events such as births, deaths, or marriages, Africans are often required to travel long distances to report the latter at a government registrar. Blockchains might alleviate this by allowing people to file records via mobile phone, offering a high level of security and transparency.[89] The same could apply to healthcare data including a patient's medical history, helping authorities to fight catastrophes such as epidemics or child mortality.[90] On a similar note, DLT could be employed for the organization of refugee camps, drawing on a Jordanian example which links refugees' IDs, supplies, and financial accounts through a permissioned private blockchain,[91] prominently allowing people to pay for groceries on the basis of an iris scan.[92]

Beyond that, it has been suggested to deploy blockchain technology in the administration of development aid, notably to increase the accountability of projects and to prevent an embezzlement of funds. A pilot is the so-called 'TruBudget' scheme of the German *Kreditanstalt für Wiederaufbau* ('KfW') Development Bank which concerns a project in Burkina Faso,[93] albeit the idea is of course being considered on a larger global scale.[94] Similar plans include the digitalization of crime control which is reportedly underway in Nigeria and

86 Stolp et al. (n. 2), 16–17; U.W. Chohan, 'Blockchain Enhancing Political Accountability? Sierra Leone 2018 Case', 16 March 2018 (<https://ssrn.com/abstract=3147006>).

87 Stolp et al. (n. 2), 16; R. Odhiambo, 'Sierra Leone Adopts Blockchain With Aim to Become Africa's First Smart Country', 1 October 2017 (<https://bitcoinafrica.io/2017/10/01/sierra-leone-adopts-blockchain/>).

88 Jackson (n. 12); D. Herbling, 'Kenya Elections Agency to Adopt Blockchain for Vote Transparency', *Bloomberg*, 20 August 2018 (available at <https://www.bloomberg.com>).

89 Schmidt & Sandner (n. 5), 7–8; B. Wright, 'What is the potential for blockchain in Africa?', 4 August 2017 (<https://www.idgconnect.com/idgconnect/analysis-review/1012567/potential-blockchain-africa>).

90 Stolp et al. (n. 2), 5; R. Odhiambo, 'Blockchain Technology Excepted to Boost Healthcare in Africa', 14 May 2018 (available at <https://bitcoinafrica.io>).

91 As to the different types of blockchains see section B.II., *supra*.

92 R. Juskalian, 'Inside the Jordan refugee camp that runs on blockchain', *MIT Tech. Rev.*, 12 April 2018; C.J. Schramm, 'Blockchain: Leveraging a Trust Technology in Expeditionary Economics', 12(3–4) *Innovations* 28, 33 (2018); *FAZ*, 'Wo Flüchtlinge mit einem Augenblick bezahlen', Issue 273 of 24 November 2017, 25.

93 KfW Development Bank, 'Digital Solutions for everyone: KfW releases TruBudget blockchain software', Press Release of 3 April 2019 (<https://www.kfw.de/KfW-Group/Newsroom/Latest-News/Pressemitteilungen-Details_515008.html>).

94 See Zwitter & Boisse-Despiaux (n. 11); Kshetri (n. 5); Schramm (n. 92), 31–32.

Kenya,[95] but also the development of blockchain-based trade and commercial registries[96] or improvements to a nation's tax regime.[97] However, the most ambitious project is certainly the Tunisia Economic City (TEC), which intends to apply DLT as the base technology of an entire city's infrastructure.[98]

IV. Supply Chain Management

DLT solutions are also expected to improve the efficiency of supply chains. In global trade, the scale and complexity of conventional logistics lead to significant transaction costs, notably due to paperwork errors, product loss, and misshipping.[99] Thanks to its transparency and trustworthiness, a blockchain could improve the traceability of goods between producers, distributors and retailers–who may not necessarily trust nor even know each other–by synchronizing data and transactions, also reducing the system's susceptibility to theft and documentation fraud.[100] Traceability ensured, DLT could further improve sustainability and consumer protection by maintaining immutable information about a product's origin, especially with respect to its health and environmental impact,[101] or assist banks and investors in streamlining trade finance procedures.[102] If a blockchain is integrated with smart contracts, it may even end costly 'procure-to-pay gaps', given that a proof of delivery from a logistics carrier could trigger digital invoicing and automatic payments through the banking system.[103]

From an African perspective, the concept may be particularly helpful to fight human rights abuses in the mining industry. In January 2018, South African-founded diamond company De Beers announced a programme using DLT to ensure that its diamonds are authentic, conflict-free and natural, seeking to avoid what is infamously known as 'blood dia-

95 Stolp et al. (n. 2), 5; A. Mbogo, 'Interpol and VoguePay to Launch Blockchain-based Crime Control Platform in Nigeria', 21 February 2018 (<https://bitcoinafrica.io/2018/02/21/interpol-voguepay-blockchain-crime-platform-nigeria>).

96 Cf. R. Knaier, 'Handelsregister 4.0 dank Blockchain-Technologie?', *GmbHR im Blickpunkt* 20/2017, R305 (<https://www.gmbhr.de/49853.htm>).

97 P. Jurowiec, 'Blockchain Applications in the World Tax Regime', 17 December 2018 (<https://blog.goodaudience.com/blockchain-applications-in-the-world-tax-regime-ea2111741f0b>).

98 See <https://www.tunisiaec.com>; Stolp et al. (n. 2), 16.

99 EPRS (n. 3), 16; A.J. Sulkowski, 'Blockchain, Law, and Business Supply Chains: The Need for Governance and Legal Frameworks to Achieve Sustainability', 23 July 2018 (<https://ssrn.com/abstract=3205452>).

100 EPRS (n. 3), 16; Bryson et al. (n. 26), 12–13.

101 Sulkowski (n. 99), 4; EPRS (n. 3), 16–17.

102 See J. Wang, 'Commodity Trade Finance Platform Using Distributed Ledger Technology', 28 March 2018 (<https://ssrn.com/abstract=3152093>).

103 EPRS (n. 3), 16; B. Bhandari, 'Supply Chain Management, Blockchains and Smart Contracts', 28 June 2018 (<https://ssrn.com/abstract=3204297>), 2ff.

monds'.[104] Similar initiatives concern commodities such as cobalt, tantalum, or coltan from conflicted areas like the DR Congo, given that Western importers are increasingly under pressure to comply with the applicable CSR (Corporate Social Responsibility) standards of the United Nations (UN)[105] and the Organisation for Economic Co-operation and Development (OECD).[106] Further projects include the Ethiopian supply chain solution for coffee shipments,[107] the delivery of lunch boxes to school children in Uganda,[108] or the initiatives to weed out Africa's counterfeit medication networks.[109]

V. Business Finance

Improvements can also be expected in the field of business finance. Traditionally, a company that wishes to attract investments may issue securitized company shares or bonds, be it in an initial public offering ('IPO')–i.e. by listing those securities on a stock exchange–or in more confidential transactions 'over the counter'. In the age of blockchain, this process could be simplified by replacing traditional securities with so-called 'security tokens', leading to what is known as an 'STO' or 'ICO'.[110] Similar to a currency coin,[111] a security token is essentially a set of data which is registered on a blockchain and represents a certain value, only that this value stems from the holder's financial stake in the issuing company. More specifically, the token certifies a set of rights or claims against the issuer which may vary according to the token's configuration, potentially including interest claims, dividend rights, or even voting and information rights.[112] As such, security tokens are not to be con-

104 Stolp et al. (n. 2), 3; K. Ray, 'The Diamond Blockchain: Ending Blood Diamonds with New Tech', 8 November 2018 (<https://coincentral.com/diamond-blockchain>).

105 Cf. the UN Global Compact (<https://www.unglobalcompact.org>) and the Guiding Principles on Business and Human Rights (<https://www.ohchr.org/documents/publications/Guidingprinciples Businesshr_eN.pdf>).

106 See the OECD's 'Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas', 20 March 2013 (<https://doi.org/10.1787/9789264185050-en>); further Stolp et al. (n. 2), 17; F.G. Giller & M. Tost, 'Konfliktminerale und Lieferkettenmanagement mineralischer Rohstoffe', 164 (2019) *Berg Huettenmaenn Monatsh* 237–240 (<https://doi.org/10.1007/s00501-019-0862-9>).

107 Stolp et al. (n. 2), 17; Koffman (n. 5).

108 R. Campbell, 'Binance's Charity Launches Blockchain Pilot For Its Lunch For Children Campaign in Uganda', *Forbes Magazine*, 25 February 2019.

109 A. Makadiya, 'IBM Developing Blockchain Solution to Combat Fake Medicine in Africa', 21 March 2019 (<https://bitsonline.com/ibm-blockchain-combat-fake-drugs-africa>); Schramm (n. 92), 32.

110 'STO' stands for 'security token offering' and 'ICO' for 'initial coin offering', both in distinction from 'IPO'.

111 *Supra*, section C.I.

112 P. Momtaz et al., 'Token Offerings: A Revolution in Corporate Finance?', *Capco J. of Fin. Transform.*, April 2019, 32, 37; R. Veil, 'Token-Emissionen im europäischen Kapitalmarktrecht', 183 (2019) *ZHR* 346, 348–349; J. Rohr & A. Wright, 'Blockchain-Based Token Sales, Initial Coin

fused with mere 'utility tokens' which do not represent any ownership at all, but simply enable future access to the products or services offered by the issuing company.[113]

From an African perspective, one of the most touted benefits of security tokens lies in their capacity to enable fractional ownership. Just like a Bitcoin can be split into fractions which are then circulated separately,[114] a security token may be divided into different tranches, thereby appealing to small-scale investors who could otherwise not afford to invest in one or more conventional company shares.[115] In turn, security tokens may not only allow businesses to address a larger circle of investors, but also offer first-time opportunities for start-up enterprises which would otherwise not be able to tap into capital markets at all, making them more independent from expensive and hard-to-get banking loans.[116] Besides, the concept could entail a significant reduction of transaction costs by cutting out intermediaries such as brokers and conventional stock exchanges, especially if it is combined with the self-executing qualities of smart contracts.[117]

VI. …and much more

The list of further DLT applications is too long to enumerate.[118] Just to mention a few, it may be promising to look into its potential for the insurance industry, most notably to boost the concept of 'micro insurance' which–despite its being heralded for quite some time–has not yet made a breakthrough in the Global South.[119] A DLT solution could be helpful with respect to crop insurance contracts in particular, assuring that a claims payment is triggered automatically in the case of drought or a typhoon.[120] Similarly, it has been suggested that DLT could improve wildlife conservation in African national parks, e.g. by tracking the lo-

Offerings, and the Democratization of Public Capital Markets', 24 March 2018 (<https://ssrn.com/abstract=3048104>), 21.

113 Utility tokens resemble more of a conventional voucher or coupon than a digital company share; cf. Momtaz et al. (n. 12), 37. For a recent example from South Africa ('Rhino Coin') see Stolp et al. (n. 2), 11.

114 *Supra*, section C.I. (at n. 46).

115 Cf. Polymath Network, 'How Securities on the Blockchain Could Transform Small Businesses', 22 February 2018 (<https://blog.polymath.network/how-securities-on-the-blockchain-could-transform-small-businesses-682ddf3b0aff>); A. Reese, 'Collective Fractional Ownership: A Proposed Blockchain Use Case', 2 June 2018 (<https://www.ethnews.com/collective-fractional-ownership-a-proposed-blockchain-use-case>).

116 For an example from India cf. Reese (n. 115); further Polymath Network (n. 115).

117 Cf. Momtaz et al. (n. 112); Y. Chatard & M. Mann, 'Initial Coin Offerings und Token-Handel im internationalen Rechtsvergleich', 22 (2019) *NZG* 567, 568.

118 See L.J. Trautman & M.J. Molesky, 'A Primer For Blockchain', 88 (2019) *UMKC L. Rev.* 1, 28–46; Zambrano (n. 62), 33–44; Zetzsche, Buckley & Arner (n. 17), 4–5.

119 Kshetri (n. 5); A.W. Singer, 'Micro-insurance hasn't worked; Can blockchain fix it?', 8 January 2019 (<https://financialit.net/blog/micro-insurance-hasnt-worked-can-blockchain-fix-it>).

120 Singer (n. 119). Cf. also F. Möslein, 'Legal Boundaries of Blockchain Technologies: Smart Contracts as Self-Help?', 10 November 2018 (<https://www.ssrn.com/abstract=3267852>), 3.

cation of animals, their heart rate, and other significant activity on-chain.[121] And as regards the production of renewable energy, DLT has most recently been considered to facilitate the development of small-scale electricity trading markets, particularly with the aim of improving power accessibility in Africa's rural areas.[122]

D. Legal Issues

I. General Considerations

With DLT becoming a global phenomenon, many feel that the existing legal frameworks are entirely inappropriate. Businesses planning to get involved may find themselves somewhere between a regulatory vacuum and downright hostility, or in a legal grey area, at best.[123] Uncertainty not only prevails in respect of technicalities, but also regarding major issues such as the allocation of responsibility in a pseudonymous, distributed system, the legal status of digital assets, or the recognition of blockchain-based transactions in the 'real world'. This situation is unfortunate as legal certainty is a crucial prerequisite for economic growth; otherwise, initiatives might not be sustainable and private businesses be deterred from investing, whilst some projects may simply be infeasible without the essential legislative support, e.g. those relating to public registries and various other civic services.[124]

As a consequence, many countries have admitted to the need for prudent DLT legislation, although the regulatory strategies may differ.[125] Whilst some nations decided to prepare a comprehensive set of rules, including Belarus which adopted a framework for the DLT industry in 2017[126] or Liechtenstein with its 'Blockchain Act' of May 2019,[127] others prefer a small-scale approach by interpreting existing laws in a targeted way and adopting

121 Koffman (n. 5); Wold Economic Forum, 'Building Block(chain)s for a Better Planet', September 2018 (<http://www3.weforum.org/docs/WEF_Building-Blockchains.pdf>).

122 T. Thurner, 'Renewable energy managed over blockchain would boost Africa's rural power access', 11 June 2019 (<https://qz.com/africa/1640800/renewable-solar-power-over-blockchain-will-light-up-rural-africa>).

123 Pollock (n. 84); Trautman (n. 13), 447ff.

124 Cf. FinTechRat, 'Statement concerning the blockchain strategy of the German government in the context of public consultations', 27 March 2019 (<https://www.bundesfinanzministerium.de/Content/EN/Downloads/2019-04-17-statement-fintech-council.pdf?__blob=publicationFile&v=5>), 4; Didenko (n. 15), 333ff. More generally K. Werbach, 'Trust, But Verify: Why the Blockchain Needs the Law', 33 (2018) *Berkeley Tech. L.J.* 489; Lee & Mueller (n. 31), 86 ('legal standing is critical for the technology').

125 For a general taxonomy see M. Finck, 'Blockchains: Regulating the Unknown', 19 (2018) *German L.J.* 665, 675–682 (<https://doi.org/10.1017/S2071832200022847>); same (n. 20), 153ff.

126 See the Official Website of the Republic of Belarus, Press Release of 28 March 2018 (<https://www.belarus.by/en/press-center/news/belarus-digital-economy-development-ordinance-comes-into-force_i_76762.html>).

127 See <https://impuls-liechtenstein.li/blockchain-gesetz> and <https://impuls-liechtenstein.li/wp-content/uploads/2019/06/bua_054_2019_tvtg.pdf>.

tailored legislation in specific areas. The latter applies to the United States (US) state of Vermont, among others, which in 2016 introduced specific rules on the admissibility of blockchain data as evidence in a court of law.[128] Yet most states are still working on their legislative strategies, including Germany whose Federal Government established an expert council named 'FinTechRat' to advise on issues concerning DLT and launched a public consultation in early 2019.[129] Although its final 'Blockchain strategy' is still to be expected, it seems that there will be benevolent legislation in line with the council's most recent recommendations.[130]

From an African perspective, given that the differences between the various applications and types of ledgers are simply too substantial, it seems that separate issues warrant separate attention, regardless of whether a state prefers a comprehensive approach or a number of piecemeal legislative solutions.[131] More specifically, it is probably less important to regulate the technological side of distributed ledgers, i.e. to establish binding technical standards regarding their creation and operation,[132] than to regulate their application to a certain use case. On that basis, the most crucial matters concern cryptocurrencies (*infra*, II.) and security tokens (III.), the status and recognition of smart contracts (IV.) and land registries (V.), the prevention of money laundering and terrorist financing (VI.), the law of data protection (VII.), and the attribution of personal liability for certain culpable mistakes (VIII.).

II. Currency Regulation

As regards cryptocurrencies, the first thing to debate is whether a state should try and regulate them at all. From a theoretical perspective, it has been suggested that cryptocurrencies could–and indeed should–operate best *without* an underlying body of currency law, arguing that regulation was redundant or even counterproductive. The notion behind this is that cryptocurrencies differ from conventional Fiat money in one important aspect: Whilst the acceptance of the latter depends entirely on the legitimacy bestowed upon it by the issuing government, making it a 'creature of law' and monetary legislation,[133] the success of a

128 2016 Vermont Statutes, 12 V.S.A. § 1913 (<https://law.justia.com/codes/vermont/2016/title-12/chapter-81/section-1913>); Condos et al. (n. 17).

129 See <https://www.bundesregierung.de/breg-de/themen/digital-made-in-de/blockchain-strategie-1546662>.

130 As to these recommendations see FinTechRat (n. 124).

131 Cf. FinTechRat (n. 124), 4, 6.

132 See M. Lehmann, 'Who Owns Bitcoin? Private Law Facing the Blockchain', EBI Working Paper Series 2019, no. 42 (<https://ssrn.com/abstract=3402678>), 19; Finck (n. 125), 689.

133 McGinnis & Roche (n. 4), 3. Herein lies a difference to 'commodity money', such as gold or silver, which has an intrinsic value and constitutes a rather 'natural' means of barter; cf. K. Langenbucher, 'Digitales Finanzwesen–Vom Bargeld zu virtuellen Währungen', 218 (2018) *AcP* 385, 389.

cryptocurrency is based on society's confidence in the underlying technology.[134] Put differently, a cryptocurrency such as Bitcoin is based on an ideology that 'has an inbred scepticism towards public authorities',[135] from which one might infer that even the most supportive regulatory embedding could, in fact, do little more than discredit its libertarian idea.[136]

Truth be told, however, a global *laissez-faire* approach is neither preferable nor realistic. Regardless of whether a nation supports the advent of cryptocurrencies or is even prepared to sponsor an official version of its own, most have decided to bring them under the rule of law in one fashion or another.[137] On the one end are regimes which adopted a restrictive or even preventionist position, including China[138] or the African states of Algeria and Morocco,[139] be it for the energy consumption associated with mining[140] or an apprehended loss of monetary control.[141] Others have taken a more benevolent approach and adopted enabling legislation, such as Japan which recognized 'virtual currencies' as a legal form of payment in 2017,[142] or Mauritius which strives to become the 'Ethereum Island' of the world.[143] Still others may not yet have passed specific legislation and regard cryptocurrencies as extralegal for the time being, but contemplate a permanent solution for the future. This can be said of Tanzania which reportedly considers cryptocurrencies a threat to East Africa's plan to launch a single, common currency in the East African Community (EAC).[144]

134 See McGinnis & Roche (n. 4), 1, 4; Langenbucher (n. 133), 392ff.

135 Barbieri & Gassen (n. 74), 4. See also Lehmann (n. 132), 4–6.

136 On the theoretical background cf. McGinnis & Roche (n. 4); Raskin (n. 39), 334–335; Langenbucher (n. 133), 394–395; and section C.I. above (re 'democratisation' and 'denationalisation').

137 For an overview see The Law Library of the US Congress, 'Regulation of Cryptocurrency Around the World', June 2018 (<https://www.loc.gov/law/help/cryptocurrency/cryptocurrency-world-survey.pdf>).

138 C. Li, 'China, a Major Bitcoin Source, Considers Moving Against It', *The New York Times*, 9 April 2019 (<https://www.nytimes.com/2019/04/09/business/bitcoin-china-ban.html>). But cf. most recently A. Cuthbertson, 'China Says State Cryptocurrency Set To Rival Bitcoin Is Close To Launch', *Independent*, 13 August 2019.

139 Stolp et al. (n. 2), 17–18; Law Library of the US Congress (n. 137), 82, 87.

140 *Supra*, section B.III.; further Stolp et al. (n. 2), 18 (with respect to Cameroon).

141 See B. Rich, 'Bitcoin Is All About Chinese Capital Flight', *Forbes Magazine*, 14 May 2019; Li (n. 138).

142 McGinnis & Roche (n. 4), 20; E. Terazono, 'Bitcoin gets official blessing in Japan', *Financial Times*, 18 October 2017 (<https://www.ft.com/content/b8360e86-aceb-11e7-aab9-abaa44b1e130>).

143 Stolp et al. (n. 2), 7. As regards Ether and Ethereum see *supra*, section C.I. (at n. 44).

144 R. Odhiambo, 'Tanzanian Central Bank Considers Bitcoin a Threat to EAC Currency Plans', 10 January 2018 (<https://bitcoinafrica.io/2018/01/10/tanzanian-central-bank-bitcoin-threat-currency-plans>); Stolp et al. (n. 2), 12–13. See also Law Library of the US Congress (n. 137), 89, 94, regarding Kenya and Uganda.

For those nations that wish to embrace cryptocurrencies, prudent legislation should ideally respect the distinction between private law and public law,[145] with the former arguably serving as the starting point. Based on the concept of personal ownership, i.e. the fundamental question of what exactly a cryptocurrency holder 'owns', private law must clarify its implications between individuals, especially the legal nature and recognition of transactions. This pertains to the status of a contract for the 'sale' of Bitcoins, for example, but also to their provision as consideration for goods and services or the classification of a Bitcoin loan.[146] Further issues include whether a creditor may be obliged to accept digital currencies if a debtor offers them as payment, whether a creditor may insist that a certain debt be paid in Bitcoin, or the attribution of transaction risks. In terms of the latter, one might picture an error of the underlying ledger technology,[147] but also the case of a rapid change in market value: Considering most cryptocurrencies' volatility,[148] it is possible that a creditor agrees to accept a specific payment, but encounters a loss of value before the transaction is complete.[149] Private law must then determine whether the creditor shall be entitled to additional payment, or if the loss will lie where it falls.

In Germany, cryptocurrencies do not qualify as 'money' in the sense of official legal tender, given that s. 14(1) of the *Bundesbankgesetz* reserves this capacity for banknotes denominated in Euro.[150] They are also neither tangible assets (*Sachen*) under s. 90 of the Civil Code ('BGB') nor do they represent a contractual debt (*Forderung*) under s. 241(1) BGB.[151] Instead, it seems that they are captured as 'irregular' intangible assets, similar to electricity or more conventional digital data.[152] The sale of a Bitcoin is thus a sale of 'another object' under s. 453(1) BGB,[153] while a Bitcoin loan is probably not a conventional loan (s. 488 BGB), but a contract 'for the loan of a thing' (*Sachdarlehen*, s. 607 BGB).[154] On that basis, the parties are neither obliged to accept nor entitled to demand a cryptocur-

145 As to this distinction see A. Harel, 'Public Law and Private Law' in D. Dubber & T. Hörnle (eds.), *The Oxford Handbook of Criminal Law* (Oxford University Press, 2014), Ch. 45.

146 As regards the different types of possible transactions see section C.I., *supra*.

147 On such errors in more detail *infra*, section D.VIII.

148 *Supra*, section A. (in respect of Bitcoin).

149 Cf. Langenbucher (n. 133), 415.

150 See also art. 128(1) of the Consolidated Version of the Treaty on the Functioning of the European Union, Official Journal (OJ) 2012 C 326/47; arts. 10, 11 of Council Regulation (EC) No. 974/98 of 3 May 1998 on the introduction of the euro, OJ 1998 L 139/1; G. Spindler & M. Bille, 'Rechtsprobleme von Bitcoins als virtuelle Währung', 68 (2014) *WM* 1357, 1360; Langenbucher (n. 133), 397.

151 Langenbucher (n. 133), 405; B. Beck & D. König, 'Bitcoin: Der Versuch einer vertragstypologischen Einordnung von kryptographischem Geld', 70 (2015) *JZ* 130, 131. Cf. also S. Bayern, 'Dynamic Common Law and Technological Change: The Classification of Bitcoin', 71 (2014) *Wash. & Lee L. Rev. Online* 22, 30.

152 See Langenbucher (n. 133), 407; G. Spindler & M. Bille (n. 150), 1360.

153 Beck & König (n. 151), 132–133; Langenbucher (n. 133), 411; Spindler & Bille (n. 150), 1362.

154 Contested; cf. Langenbucher (n. 133), 413–414 (including further reference).

rency payment unless they contractually agreed to do so; in the latter case, the risk of devaluation usually lies with the creditor, whereas the risk of a technical error is borne by the payer.[155]

Admittedly though, even the best private law legislation will be ineffective if it cannot be employed. More specifically, one must first determine the applicable jurisdiction in accordance with Private International Law (PIL),[156] which can be challenging due to the blockchain's distributed nature. Especially in a public and permissionless system,[157] the participating nodes may be placed in very different corners of the planet, which makes it difficult to determine the jurisdiction with the closest regulatory connection. Moreover, PIL frameworks may draw an intricate distinction between the law of contracts, torts, and property, or offer parties a substantial choice of law. To reduce this complexity, it seems that a global PIL rulebook for cryptocurrencies would be needed, although the latter is currently not in sight.[158]

Under public law, the focus is on matters such as money laundering[159] and taxation,[160] but mostly on the law of consumer protection. Despite its general success, the 'crypto hype' also produced a division of black sheep, ranging from amateurish 'altcoin' copycats and sinister trading platforms to downright Ponzi schemes that never had a viable cryptocurrency to offer, but cheated consumers out of the better part of their savings. In Nigeria, a Bitcoin-related Ponzi scheme resulted in almost 2 million residents losing a total of 50 million US-Dollars in 2017, whilst a South African scam reportedly defrauded investors of a combined 1 billion South African Rand (ZAR) in early 2018.[161] In addition, many coins are offered on the basis of utterly inadequate information, with no disclosures of their developers, risks or the relevant rules of participation. As a result, there is a global call for better tools of consumer protection, notably including licensure and information requirements.[162]

So far, however, it seems that most regulators can do little more than issue warnings[163] or put a supervisory reign on certain intermediary players. In Germany, market-making ac-

155 In detail Langenbucher (n. 133), 415 (with reference to s. 365 BGB); B. Beck & D. König, 'Bitcoins als Gegenstand von sekundären Leistungspflichten', 215 (2015) *AcP* 655, 667.

156 Also known as conflict-of-laws rules; Lehmann (n. 132), 13; L.C. Piñeiro & X. Kramer, 'The Role of Private International Law in Contemporary Society: Global Governance as a Challenge', 8 (2014) *ELR* 109.

157 *Supra*, section B.II.

158 In detail Lehmann (n. 132), 13–17; also J. Naves et al., 'Legal Aspects of Blockchain', 12(3–4) *Innovations* 88, 90–91 (2018); Didenko (n. 15), 346.

159 In detail *infra*, section D.VI.

160 More specifically, the imposition of VAT and income tax on cryptocurrency transactions; cf. Stolp et al. (n. 2), 11–12 (for South Africa); Schlund & Pongratz (n.54), 601–604 (for Germany).

161 See Stolp et al. (n. 2), 9, 12; Rao (n. 61).

162 Cf. J. Koenraadt & E. Leung, 'The Impact of Regulation and Transparency in the Cryptocurrency Market', 22 February 2019 (<https://ssrn.com/abstract=3339197>), 2; Jabotinsky (n. 19), 23–29.

163 This seems to be the approach of many African governments and/or central banks, including those of Ghana, Lesotho, or Mozambique; Law Library of the US Congress (n. 137), 1, 89–95. In

tivities such as proprietary trading–i.e. the selling and purchasing of cryptocurrencies on a commercial basis–or the operation of a cryptocurrency exchange require prior authorization under s. 32(1) of the German Banking Act ('KWG'), given that the German Federal Financial Supervisory Authority ('BaFin') considers Bitcoin a 'financial instrument' under s. 1(11) no. 7 KWG.[164] The businesses concerned must hence comply with the conditions of s. 33(1) KWG, including capital requirements and a 'fit and proper' test, and are subject to the reporting obligations of s. 24 KWG.[165] By contrast, whilst activities such as mining or the use of cryptocurrencies as an alternative means of payment are rightly outside the scope of regulation, it is disturbing that altcoin developers remain entirely unchecked. Again, the best way to proceed would be a global or at least a regional approach, coordinated by institutions such as the G20 (Group of Twenty) and the EU[166] or–in Africa–economic communities such as the Southern African Development Community (SADC) or the Economic Community of West African States (ECOWAS).[167]

III. Security Token Regulation

Similar issues arise in the field of security tokens and business finance.[168] In this context as well, the legal debate revolves around a multitude of questions, including aspects of both private law and public law. Yet even more so than in respect of cryptocurrencies, the debate is predominantly fuelled by issues of consumer (or rather: investor) protection, putting the focus on regulatory legislation and supervisory intervention.[169]

respect of South Africa and Kenya see also Didenko (n. 15), 357–359 (South Africa), 363 (Kenya).

164 So-called 'unit of account'; BaFin, *Merkblatt–Hinweise zum Zahlungsdiensteaufsichtsgesetz (ZAG)*, 29 November 2017, 4.a), and *Virtuelle Währungen/Virtual Currency (VC)*, 28 April 2016, Ch. 'Erlaubnispflicht' (both available at <https://www.bafin.de>). Although the Berlin Court of Appeal (*Kammergericht*) rejected this assessment in a criminal law case of September 2018, it seems that the BaFin's supervisory practice will not change unless the German legislator intervenes; cf. the German Federal Government, *BT-Drucksache* No. 19/6034 (<https://dip21.bundestag.de/dip21/btd/19/060/1906034.pdf>), 1–2.

165 The latter concern the entity's intention to appoint senior managers, changes in its legal form, or the relocation of its office or domicile, among others; Spindler & Bille (n. 150), 1366; Schlund & Pongratz (n. 54), 600–601. Similar rules reportedly apply in Australia; Law Library of the US Congress (n. 137), 103.

166 Cf. L. Klöhn & N. Parhofer, 'Bitcoins Under European and German Banking and Capital Markets Law', 19 November 2018 (<https://ssrn.com/abstract=3287189>), 14.

167 With respect to SADC in particular cf. L. Abrahams, 'Regulatory imperatives for the future of SADC's digital complexity ecosystem', 20 (2017) *AJIC* 1–29; see also Didenko (n. 15), 346–348, 368.

168 *Supra*, section C.V.

169 Cf., for instance, P. Maume & M. Fromberger, 'Regulation of Initial Coin Offerings: Reconciling US and EU Securities Laws', (2019) 19.2 *Chi. J. Int'l L.* 548; I.M. Barsan, 'Legal Challenges of Initial Coin Offerings (ICO)', *RTDF*, no. 3, 2017, 54.

The reasons for this are numerous. To begin with, the increasing appeal of ICOs worldwide[170] has attracted a variety of swindlers and led to numerous scams and Ponzi schemes; according to a US research group, almost eighty percent of ICOs conducted in 2017 were entirely fraudulent.[171] Secondly, many ICOs are offered on the basis of utterly inadequate information, with issuers providing little more than a website, a YouTube video, or a simple 'white paper', at best;[172] as a consequence, investors are often left in the dark about what rights exactly are given to them, the inherent risks of loss, the applicable legal rules (if any), or the issuing entities and backers.[173] And thirdly, it has been suggested that the rapid growth of ICO markets may lead to a new 'too-big-to-fail' problem, i.e. cause a global systemic risk unless regulators intervene;[174] in fact, it seems that almost all ICOs so far have relied on legislative loopholes in at least one way or another,[175] which illustrates the macroeconomic necessity of more effective supervision.

In the light of this, initial regulatory responses have differed significantly across the globe. Whilst some nations imposed outright bans of any ICO activity, including China and South Korea,[176] others have taken a more nuanced or even benevolent position, including Singapore and Switzerland.[177] In Africa, the topic is apparently not yet a regulatory priority, given the relatively small volume of ICOs on the continent so far;[178] nevertheless, Africa's first security token framework is reportedly being prepared in Kenya,[179] and the Mauritian

170 Global contributions to ICOs may have passed the 75 billion US-Dollar mark in 2018; for details see D. Zetzsche et al., 'The ICO Gold Rush: It's a Scam, It's a Bubble, It's a Super Challenge for Regulators', EBI Working Paper Series 2018–no. 18, July 2018 (<https://ssrn.com/abstract=3072298>), 2, 17.

171 Satis Group, 'Cryptoasset Market Coverage Initiation: Network Creation', 11 July 2018 (available at <https://research.bloomberg.com>), 24. See also Zetzsche et al. (n. 170), 3; L. Klöhn et al., 'Initial Coin Offerings (ICOs): Economics and Regulation', 26 November 2018 (<https://ssrn.com/abstract=3290882>), 13; P. de Andres et al., 'Regulatory and Market Challenges of Initial Coin Offerings', ecgi Law Working Paper No. 461/2019, July 2019 (<https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3413117>), 11.

172 Zetzsche et al. (n. 170), 11; P. Hacker & C. Thomale, 'Crypto-Securities Regulation: ICOs, Token Sales and Cryptocurrencies under EU Financial Law', 15 (2018) *ECFR* 645, 693.

173 Zetzsche et al. (n. 170), 10–11, 38; Klöhn et al. (n. 171), 12–13; Veil (n. 112), 354.

174 Zetzsche et al. (n. 170), 17–20. Cf. also D.W. Arner et al., 'FinTech, RegTech, and the Reconceptualization of Financial Regulation', 37 (2017) *Nw. J. Int'l L. & Bus.* 371, 403–404.

175 Zetzsche et al. (n. 170), 11.

176 H. Deng et al., 'The Regulation of Initial Coin Offerings in China: Problems, Prognoses and Prospects', 19 (2018) *EBOR* 465; Zetzsche et al. (n. 170), 4, 30–32; Veil (n. 112), 364.

177 Zetzsche et al. (n. 170), 4, 33–35; Klöhn et al. (n. 171), 23–24.

178 According to Zetzsche et al. (n. 170), 11, the vast majority of ICOs so far happened in Europe, Asia and North America, whereas 6.07% cluster around the Middle East, Africa, and Latin America combined.

179 *African Review*, 'Africa to receive its first security token framework', 13 December 2018 (<http://www.africanreview.com/ict/information-security/africa-to-receive-its-first-security-token-framework>).

Financial Services Commission (FSC) recently clarified that companies seeking to raise funds must obtain prior approval and comply with the country's Securities Act of 2005.[180] Besides, it seems that some regulation is already in place in South Africa, given that ICOs are reportedly covered by the country's rather general 'crowdfunding' legislation.[181]

In the United States and in the EU, including Germany, regulators have at first reacted by issuing public warnings.[182] The key debate, however, is on whether security tokens qualify as 'securities' (*Wertpapiere*) under existing capital market regulations, given that ICOs would then be subject to registration and/or prospectus requirements under the German Securities Prospectus Act ('WpPG'), the EU Prospectus Regulation 2017,[183] or the US Securities Act.[184] Albeit digital tokens are by no means 'securitized' (*verbrieft*) in the orthodox sense of the term,[185] it seems that the answer is usually in the affirmative: According to the famous 'Howey test' which the US Securities and Exchange Commission (SEC) traditionally applies,[186] a token will essentially qualify as a security if it (a) promises a financial return (as opposed to mere consumption benefits[187]) and if (b) that return depends primarily on the efforts of the issuer's management (which it typically does).[188] In a similar vein, such tokens will usually be equivalent to shares or bonds and hence constitute 'transferable securities' under applicable EU law,[189] provided the underlying DLT does not–by way of exception–exclude a transfer of the tokens.[190] As a corollary, services rendered by market

180 M. Knowles, 'Mauritius Regulator Clarifies Stance on STOs', *Coinlaw*, 8 April 2019 (<https://coinlaw.io/security-tokens-are-securities-says-mauritian-financial-watchdog>).

181 *FSB Bulletin*, 'Strengthening South Africa's Financial Institutions', First Quarter 2016 (<https://perma.cc/RW6J-8Q9W>), 15; Didenko (n. 15), 359–360.

182 See, for instance, the US Securities and Exchange Commission (SEC), Public Statement of 11 December 2017 (<https://www.sec.gov/news/public-statement/statement-clayton-2017-12-11>); European Securities and Markets Authority (ESMA), Public Statement of 13 November 2017 (<https://www.esma.europa.eu/press-news/esma-news/esma-highlights-ico-risks-investors-and-firms>). Cf. also the collection of international regulators' statements at <https://www.iosco.org/publications/?subsection=ico-statements>.

183 Regulation (EU) 2017/1129 of 14 June 2017, OJ No. L 168 of 30 June 2017, 12.

184 In particular, s. 5 of the Securities Act (<https://www.sec.gov/answers/about-lawsshtml.html>).

185 Cf. BaFin, 'Digitalisation: Impact on financial markets, supervision and regulation–Part I', *Perspectives*, Issue 1/2018 (<https://www.bafin.de/dok/11506544>), 61.

186 Based on SEC v. W.J. Howey Co., 328 U.S. 293 (1946); cf. Hacker & Thomale (n. 172), 660.

187 Cf. the case of mere utility tokens, *supra* section C.V.

188 Klöhn et al. (n. 171), 16–20; Maume & Fromberger (n. 169), 564–566.

189 In particular, such tokens will usually fall under the definition of art. 4(1)(44) of the Markets in Financial Instruments Directive ('MiFID II'; Directive 2014/65/EU of 15 May 2014, OJ L 173 of 12 June 2014, 349) which is also determinative for the EU prospectus regime; cf. ESMA, *Advice on Initial Coin Offerings and Crypto-Assets*, ESMA50–157–1391, 9 January 2019 (<https://www.esma.europa.eu/sites/default/files/library/esma50-157-1391_crypto_advice.pdf>), 4–5, 18ff.; Klöhn et al. (n. 171), 27–35.

190 In that case (so-called 'lockup'), the tokens will not be 'negotiable on the capital market' in the sense of art. 4(1)(44) MiFID II (*ibid*); cf. BaFin (n. 185), 61; Klöhn et al. (n. 171), 28.

intermediaries–such as trading platforms or brokers–may be governed by the EU rules on securities services,[191] whilst the EU Market Abuse Regulation[192] will prohibit insider trading and market manipulation on certain post-ICO secondary markets.[193]

That being said, it would, however, be misguiding to infer that all ICO problems can be solved by subjecting security tokens to the full scope of securities regulation. Aside from the fact that such regulation may be incomplete–or even non-existent–in quite a number of jurisdictions, this would send a chilling message to small and medium-sized businesses, given the significant costs that compliance usually entails.[194] More to the point, the costs of legal advice or the distribution of a full prospectus might well overstrain precisely those entities that would benefit the most from an ICO, be it in Europe, in Africa, or elsewhere in the world.[195] Regulators should therefore strike a balance between investor protection on the one hand and the needs of entrepreneurs on the other, e.g. by mitigating general prospectus requirements or by imposing more bespoke disclosure rules.[196] Again, given the cross-border nature of many DLT applications, this should be done at the global or at least regional regulatory level, for instance through the International Organization of Securities Commissions[197] ('IOSCO') or its regional committees.[198]

Finally, an issue that tends to be neglected concerns the private law dimension of security tokens, notably their integration into domestic company law.[199] Whilst a digital token may qualify rather readily as a security for the purpose of regulation, private law may be more reluctant to accept the idea of dematerialization. In Germany, for instance, the securitization of contractual rights still requires the creation of a physical certificate, mainly in order to guarantee the fungibility of the product.[200] A business that wishes to issue bonds (*Anleihen*) or shares (*Aktien*) under the Stock Corporation Act (*Aktiengesetz*) must hence ensure the securitization of the relevant positions, which is usually done in a global certificate that is held by a custodian.[201] Similarly, it is hard to qualify security tokens as 'compa-

191 Based on art. 5ff. of MiFID II (n. 189); cf. ESMA (n. 189), 24–28; BaFin (n. 185), 62.

192 Regulation (EU) No 596/2014 of 16 April 2014, OJ L 173 of 12 June 2014, 1.

193 ESMA (n. 189), 29–30; BaFin (n. 185), 62; Hacker & Thomale (n. 172), 655ff.

194 Concisely Hacker & Thomale (n. 172), 690.

195 Cf. Hacker & Thomale (n. 172), 690; Klöhn et al. (n. 171), 35–36.

196 For details see Hacker & Thomale (n. 172), 690–694; Klöhn et al. (n. 171), 38, 42.

197 See <https://www.iosco.org>.

198 As regards IOSCO's Africa & Middle-East Regional Committee ('AMERC') see <https://www.iosco.org/about/?subsection=display_committee&cmtid=7>. On the necessity of international collaboration in general Zetzsche et al. (n. 170), 39; Hacker & Thomale (n. 172), 695.

199 See M. Kaulartz & R. Matzke, 'Die Tokenisierung des Rechts', 71 (2018) *NJW* 3278, 3280.

200 J. Ekkenga, 'Wertpapierhandel' in: R. Erne (ed.), *Claussen: Bank- und Börsenrecht* (C.H. Beck, 5th edn., 2014), § 7. More supportive in respect of tokens Kaulartz & Matzke (n. 199), 3281–3283.

201 M. Berberich & T. Wohlfarth, 'Germany' in M.S. Sackheim & N.A. Howell (eds.), *The Virtual Currency Regulation Review* (Law Business Research, 2018), Ch. 11, 136.

ny shares' under the Limited Liability Companies Act (*GmbH-Gesetz*), given that this would require notarization of the underlying contracts.[202] Pending further legislation, it therefore seems that an ICO may result in a 'silent partnership', a profit-participating loan, or a similar type of undisclosed cooperation, but hardly in an association in the sense of traditional company law.[203] At any rate, albeit other jurisdictions may be more permissive on this matter,[204] governments would be well advised to review their existing company law frameworks, not least to avoid inconsistence with applicable ICO regulation.

IV. Smart Contracts

In respect of smart contracts, the most salient feature of the legal discussion so far pertains to the ideological mindset of many of their evangelists. Insofar as smart contracts are essentially self-enforcing,[205] it has been suggested that they are by no means confined to the reduction of transaction costs, but may even operate entirely independent of the traditional legal system. More specifically, by reducing the need for institutions such as courts, lawyers, or judicial officers, the idea is that the judiciary of a state can be supplanted altogether by a smart contract's 'electronic rules'.[206] In fact, technology providers such as the 'Aragon Project' have explicitly announced the development of a quasi-jurisdictional infrastructure, including an arbitration network similar to a real-world judicial system.[207] Whilst some legal scholars already bemoan 'the end of civil procedure' or 'the end of classic contract law',[208] the most frequently cited equation simply claims that 'code *is* law'.[209]

202 P. Koch, 'Die Tokenisierung von Rechtspositionen als digitale Verbriefung', 30 (2018) *ZBB* 359, 365; Langenbucher (n. 133), 421–422. But cf. also (most recently) CDU/CSU-Fraktion im Deutschen Bundestag, *Zukunftstechnologie Blockchain–Chancen für Deutschland nutzen*, 25 June 2019, 5–6 ('Digitale GmbH'); B. Godenrath, 'Wir digitalisieren den GmbH-Anteil', *Börsen-Zeitung*, Issue 128 of 9 July 2019, 4.

203 Cf. C. Behme & P. Zickgraf, 'Zivil- und gesellschaftsrechtliche Aspekte von Initial Coin Offerings (ICOs)', 5 (2019) *ZfPW* 66, 78ff.; Langenbucher (n. 133), 421–425; Koch (n. 202), 365.

204 See Zetzsche, Buckley & Arner (n. 17), 36–37; Zetzsche et al. (n. 170), 20.

205 *Supra*, section B.IV.

206 For an overview see Möslein (n. 120), 1ff.; Raskin (n. 39), 334ff. More generally H. Wilsch, 'Die Blockchain-Technologie aus der Sicht des deutschen Grundbuchrechts', 116 (2017) *DNotZ* 761, 779–782.

207 See <https://aragon.org/network>; Möslein (n. 120), 4–5; W.A. Kaal & C. Calcaterra, 'Crypto Transaction Dispute Resolution', 19 October 2017 (<https://ssrn.com/abstract=2992962>), 49.

208 See M. Fries, 'Law and Autonomous Systems Series: Smart consumer contracts–The end of civil prodecure?', 29 March 2018 (<https://www.law.ox.ac.uk/business-law-blog/blog/2018/03/smart-consumer-contracts-end-civil-procedure>); A. Savelyev, 'Contract law 2.0: Smart contracts as the beginning of the end of classic contract law', 26 (2017) *ICTL* 116; Möslein (n. 41), 266.

209 Cf. the seminal work of L. Lessig, *Code and other Laws of Cyberspace* (Basic Books, 2000), 3ff.; Zetzsche, Buckley & Arner (n. 17), 24–25; F. Möslein, 'Conflicts of Laws and Codes: Defining the Boundaries of Digital Jurisdictions', 22 July 2018 (<https://ssrn.com/abstract=3174823>), 1.

Upon closer inspection, the suggestion that smart contracts may take precedence over the rule of law can yet hardly be sustained. Firstly, in the light of their self-enforcing nature, smart contracts may collide with the state monopoly on the use of force or the indispensable limits to 'self-help' that are designed to keep the peace; in Germany, smart contracts may infringe the boundaries of *Selbsthilfe* (s. 229 BGB) or constitute 'unlawful interference' under s. 858 BGB.[210] Secondly, automated execution may spawn results which are contrary to public policy or even entirely unconscionable; for instance, take the (hypothetical) case of a smart contract triggering the shipment of illicit goods such as narcotics,[211] or the (actual) case of a sold car being deactivated for a lack of payment, notwithstanding the buyer's need to rush her dying child to a hospital.[212] Besides, whilst smart contracts may be most efficient for transactions that can be reduced to a simple 'if-then' combination ('if payment, then shipment'),[213] they will probably fail to deal with more intricate contractual relations; for instance, it seems that abstract legal concepts like the *ordre public*[214] or the principle of good faith (*Treu und Glauben*)[215] will inevitably escape all formulaic application, which is particularly grave in the case of long-term general agreements that contain *deliberate* ambiguities.[216]

Against this backdrop, even the most sophisticated 'digital jurisdiction' can never operate within a legal vacuum, but must be subject to the rule of law.[217] The challenge, however, is to reconcile the benefits of self-execution on the one hand with the applicable legal principles on the other. Save for the most egregious cases in which smart contracts should be banned,[218] the best approach is probably to err on the side of party autonomy and confine the judiciary to a policing *ex post*: If the outcome or the process of a 'smart enforce-

210 *Verbotene Eigenmacht*; see T. Riehm, 'Smart Contracts und verbotene Eigenmacht' in M. Fries & B.P. Paal (eds.), *Smart Contracts* (Mohr Siebeck, 2019), 85–98; Möslein (n. 41), 268–270, 281–283.

211 Cf. Raskin (n. 39), 306, 309, 328, 333; similarly Zetzsche, Buckley & Arner (n. 17), 38.

212 M. Corkery & J. Silver-Greenberg, 'Miss a Payment? Good Luck Moving that Car', 24 September 2014 (<https://dealbook.nytimes.com/2014/09/24/miss-a-payment-good-luck-moving-that-car>); Möslein (n. 41), 281.

213 A. Cohn et al., 'Smart After All: Blockchain, Smart Contracts, Parametric Insurance, and Smart Energy Grids', 1 (2017) *Geo. L. Tech Rev.* 273, 276, 281; Möslein (n. 209), 3; OECD (n. 10), 315.

214 R. de Lange, 'The European Public Order, Constitutional Principles and Fundamental Rights', 1 (2007) *ELR* 3 (<https://ssrn.com/abstract=1498326>).

215 M.W. Hesselink, 'The Concept of Good Faith' in: A.S. Hartkamp et al. (eds.), *Towards a European Civil Code* (Kluwer Law International, 2004), 471–498.

216 Möslein (n. 41), 288–289; EPRS (n. 3), 15. See also J.M. Lipshaw, 'The Persistence of "Dumb" Contracts', 2 (2019) *Stan. J. Blockchain L. & Pol.* 1, 31ff.; Raskin (n. 39), 326–328.

217 Möslein (n. 120), 5; EPRS (n. 3), 15; Zetzsche, Buckley & Arner (n. 17), 24–26.

218 Cf. Raskin (n. 39), 339, picturing 'a scenario where creditors can install devices into the bodies of debtors and have the device force them into slavery or some state of impaired consciousness if they default.'

ment' are unlawful, e.g. because they violate the applicable ordre public,[219] the party concerned should be entitled to restitution; if the latter is impossible or tied to prohibitive costs, e.g. because the triggered DLT transaction is essentially irrevocable, the remedy should be damages or compensation for unjust enrichment.[220]

Other than that, it is a moot point whether smart contracts might not only serve for the execution, but also for the *formation* of a legally binding agreement. In opposition to this, it has been argued that smart contracts were unable to express human declarations of intent (*Willenserklärungen*) such as offer and acceptance which are generally considered necessary for the formation of a contract.[221] As a corollary, some authors noted that a smart contract was in fact 'neither smart nor a contract' because it 'simply executes previously-written code'.[222] However, given that most jurisdictions have accepted digital contract formation under comparable conditions, be it in respect of vending machines, the Internet, or some other electronic medium,[223] it would be misplaced to reject 'smart contract formation' as a matter of legal principle.[224] To the contrary, some jurisdictions such as the US state of Arizona even clarified that smart contracts are as legally effective as conventional agreements, e.g. by enacting legislation giving legal status to blockchain-based electronic signatures.[225] A mark is only overstepped if the decision to contract is taken by a self-learning algorithm that is totally autonomous, in which case it may be impossible to attribute its actions to a specific human being.[226] Besides, a legally binding smart contract should be subject to the same limitations as any other contractual arrangement, including a state's legislation on unfair general terms and conditions[227] or applicable consumer protection law.[228]

V. Digital Land Registries

In respect of land registries, the situation is quite different. Unlike with many other DLT applications, development in this area is probably not going to be driven first and foremost

219 Möslein (n. 120), 8; same (n. 209), 10; similarly Raskin (n. 39), 333–334, 339.

220 For a similar approach see Raskin (n. 39), 310, 326–341. Cf. also Möslein (n. 41), 283–286.

221 Cf. A. Djazayeri, 'Rechtliche Herausforderungen durch Smart Contracts', *jurisPR-BKR* 12/2016, Anm. 1; T. Söbbing, 'Smart Contracts und Blockchain-Technologie', 18 (2018) *ITRB* 43, 45.

222 Cohn et al. (n. 213), 276. See also Möslein (n. 41), 259.

223 From an African perspective S.L. Snail, *A Comparative Review of Legislative Reform of Electronic Contract Formation in South Africa*, February 2015 (available at <http://uir.unisa.ac.za>).

224 In detail K. Werbach & N. Cornell, 'Contracts *Ex Machina*', 67 (2017) *Duke L.J.* 313, 338–343; Möslein (n. 41), 270–280; Raskin (n. 39), 322–326.

225 See <https://www.azleg.gov/legtext/53leg/1r/bills/hb2417p.pdf>; Zetzsche et al. (n. 170), 24.

226 Möslein (n. 41), 273–274. For more on the issues of algorithms and 'artificial intelligence' in respect of contract law see L.H. Scholz, 'Algorithmic Contracts', 20 (2017) *Stan. Tech. L. Rev.* 128–169.

227 *AGB-Recht*; cf. Blocher (n. 14), 618; Möslein (n. 209), 14–15; D. Paulus & R. Matzke, 'Smart Contracts und das BGB: Viel Lärm um nichts?', 4 (2018) *ZfPW* 431, 459–460.

228 Riehm (n. 210), 87; Blocher (n. 14), 618.

by the private sector, but by national governments themselves. The reason for this is that any system of land registration, be it paper-based or digital, is essentially a tool to implement a nation's policies in respect of property law. More specifically, the major function of any land registry is to assist the public in ascertaining ownership of a property *as it stands* under applicable property law, be it for the purpose of conveyance or to pledge it as collateral. Insofar as property rights constitute *rights in rem* and are effective against the world at large,[229] such ascertainment may be crucial to avoid undesired legal consequences like vindication or expropriation by the government.[230] Even before the advent of distributed ledgers, it has therefore been submitted that land registration without government endorsement is essentially moribund;[231] in the age of blockchain, this idea has lost nothing of its persuasiveness.[232]

However, government initiatives to implement DLT solutions should consider that there are, in principle, two different types of public registers, namely *deed registration* systems on the one hand and *title registration* systems on the other. In a deed registration system, which is said to have evolved in the Romanist cultures of Europe,[233] the act of registration is confined to a registration of the legal documents (or 'deeds') affecting interests in a specific piece of land, notably transaction documents such as sale and conveyance contracts.[234] Such registration is usually neither constitutive of ownership nor does it guarantee a person's title, but serves a recording, information-gathering function[235] and may help to resolve conflicts of priority.[236] In a title registration system, by contrast, entitlement to a piece of land is essentially *contingent* on official registration, meaning that for every parcel the current legal status must be recorded on the basis of an assessment by a public registrar.[237]

229 As to the general distinction between *rights in rem* and *rights in personam* see C. Webb, 'Three Concepts of Rights, Two of Property', 38 (2018) *Oxford J. Leg. Stud.* 246, 257ff.

230 Cf. Feder & Nishio (n. 73), 26.

231 Feder & Nishio (n. 73), 37 ('there needs to be an enabling regulatory framework for land registration').

232 See Peiró & García (n. 77), 317 ('There is a need of public order'), 319 ('Without public intervention it [the blockchain] is only an archive'); B. Arruñada, 'Blockchain's Struggle to Deliver Impersonal Exchange', 19 (2018) *Minn. J. Law Sci. Technol.* 55, 96. Most recently also the Kenyan *Distributed Ledgers Technology and Artificial Intelligence Taskforce* (DLT & AI Taskforce), 'Emerging Digital Technologies for Kenya: Exploration and Analysis', July 2019 (<http://www.ict.go.ke/blockchain.pdf>), 35 ('Without governments being at the forefront, Blockchain solutions risk being relegated to niche participants'); Lee & Mueller (n. 31), 85.

233 L. van Vliet, 'Transfer of Property Inter Vivos', Maastricht European Private Law Institute Working Paper No. 2017/1 (<https://ssrn.com/abstract=2918756>), 22ff.; M. Raff, *Private Property and Environmental Responsibility* (Kluwer Law International, 2003), 10.

234 For instance, see T. Hanstad, 'Designing Land Registration Systems for Developing Countries', 13 (1998) *Am. U. Int'l L. Rev.* 650–651; Zimmer (n. 72).

235 J. Howell, 'Deeds Registration in England: A Complete Failure?', 58 (1999) *Cambridge L.J.* 366, 370; van Vliet (n. 233), 17.

236 Raff (n. 233), 10–11; Peiró & García (n. 77), 303.

237 Peiró & García (n. 77), 303, 308, 319; van Vliet (n. 233), 17; Hanstad (n. 234), 651.

Such registration will not only secure priority, but carry a legal presumption of accuracy in order to guarantee the validity of the right at stake. The latter is particularly strong in the 'Torrens' system of Australia,[238] but can also be derived from ss. 891, 892 of the German Civil Code.[239]

On this basis, it seems that DLT is probably less appropriate to implement a system of title registration. Albeit DLT will generally guarantee the authenticity of a ledger, it is not necessarily prepared to ensure its veracity.[240] In particular, given the absence of a professional registrar who could assess the validity of transactions, there seems to be little room for a legal presumption of accuracy in the sense of a Torrens or a German-style registration.[241] German lawyers are hence generally sceptical of a 'blockchainization' of the German land registry system,[242] and in developing regions such as Africa, a blockchain-based title registry may be even more misplaced.[243] Besides, it is generally accepted that a modern land title registry should not only display the ownership structure of a property, but also comprise more sophisticated entries such as pre-emptive rights, easements, or different types of mortgages. Yet in the light of their complexity, it seems questionable whether such entries could be adequately recorded without the guidance of a legally trained intermediary.[244]

On the other hand, a DLT solution may be perfect for the purpose of deed registration. Insofar as a blockchain can provide for a tamper-proof storage of the relevant documentation, pre-transaction due diligence procedures which are necessary to review the legal status of a property would be simplified.[245] Governments might also consider the introduction of a hybrid model, i.e. a combination of deed and title registration which is only *partially* supported by a blockchain. For instance, a conventional intermediary–such as a government registrar or a notary public–might be charged with the notarization of a real estate transaction in a first step, which could then, together with the underlying documents, be registered

238 M. Raff, 'Characteristics of the International Model of Land Title Registration Illuminated by Comparative Study of the German and Torrens System', 1 (2012) *EPLJ* 54, 68–79; L.J. Arrieta-Sevilla, 'A comparative approach to the Torrens Title system', 20 (2012) *Aust. Prop. Law J.* 203–223.

239 See Raff (n. 238), 70–77; van Vliet (n. 233), 21; Arruñada (n. 232), 95.

240 In general *supra*, section B.III.

241 Peiró & García (n. 77), 308, 310; Barbieri & Gassen (n. 74), 10–12.

242 See Wilsch (n. 206), 766–767; Zimmer (n. 72).

243 Cf. Stolp et al. (n. 2), 6; Barbieri & Gassen (n. 74), 10.

244 Barbieri & Gassen (n. 74), 11; Wilsch (n. 206), 768; L. Griggs et al., 'Blockchains, Trust and Land Administration–the Return of Historical Provenance', 21 February 2019 (<https://ssrn.com/abstract=3325558>), 2, 17–19; Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ), *Blockchain: A World Without Middlemen?* (2019), Ch. 3, 41 (<https://www.giz.de/en/worldwide/67045.html>).

245 Peiró & García (n. 77), 306–310, 316; Arruñada (n. 232), 96; Zimmer (n. 72).

on the blockchain in a second.[246] In fact, it seems that hybrid solutions which essentially support the function of conventional intermediaries are already favoured in China[247] and Sweden[248] and might also be preferable in Africa, given that various African jurisdictions have adopted (paper-based) hybrid systems of deeds and title registration anyway.[249] In such a context, a private and permissioned blockchain[250] is probably the most promising way to go.[251]

Admittedly though, regardless of the model that is eventually chosen, it may be difficult to 'fix' the applicable status quo from which the system can start out. Owing to the obscurity of current title situations and the incompleteness of existing paperwork, African governments may have to consider some form of legal consolidation before registration can begin.[252] However, that issue is by no means idiosyncratic to the adoption of DLT in particular, but constitutes a recurring topic on developing nations' regulatory agenda.[253]

VI. Money Laundering, Terrorist Financing and (other) Cyber Crime

Without a doubt, the darkest side of DLT pertains to the criminal activities for which it can be misused. Due to the pseudonymity and cross-border nature of many blockchain applications,[254] the system is susceptible to activities such as money laundering,[255] terrorist financ-

246 For similar suggestions see Zimmer (n. 72); Peiró & García (n. 77), 318–320; Arruñada (n. 232), 105; Griggs et al. (n. 244), 14–16; GIZ (n. 244), 39–40, 42.

247 A. Zmudzinski, 'China's First Blockchain-Enabled Notary Opens Office in Beijing', *Cointelegraph*, 22 April 2019 (<https://cointelegraph.com/news/chinas-first-blockchain-enabled-notary-opens-office-in-beijing>).

248 Peiró & García (n. 77), 317. Regarding the Swedish project see already *supra*, section C.II.

249 See S.R. Simpson, *Land Law and Registration* (Cambridge University Press, 1976), 105, in respect of South Africa. More generally C.W. Dickerman et al., 'Security of Tenure and Land Registration in Africa', LTC Paper 137, 1989 (<https://core.ac.uk/download/pdf/6778934.pdf>), viii-xiii; Raff (n. 233), 9.

250 *Supra*, section B.II.

251 Peiró & García (n. 77), 311; Arruñada (n. 232), 96; J.M Graglia & C. Mellon, 'Blockchain and Property in 2018: At the End of the Beginning', 12(1–2) *Innovations* 90, 95 (2018). However, the Bitland project in Ghana (section C.II.) reportedly employs a public blockchain network; DLT & AI Taskforce (n. 232), 56.

252 Cf. Graglia & Mellon (n. 251), 96–97; Peiró & García (n. 77), 306–307 ('The primary application requires a high degree of evidence, in the old systems it was a purge of rights and in some jurisdictions is needed a judicial decision.'); M. Busstra, 'Human Rights' in UNOPS (ed.), *The Legal Aspects of Blockchain* (UNOPS, 2018), Ch. 4, 44 ('The chain cannot create land rights, only record them.'); Schmidt & Sandner (n. 5), 5.

253 See, for instance, Hanstad (n. 234), 666 (writing from the perspective of 1998).

254 *Supra*, sections B.II., C.I., and D.II. (in respect of cryptocurrencies in particular).

255 OECD (n. 10), 317–318; R. Houben & A. Snyers, *Cryptocurrencies and blockchain*, 5 July 2018 (<http://www.europarl.europa.eu/thinktank/en/search.html?word=houben>), 54; Trautman (n. 13), 468.

ing,[256] and various other (cyber) crimes, notably including tax evasion,[257] the illegal sale of drugs and weapons via trading platforms such as 'Silk Road',[258] the circumvention of economic sanctions,[259] or the execution of 'ransomware attacks'.[260] Whilst the focus of the debate is usually on cryptocurrencies, it seems that almost any DLT-based electronic asset can theoretically be deployed for illegitimate activities.[261] In Africa, cybercrime is particularly common in Nigeria, South Africa and Kenya, albeit concerns have also been raised in Namibia, Zimbabwe, and Algeria, among others.[262]

From a regulatory perspective, it is established that the fight against money laundering, terrorist financing, and other cross-border criminal activities should be coordinated on a broader international level, which is currently done by the OECD's Financial Action Task Force on Money Laundering (FATF).[263] In June 2019, the FATF updated its general (non-binding) recommendations and issued more specific guidelines with respect to 'virtual assets'.[264] The key objective is to pull cryptocurrencies and other virtual assets 'into the light', notably by targeting certain service providers acting as 'gatekeepers' for the use of cryptocurrencies.[265] In the EU, this approach is reflected by the 5th Anti-Money Laundering Directive ('AMLD5')[266] which qualifies undertakings engaged in exchange services between 'virtual' and Fiat currencies as well as certain 'wallet providers'[267] as 'obliged enti-

256 Houben & Snyers (n. 255), 53; FATF, *Emerging Terrorist Financing Risks*, October 2015 (<http://www.fatf-gafi.org/media/fatf/documents/reports/Emerging-Terrorist-Financing-Risks.pdf>), 36.

257 Barbieri & Gassen (n. 74), 8; Houben & Snyers (n. 255), 53, 70–72.

258 D. Adler, 'Silk Road: The Dark Side of Cryptocurrency', *Fordham J. Corp. & Fin. L.*, 21 February 2018 (<https://news.law.fordham.edu/jcfl/2018/02/21/silk-road-the-dark-side-of-cryptocurrency>).

259 See E. Erdbrink, 'How Bitcoin Could Help Iran Undermine U.S. Sanctions', *The New York Times*, 29 January 2019 (<https://www.nytimes.com/2019/01/29/world/middleeast/bitcoin-iran-sanctions.html>).

260 Trautman (n. 13), 468; D.R. Farringer, 'Send Us the Bitcoin or Patients Will Die: Addressing the Risks of Ransomware Attacks on Hospitals', 40 (2017) *Seattle U. L. Rev.* 937.

261 Cf. OECD (n. 10), 318; Trautman (n. 13), 468.

262 See Stolp et al. (n. 2), 6, 8, 9, 15, 18–19; Didenko (n. 15), 355. More generally N. Kshetri, 'Cybercrime and Cybersecurity in Africa', 22 *JGITM* 77–81 (<https://doi.org/10.1080/1097198X.2019.1603527>).

263 See <https://www.fatf-gafi.org>; M. Campbell-Verduyn, 'Bitcoin, Crypto-Coins, and Global Anti-Money Laundering Governance', 69 (2019) *Crime Law Soc. Change* 283, 292–293.

264 FATF, *International Standards on Combating Money Laundering and the Financing of Terrorism & Proliferation: The FATF Recommendations*, Update of June 2019; same, *Virtual Assets and Virtual Asset Service Providers*, June 2019 (both available at <https://www.fatf-gafi.org>).

265 *Ibid*. See also Campbell-Verduyn (n. 263), 292–300; C. Rueckert, 'Cryptocurrencies and fundamental rights', 5 (2019) *J. Cybersecur.* 1, 3 (<https://doi.org/10.1093/cybsec/tyz004>).

266 Directive (EU) 2018/843 of 30 May 2018, OJ No. L 156 of 19 June 2018, 43.

267 As to the function of wallets cf. *supra*, B.II. & C.I. In detail L. Haffke et al., 'Virtual Currencies and Anti-Money Laundering: The Shortcomings of the 5th AML Directive (EU) and How to Address Them', 15 April 2019 (<https://ssrn.com/abstract=3328064>), 5–6.

ties' for the purpose of regulation.[268] The latter must hence identify all customers via so-called KYC ('Know-Your-Customer') checks and report suspicious activities to the competent authorities.[269] By contrast, although the Directive arguably covers all types of cryptocurrencies as well as security and even utility tokens,[270] providers of exchange services between different types of crypto assets ('crypto-to-crypto exchanges') and financial service providers for ICOs are currently outside the scope of regulation.[271] A more intrusive framework seems to have been implemented in the US,[272] judging at least from the number of criminal convictions that have been reported in recent years.[273]

Against this backdrop, it seems that African nations must decide if they wish to follow the beaten track of FATF/EU-style regulation or if they prefer to take an alternative approach. So far, albeit few jurisdictions already possess a comprehensive legal framework in respect of cybercrime, many have successfully implemented a set of money laundering legislation[274] on which more DLT-specific regulation could build. Notwithstanding the occasional call for an outright ban of 'crypto assets',[275] it seems that the key importance of prudent KYC procedures–which could, by the way, be facilitated by smart contracts and DLT themselves[276]–is more and more coming to the fore.[277] Yet in comparison with the AMLD5, African lawmakers should probably consider a variety of deviations, most notably to include crypto-to-crypto exchanges and ICO service providers, too. Given the growing significance of these players,[278] it would otherwise be rather easy for a delinquent to stay under the radar of regulation.[279]

268 See art. 1(1)(c) AMLD5; ESMA (n. 189), 36; Houben & Snyers (n. 255), 53–72.

269 Arts. 10ff., 32ff. of Directive (EU) 2015/849 of 20 May 2015 ('AMLD4'), OJ L 141 of 5 June 2015, 73.

270 Houben & Snyers (n. 255), 73–76. But see also Haffke et al. (n. 267), 9–13, for a sceptical take in respect of security and utility tokens. Regarding the taxonomy *supra*, section C.V.

271 Haffke et al. (n. 267), 5, 14ff.; Houben & Snyers (n. 255), 74–79.

272 For an overview see FATF, *Virtual Assets and Virtual Asset Service Providers* (n. 264), 50–54.

273 See Campbell-Verduyn (n. 263), 290, considering the US to be 'most aggressive in prosecuting money laundering'. Regarding other jurisdictions see The Law Library of the Congress (n. 137), 1–2.

274 See <https://www.esaamlg.org>; N.S. Okogbule, 'Regulation of money laundering in Africa: the Nigerian and Zambian approaches', 10 (2007) *JOMLC* 449–463; T. Herman, 'Implications of Uganda's Anti-Money-Laundering Legal Regime on the Banking Sector', 2 (2016) *AML Journal of Africa* 15–22 (<https://ssrn.com/abstract=2887482>).

275 Cf. J. Bloomberg, 'We Need To Shut Bitcoin And All Other Cryptocurrencies Down. Here's Why.', *Forbes Magazine*, 10 March 2018.

276 Zetzsche, Buckley & Arner (n. 17), 5, 13; J. Parra-Moyano & O. Ross, 'KYC Optimization Using Distributed Ledger Technology', 8 August 2017 (<https://ssrn.com/abstract=2897788>); FinTechRat (n. 124), 11.

277 See, for instance, Stolp et al. (n. 2), 6 (regarding Kenya).

278 See the European Banking Authority, *Report with advice for the European Commission: on crypto assets*, 9 January 2019 (<https://eba.europa.eu/-/eba-reports-on-crypto-assets>), 20.

279 Cf. Houben & Snyers (n. 255), 77; ESMA (n. 182), 36 (both in respect of the EU legislation).

Beyond that, among the numerous alternative and/or supplementary strategies which are discussed by scholars and regulators,[280] two seem to stand out in particular. The first relates to a so-called 'blacklisting' of DLT transactions which were caused by illegal activities such as blackmail or money laundering, meaning that exchange platforms or cryptocurrency-friendly merchants are no longer allowed to accept a coin or token which can be traced back to such a transaction.[281] However, aside from the fact that this approach could be undermined rather easily by using 'tumblers' or 'Bitcoin mixers' which disguise the origin of an asset,[282] it seems that any blacklisting legislation would have to be implemented on a global, international scale if it were to be effective.[283] Others suggest an expansion of the regulatory perimeter to also include miners,[284] arguing that criminals were increasingly attracted to the mining business in particular.[285] Yet although this could theoretically be done on the basis of KYC-like 'know your miner' requirements, it seems that the latter would only be conceivable in a *permissioned* DLT ecosystem and hence amount to a piecemeal solution, at best.[286]

VII. Data Protection Law

An even less straightforward case is the relationship between DLT and the law of data protection. In recent years, many nations have adopted sophisticated data protection legislation to promote individual data sovereignty, i.e. to enhance natural persons' control over personal data and information.[287] In the EU, the General Data Protection Regulation 2018[288] (GDPR) introduced a set of substantive data protection rights and principles, notably to keep pace with technological developments in the age of globalisation.[289] For instance, any 'data controller' within the meaning of art. 4(7) GDPR must ensure that the personal data of a 'data subject' is always accurate and up to date, otherwise the latter may claim rectification under art. 16 GDPR. Also, there is a 'right to be forgotten' enshrined in art. 17

280 For an overview see Rueckert (n. 265), 3–4; S.T. Middlebrook & S.J. Hughes, 'Regulating cryptocurrencies in the United States: current issues and future directions', 40 (2014) *William Mitchell L. Rev.* 813–848 (<https://open.mitchellhamline.edu/wmlr/vol40/iss2/11>).

281 Rueckert (n. 265), 4; Spindler & Bille (n. 150), 1367–1368.

282 See Haffke et al. (n. 267), 6–7; R. van Wegberg, J.-J. Oerlemans & O. van Deventer, 'Bitcoin money laundering: mixed results?', 25 (2018) *J. Financ. Crime* 419, 425 (<https://doi.org/10.1108/JFC-11-2016-0067>).

283 This, however, is as yet difficult to conceive; see Rueckert (n. 265), 4.

284 As to the process of 'mining' cf. *supra*, section B.III.

285 See Bloomberg (n. 275); Houben & Snyers (n. 255), 77; Campbell-Verduyn (n. 263), 296.

286 For details see Houben & Snyers (n. 255), 77; Bloomberg (n. 275). As to the underlying taxonomy (permissioned vs. permissionless DLT solutions) already *supra*, B.II.

287 For an overview see Consumers International, 'The State of Data Protection Rules Around the World', May 2018 (<https://www.consumersinternational.org/media/155133/gdpr-briefing.pdf>).

288 Regulation (EU) 2016/679 of 27 April 2018, OJ No. L 119 of 4 May 2016, 1.

289 See, for instance, recitals 6–7 of the GDPR.

GDPR, stipulating that a data controller shall–under certain conditions–be obliged to erase a data subject's personal data without undue delay upon request.[290] Similar rights have been created in the US,[291] among others, but also in African countries such as Nigeria, Niger, South Africa, and Mauritania.[292] In fact, based on the African Union's Data Protection Convention of June 2014[293] and the ECOWAS Data Protection Act of 2010,[294] it seems that African awareness of data protection is consistently on the rise, with a reported total of 17 states having enacted comprehensive data protection legislation.[295]

That being said, DLT and data protection may collide in a variety of ways. To begin with, although it is widely accepted that DLT-stored information may well constitute 'personal data' for the purpose of data protection regulation,[296] it seems that the underlying statutes are typically designed for *centralized* data silos in particular, namely for information intermediaries such as Google, Amazon, or Facebook.[297] In the EU, there is hence considerable confusion about their application to distributed ledgers, starting with the very question of who, if anyone, might qualify as a 'data controller' under art. 4(7) GDPR. Whilst the latter may cause less of a headache in a private blockchain network governed by a bank or a government, it seems that there is no satisfying answer concerning public DLTs which are run by an unknown number of pseudonymous nodes.[298] In addition, DLT is at odds with a data subject's right to rectification and the right to be forgotten,[299] given that

290 For further details–also on other rights and principles under GDPR–see M. Finck, 'Blockchains and Data Protection in the European Union', 1 (2018) *EDPL* 17, 28ff. (<https://edpl.lexxion.eu/article/edpl/2018/1/6>).

291 See A. Gajda, 'Privacy, Press, and the Right to Be Forgotten in the United States', 93 (2018) *Wash. Law Rev.* 201; S.M. Boyne, 'Data Protection in the United States', 66 (2018) *Am. J. Comp. L.* 299.

292 See G. Greenleaf & B. Cottier, 'Data privacy laws and bills: Growth in Africa, GDPR influence', 152 (2018) *PL&B International* 11, 12; G. Greenleaf, 'Nigeria Regulates Data Privacy: African and Global Significance', 158 (2019) *PL&B International* 23ff.

293 Available at <https://au.int/en/treaties/african-union-convention-cyber-security-and-personal-data-protection>. See also L.A. Abdulrauf, 'The African Union's data protection Convention 2014: a possible cause for celebration of human rights in Africa?', 8 (2016) *J. Media Law* 67–97.

294 See <https://www.statewatch.org/news/2013/mar/ecowas-dp-act.pdf>).

295 See C. Rich, 'A Look at New Trends in 2017: Privacy Laws in Africa and the Near East', 16:6 (2016) *Bloomberg BNA World Data Protection Report* 1–13 (<https://media2.mofo.com/documents/170911-privacy-africa.pdf>); Deloitte, *Privacy is Paramount: Personal Data Protection in Africa*, 2017 (<https://www2.deloitte.com/za/en/pages/risk/articles/personal-data-protection-in-africa.html>), 3ff.

296 See Finck (n. 20), 92–99; same (n. 290), 22–23; Spindler & Bille (n. 150), 1368.

297 Cf. Finck (n. 20), 88; same (n. 290), 20, 32.

298 In detail Finck (n. 290), 26–27; same (n. 20), 99–102; Kuner et al., 'Blockchain versus data protection', 8 (2018) *Int. Data Priv. Law* 103, 104.

299 OECD (n. 10), 318; Finck (n. 290), 29–31; same (n. 20), 104–108; M. Martini & Q. Weinzierl, 'Die Blockchain-Technologie und das Recht auf Vergessenwerden', 36 (2017) *NVwZ* 1251, 1252ff.

data stored on a blockchain is conceptually irreversible.[300] All of this is particularly disturbing in the case of intimate or politically sensitive personal information, including medical or electoral data,[301] but has also raised concerns in the context of land registration,[302] among others.

However, although it has been submitted that DLT will in most–if not all–instances be incompatible with existing data protection legislation,[303] it seems that no issue is actually insurmountable. As regards the right to rectification and the right to be forgotten, it may be a solution to store protected personal data in a modifiable database off-chain and merely link it to the ledger through a so-called 'hash pointer'. On this basis, it may be possible to allow GDPR-induced data modification whilst the blockchain could still hold proof that the referenced data is authentic.[304] Beyond that, numerous alternatives are currently being tested, and research is still largely in a fledgling stage.[305] Yet in turn, regulators are also called upon to facilitate the reconciliation of data protection and DLT, e.g. by showing more flexibility in the application of legal principles.[306] Albeit data protection is undoubtedly a high-value policy objective, it would be misplaced to sacrifice technological progress at all costs for the sake of an overly formalistic regulatory approach.[307]

VIII. Personal Liability for 'Mistakes'

Finally, a topic that has received relatively little attention so far concerns the liability for 'mistakes', i.e. the private law responsibility for things gone wrong during a blockchain application. In spite of DLT's general resilience,[308] technical errors are not entirely impossible and have, in fact, already happened in the past. Most importantly, there is a record of hacking incidents that were facilitated by poorly maintained or deficient programme codes, including several attacks on cryptocurrency exchange platforms such as Mt. Gox, Bitstamp,

300 This is, in fact, the most salient feature of DLT; cf. *supra*, section B.I.

301 As to respective DLT use cases *supra*, section C.III.; further Zetzsche, Buckley & Arner (n. 17), 15; M. Pisa, 'Reassessing Expectations for Blockchain and Development', 12(1–2) *Innovations* 80, 85 (2018).

302 See Wilsch (n. 206), 778; Peiró & García (n. 77), 311; B. Makala & A. Anand, 'Blockchain and Land Administration' in UNOPS (ed.), *The Legal Aspects of Blockchain* (UNOPS, 2018), Ch. 9, 148.

303 Cf. Finck (n. 290), 17; E. Politou et al., 'Blockchain Mutability: Challenges and Proposed Solutions', 16 July 2019 (<https://arxiv.org/pdf/1907.07099.pdf>), 6.

304 See Politou et al. (n. 303), 6–7; Finck (n. 290), 23; same (n. 20), 105, 107.

305 For an overview see Politou et al. (n. 303), 6–10; Martini & Weinzierl (n. 299), 1255–1257.

306 Cf. Finck (n. 290), 18; same (n. 20), 110–115; Martini & Weinzierl (n. 299), 1257–1258.

307 Similarly Martini & Weinzierl (n. 299), 1258.

308 *Supra*, section B.I.

or Bitfinex.[309] Similarly, in the case of a crowdfunding entity called 'the DAO', a hacker channelled a substantial amount of cryptocurrency to a third-party controlled account after exploiting previously published vulnerabilities in the underlying code.[310] It has hence been commented that 'some blockchain applications can be as unhackable as the Titanic was unsinkable',[311] although it seems that the decisive factor is usually a lack of rather human diligence. Moreover, mistakes can occur during the process of data input and result in inaccurate data being added to the ledger, be it for a lack of caution or because an external attacker compromised the 'input link', e.g. a user's 'wallet' in the case of a cryptocurrency.[312] Besides, even if a proof-of-work protocol is chosen,[313] there is a theoretical risk of a so-called '51% attack', meaning that a single miner–or a group of collaborating miners–might capture an absolute majority of the network's computing power which could then be used to manipulate transactions.[314]

As a consequence, although DLT is probably still the safest way to ensure the authenticity of data,[315] lawmakers, courts, and legal scholars are called upon to determine the attribution of liability for losses caused–or enabled–by a relevant mistake. Whilst some authors posit that there is no such liability among DLT participants,[316] others have taken a more differentiated approach and considered liability under the law of contract, torts, and general partnership.[317] For instance, it has been suggested that a distributed ledger might be deemed a 'joint venture' between software developers, miners, and even ordinary participants, given that by operating the ledger they could pursue a 'joint objective' within the meaning of

309 Concisely Zetzsche, Buckley & Arner (n. 17), 7–8; further C. Decker & R. Wattenhofer, 'Bitcoin Transaction Malleability and MtGox' in M. Kutyłowski & J. Vaidya (eds.), *Computer Security–ESORICS 2014* (Springer International, 2014), 313–326; de Andres et al. (n. 171), 14–18.

310 Zetzsche, Buckley & Arner (n. 17), 8; OECD (n. 10), 315, 316; P. Paech, 'The Governance of Blockchain Financial Networks', 80 (2017) *MLR* 1073, 1087 (<https://dx.doi.org/10.1111/1468-2230.12303>).

311 Sulkowski (n. 99), 2; similarly OECD (n. 10), 315 ('no software is bug-free').

312 Zetzsche, Buckley & Arner (n. 17), 16–17; J. Umeh, 'Blockchain: Double Bubble or Double Trouble?', 58 (2016) *ITNow* 58, 61; OECD (n. 10), 311, 317. On the function of wallets cf. *supra*, sections B.II. & C.I.

313 *Supra*, section B.I.

314 OECD (n. 10), 311; Zetzsche, Buckley & Arner (n. 17), 16–18; S. Sayeed & H. Marco-Gisbert, 'Assessing Blockchain Consensus and Security Mechanisms against the 51% Attack', 9 (2019) *Appl. Sci.* 1788.

315 Zetzsche, Buckley & Arner (n. 17), 20.

316 See F. Glatz, 'Smart Contracts: Niemand haftet für Fehler im Code', *Wirtschaftswoche*, Issue 38 of 8 September 2017, 83.

317 Most notably, see the pioneering article of Zetzsche, Buckley & Arner (n. 17), 20–43; further P. Østbye, 'Who is Liable if a Public Cryptocurrency Protocol Fails?', July 2019 (<https://ssrn.com/abstract=3423681>), 12ff.

many jurisdictions' partnership laws.[318] Alternatively, the underlying network may constitute a more simplistic multi-party contract,[319] comparable perhaps to the so-called 'alliance contracts' that emerged in the European construction industry.[320] Besides, there is a broad consensus that DLT participants should at least be responsible under the law of torts, meaning that they should owe each other a (limited) duty of care in the performance of their functions. The latter could even be extended to include the interests of third parties, namely external counterparties and intermediaries which are affected by the system without directly relying on it.[321]

Unfortunately, none of these suggestions is entirely without problems. In respect of a contractual solution, be it on the basis of a partnership or a multi-party contract, the key question is probably whether DLT participants will possess the necessary *intention* to create legal relations, given that this is usually a prerequisite for the formation of a contract in many regions of the world.[322] Notwithstanding that there may well be contractual relations as a *by-product* of a DLT operation, e.g. if an ICO results in an investment contract between investor and investee,[323] such intention may be lacking if a person is merely participating as a developer or a miner. Especially if the ledger is permissionless and public,[324] it may be difficult to assume that every single user is prepared to enter into a legally binding contract with an unknown number of pseudonymous counterparts.[325] Moreover, in jurisdictions that are influenced by the common law, including Ghana, South Africa, or Nigeria,[326] it may be difficult to show that the parties provided a sufficient form of consideration, which is another prerequisite for the formation of a contract.[327] From a tort law perspective, such complications are, of course, immaterial; yet in this respect, it should be noted that the courts are

318 See Zetzsche, Buckley & Arner (n. 17), 28, 36; A. Garcia Rolo, 'Challenges in the legal qualification of Decentralised Autonomous Organisations (DAOs): the rise of crypto-partnership?', 1 (2019) *RDTec* 33, 62ff. (<https://ssrn.com/abstract=3417900>). As to the underlying taxonomy (civil law vs. common law) cf. K. Oumer, 'Key Differences between the Civil and the Common Law Legal Systems', 7 March 2018 (<https://ssrn.com/abstract=3129755>).

319 Zetzsche, Buckley & Arner (n. 17), 28, 29–33.

320 See J.R. Turner, 'Project Contract Management and a Theory of Organization', ERIM Report Series Reference No. ERS-2001–43-ORG, 20 February 2003 (<https://ssrn.com/abstract=370900>); B. Dauner-Lieb, 'Mehrparteienverträge für komplexe Bauvorhaben', 20 (2019) *NZBau* 339.

321 Zetzsche, Buckley & Arner (n. 17), 22, 33–35; cf. also Raskin (n. 39), 328; Østbye (n. 317), 14–15, 17.

322 G. Klass, 'Intent to Contract', 95 (2009) *Virginia L. Rev.* 1437; U.U. Uche, *Contractual Obligations in Ghana and Nigeria* (Routledge, 2013), Part II, Ch. 7; Schlund & Pongratz (n. 54), 600 ('*Rechtsbindungswille*').

323 *Supra*, section D.III.

324 *Supra*, section B.II.

325 Cf. Bayern (n. 151), 31–33; A. Wright & P. De Filippi, 'Decentralized Blockchain Technology and the Rise of Lex Cryptgraphia', 25 July 2017 (<https://ssrn.com/abstract=2580664>), 55.

326 See C. Ubezonu, 'Africa (Common Law Countries)', 28 (1994) *Int. Lawyer* 1105–1108.

327 Cf. Zetzsche, Buckley & Arner (n. 17), 30; further Uche (n. 322), Part II, Ch. 6.

usually restrictive in awarding damages for 'pure economic loss' unless the tortfeasor acted with intent.[328] As a consequence, unless courts decide to take a more extensive approach concerning DLT in particular,[329] it seems that a plaintiff who suffered a loss in Bitcoin or the like will only receive compensation if he or she demonstrates 'damages to property', which will depend on the respective currency's legal status under applicable private law.[330]

E. Conclusion and Outlook

At the time of finishing this article in July 2019, the city of Kampala in Uganda hosted a Blockchain Conference themed 'Africa 4.0: Preparing Africa for the Fourth Industrial Revolution'.[331] Indeed, given the disruptive potential of DLT and the blockchain technology in particular, African nations are well advised to explore the full spectrum of relevant use cases as well as the policy implications surrounding them. Aside from the most pressing legal issues that have been analysed above,[332] four aspects seem to stand out from a policymaker's perspective and will probably shape the regional discussion in the imminent future.

Firstly, a point that cannot be made strongly enough is that education is essential. DLT innovations require solid skills in information technology, digital applications, and programming to be economically viable.[333] Such expertise is not only needed in the private sector, i.e. among entrepreneurs and their respective workforce, but also among lawmakers and regulators. Governments might hence consider the establishment of dedicated working groups, round tables, and consultation platforms, following examples from the US, the EU, or the United Arab Emirates (UAE).[334] In this respect, African demographics may be regarded as an advantage, given that a large proportion of the continent's population is young and eager to learn and seems to have an overall pro-technological sentiment.[335]

Secondly, in order to promote the success of DLT, African nations must invest in the underlying infrastructure. Without reliable Internet connections and a stable supply of electricity, it may be difficult to ensure that DLT solutions actually reach the people and busi-

328 See C.M Sharkey, 'Tort Liability for Pure Economic Loss: A Perspective from the United States and Some Comparative European Insights', 7 (2016) *JETL* 237; J.P.B. De Mot, 'Pure Economic Loss', 26 September 2009 (<https://ssrn.com/abstract=1477270>); Zetzsche, Buckley & Arner (n. 17), 33–34.

329 For arguments in this direction see Zetzsche, Buckley & Arner (n. 17), 33–35.

330 On this issue cf. *supra*, D.II.; further Zetzsche, Buckley & Arner (n. 17), 33.

331 See <https://www.africanblockchain.org/about>.

332 *Supra*, section D.

333 DLT & AI Taskforce (n. 232), 37; FinTechRat (n. 124), 2–3, 16; Zambrano (n. 62), 9–10, 24, 46–47.

334 Cf. J. Berryhill et al., *Blockchains Unchained: Blockchain Technology and its Use in the Public Sector*, OECD Working Paper on Public Governance No. 28, 19 June 2018 (<https://dx.doi.org/10.1787/3c32c429-en>), 22–23 (US & EU), 36–37 (UAE); Didenko (n. 15), 346–349; Arner et al. (n. 174), 397ff. Most recently also the Kenyan DLT & AI Taskforce (n. 232), 37.

335 Didenko (n. 15), 351.

nesses who would benefit the most.[336] A preliminary solution could be to integrate the underlying networks with more established regional platforms that rely on simple mobile phone connections, such as the SMS-based payment system of M-Pesa.[337] Yet in the long run, more bespoke infrastructural facilities are probably indispensable, which would make excellent projects for institutions like the World Bank or the African Development Bank.[338]

Thirdly, the question of energy consumption remains a serious issue of many public blockchains in particular.[339] In this respect, additional research is essential to help develop more efficient and eco-friendly DLT solutions.[340] However, aside from the fact that more energy-saving private and permissioned DLTs may be preferable in many cases anyway,[341] it seems that the proliferation of renewable energies on the African continent[342] may offer a perspective for the sustainability of many DLT solutions in the future.[343]

Finally, lawmakers should be aware that just like any other technological innovation, DLTs are subject to rapid developments and technological progress.[344] It is hence conceivable that the blockchain technology as we know it today may already be outdated in a couple of years to come, which may also render potential first-generation DLT regulation (partially) obsolete. As far as possible, lawmakers should therefore set out legal requirements in a technology-neutral way, most notably to give future developers, businesses, and supervisory authorities the necessary leeway to react.[345]

336 Cf. Schmidt & Sandner (n. 5), 7; H. Adam, 'The Digital Revolution in Africa: Opportunities and Hurdles', 5 January 2019 (<https://ssrn.com/abstract=3307703>), 239, 246; Zambrano (n. 62), 5, 9, 46–47.

337 In respect of cryptocurrencies in particular cf. L. Coleman, 'Bitwala Enables Free Bitcoin Transfers to MPesa Accounts in Africa', 9 March 2017 (<https://www.ccn.com/bitwala-allows-users-to-send-bitcoin-free-to-mpesa-accounts>). For details on M-Pesa see S. Burns, 'Mobile Money and Financial Development: The Case of M-Pesa in Kenya', 10 November 2015 (<https://ssrn.com/abstract=2688585>).

338 De Senneville (n. 5); Schmidt & Sandner (n. 5), 19.

339 *Supra*, section B.III.

340 See, for instance, P. Jacquet & B. Mans, 'Green Mining: toward a less energetic impact of cryptocurrencies', 21 December 2018 (<https://arxiv.org/abs/1801.07814>); K. Matthews, '4 ways to counter blockchain's energy consumption pitfall', 18 April 2019 (<https://www.greenbiz.com/article/4-ways-counter-blockchains-energy-consumption-pitfall>).

341 E.g. *supra*, section D.V. regarding land registries; further Berryhill et al. (n. 334), 32–33; Politou et al. (n. 303), 3; FinTechRat (n. 124), 17.

342 *Supra*, section A.; in detail N. Cantore et al., 'Promoting Renewable Energy and Energy Efficiency in Africa: A Framework to Evaluate Employment Generation and Cost-Effectiveness', FEEM Working Paper No. 45, 2 March 2017 (<https://ssrn.com/abstract=2800976>); see also <https://www.irena.org/africa>.

343 Cf. Matthews (n. 340); critically A. de Vries, 'Renewable Energy Will Not Solve Bitcoin's Sustainability Problem', 3 (2019) *Joule* 893–898.

344 Zambrano (n. 62), 53–54; GIZ (n. 244), 42; C.M. Christensen et al., 'The Third Answer: How Market-Creating Innovation Drives Economic Growth and Development', 12(3–4) *Innovations* 10, 22 (2018).

345 Cf. FinTechRat (n. 124), 17.