THE SMARTS OF 'SMART CONTRACTS': RISK MANAGEMENT CAPABILITIES AND APPLICATIONS OF SELF-EXECUTING AGREEMENTS

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Smart contracts represent a form of contract automation with a considerable breadth of anticipated applications. These range from more tangible, traditional agreements such as supply contracts, many elements of which are readily automatable,[1] to more complex candidates in insurance and financial markets.[2] This article seeks to provide background for legal practitioners to understand the nature of smart contracts, the commercial case behind their applications, as well as the benefits and challenges associated with implementation. The article first canvasses the development of smart contracts, discussing the origins of the technology and the role of blockchain in its applications, illustrated practically through the AgriDigital trial. The article then seeks to frame the advantages associated with implementation by reference to risk management theory, given its potential benefits in pre-emptive risk identification and analysis. In light of the development of the Australian National Blockchain,[3] various potential smart contract applications are considered across sectors including in supply chain management, insurance contracts and financial markets. The risk management capabilities and legal implications associated with these discrete applications are then discussed, informing a broader consideration of the impact of smart contracts on legal practice.

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[1] Buwaneka Arachchi, 'Chains, Coins and Contract Law: The Validity and Enforceability of Smart Contracts' (2019) 47(1) Australian Business Law Review 40, 40; Michael Henke and Axel Schulte, 'Blockchain and Smart Contracting: Applications and Use Cases in Logistics and Supply Chain', (Lecture, *Fraunhofer,* 19 February 2019) <http://publica.fraunhofer.de/dokumente/N-541197.html>.

[2] Robert Boadle, 'Commercial and Finance Law: Financial Technology in the Securities Markets' (2016) 27(4) *Journal of Banking and Finance Law and Practice* 333, 335.

[3] The Australian National Blockchain is an industry-led project seeking to establish a platform enabling smart contract use in mainstream legal practice. Primary members of the consortium include IBM, CSIRO, Herbert Smith Freehills and King & Wood Mallesons.

I THE SMARTS OF 'SMART CONTRACTS'

A *Introduction to Smart Contracts*

Smart contracts are computer programs that embody the execution of a contractual agreement, enabling the automation of selected clauses such that the contract is able to 'self-execute'.[4] For lawyers, the basic premise of a smart contract may be considered as the automation of familiar contractual terms such as conditions precedent in accordance with an algorithm. Such clauses are directly referable to Boolean logic imbued in programming tools such as 'if statements' and are therefore illustrative of the intended self-executing function of smart contracts.[5] For example, a supply contract may determine that payment be made upon receipt of goods in accordance with a programming statement to the effect of 'if A, then do B'.[6] In this scenario the input, the goods delivered, is verified and the outcome, payment to the supplier, is automatically produced as a direct result.

This section will detail the development of smart contracts in the interests of informing preliminary discussion of the reasons underpinning implementation in mainstream legal practice as well as anticipated legal and regulatory implications. The themes canvassed in this chapter will subsequently serve as a foundation for the key focus of this article, being the risk management applications of smart contracts (Part II) and discussion of factors relevant to the selection of appropriate use cases (Part III).

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4 Paul Melican et al, 'The Law and the Legal Profession in the Next Decade: The Student's Perspective' (2016) 90(6) *Australian Law Journal* 434, 439.

5 Arachchi (n 1) 45. Boolean logic is logic determining the truth or otherwise of a statement in accordance with Boolean operators 'AND', 'OR' and 'NOT'.

6 Arachchi (n 1) 45. See also Rachel Lidgate and Charlie Morgan, 'Hashing Out the Implications of Smart Contracting Under English Law', *Herbert Smith Freehills* (Web Page, 2 October 2018) <https://www.herbertsmithfreehills.com/latest-thinking/hashing-out-the-implications-of-smart-contracting-under-english-law>. It is noted that industry-based materials of this type are relied on by the author in relation to practical matters where industry insight is key to understanding current views on smart contract applications, particularly where the matter in question has not been subject to significant academic consideration.

B *History and Development of Smart Contracts*

Whilst smart contracts are a relatively novel feature of Australia's mainstream legal landscape, their broader applications have developed over a period of approximately 25 years and originated as a creation of legal scholar, computer scientist and cryptographer Nick Szabo.[7] In 1994, Szabo coined the term 'smart contract' as 'a computerised transaction protocol that executes the terms of a contract.'[8] He conceived that the objectives of smart contracts were

> to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimize exceptions both malicious and accidental, and minimize the need for trusted intermediaries. Related economic goals include lowering fraud loss, arbitration and enforcement costs, and other transaction costs.[9]

Szabo's objectives are not simply abstract concepts but are clearly referable to the goals of commercial contracting parties today. It is this congruency that has driven the development of smart contracts in mainstream commercial and legal circles. The turn of the century saw smart contracts brought into popular use, notably through the development of Bitcoin in 2009,[10] although this has largely been restricted to the rise of independent platforms such as NXT and Ethereum.[11] To facilitate mainstream commercial use of smart contracts, attempts have been made in some countries to introduce national blockchain infrastructure.[12] Given these projects are largely still works in progress, it is unclear at this point the degree to which a national platform may succeed in developing widespread use of smart contracts in commercial legal services.

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7 Stuart Levi and Alex Lipton, 'Introduction to Smart Contracts and Their Potential and Inherent Limitations', *Harvard Law School Forum on Corporate Governance and Financial Regulation* (Forum Post, 26 May 2018) <https://corpgov.law.harvard.edu/2018/05/26/an-introduction-to-smart-contracts-and-their-potential-and-inherent-limitations/>.

8 Henke and Schulte (n 1); Lidgate and Morgan (n 6).

9 Henke and Schulte (n 1).

10 Modex, 'A Brief History of Blockchain, Smart Contracts and their Implementation', *Modex* (Web Page, 7 March 2018) <https://blog.modex.tech/a-brief-history-of-blockchain-smart-contracts-and-their-implementation-c3ac6f00f014>. Bitcoin facilitates execution of simple smart contracts.

11 Ibid.

12 Karen Andrews, 'Australia Takes the Lead in Blockchain Globally', *Ministers for the Department of Industry, Science and Technology* (Media Release, 9 April 2019) <https://www.minister.industry.gov.au/ministers/karenandrews/media-releases/australia-takes-lead-blockchain-globally>; See also Royal Canadian Mint, 'nanoPay Acquires MintChip (TM) from the Royal Canadian Mint' *Royal Canadian Mint* (Web Page, 12 January 2016) <https://www.mint.ca/store/news/nanopay-acquires-mintchiptm-from-the-royal-canadian-mint-26400032#.XbKVTS1L10s>.
MintChip was developed by the Royal Canadian Mint as a digital payment technology with low barriers to entry, specifically designed to comply with national regulatory standards including anti-money laundering and financial services legislation.

C *The Australian National Blockchain*

The infrastructure facilitating smart contract use is 'Distributed Ledger Technology', more commonly known as blockchain technology.[13] In simple terms, a blockchain is a decentralised register or database in which individual transactions form *blocks* that, once verified, are added together to create a sequential *chain*.[14] Smart contracts are the programs stored on a blockchain, executed in accordance with pre-determined rules to which the parties agree.[15] The Australian National Blockchain ('ANB') is a project currently undertaken by a consortium of industry members, including IBM, CSIRO, Herbert Smith Freehills and King & Wood Mallesons. The Law Council of Australia cites CSIRO in describing the ANB as

> a significant new piece of infrastructure in Australia's digital economy, enabling companies nationwide to join the network to use digitised contracts, exchange data and confirm the authenticity and status of legal contracts.[16]

The platform is unique in that it is publicly available with low barriers to entry and its design is intended specifically for Australian legal compliance.[17] This, in theory, enables a legal and regulatory framework to form organically around the platform, mitigating the need to rely on ad hoc law reform arising from disputes in independent smart contract transactions.

It is noted that ultimately, the ANB is a business venture with specific commercial and legal outcomes at its core. In this respect, design of the platform has stemmed from anticipated and desired use cases for both blockchain and smart contract technology, such that high-level consideration of legal implications and theoretical frameworks is not the central concern of

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[13] Balázs Bodô, Daniel Gervais and João Pedro Quintais, 'Blockchain and Smart Contracts: The Missing Link in Copyright Licensing?' (2018) 26(4) *International Journal of Law and Information Technology* 311, 314; Lidgate and Morgan (n 6).

[14] Robert Size, 'Taking Advantage of Advances in Technology to Enhance the Rule of Law' (2017) 91(7) *Australian Law Journal* 575, 581.

[15] Eliza Mik, 'Smart Contracts: Terminology, Technical Limitations and Real World Complexity' (2017) 9(2) *Law, Innovation and Technology* 269, 269-70.

[16] Law Council of Australia, 'Futures Summit' (Background Paper, Law Council of Australia, 13 September 2018) 33 <https://www.lawcouncil.asn.au/publicassets/401e7ec2-c104-e911-93fc-005056be13b5/Background%20Paper%20-%20Futures%20Summit.pdf>; Lidgate and Morgan (n 6).

[17] Mark Staples et al, 'Risks and Opportunities for Systems Using Blockchain and Smart Contracts' (Technical Report, CSIRO Data61, May 2017) <https://www.researchgate.net/profile/Sara-Falamaki/publication/320619389_Risks_and_opportunities_for_systems_using_blockchain_and_smart_contracts/links/59f145a6458515bfd07fbbc6/Risks-and-opportunities-for-systems-using-blockchain-and-smart-contracts.pdf>. The reality of the ANB's compliance with existing legal and regulatory frameworks is unconfirmed.

developers. Legal academic analysis of smart contracts in the context of the ANB will therefore naturally be reactive in nature, with much dependent on the final form of implementation.

D *Blockchain—Mere Puff?*

Doubts have been raised as to whether blockchain technology represents the most appropriate means of facilitating smart contracts in mainstream legal practice.[18] This reflects broader concerns for the blockchain 'hype cycle', which may mask deficiencies in the technology, or otherwise work against other more appropriate alternatives.[19] Despite security concerns,[20] there are a number of potential advantages of blockchain technology that render it appropriate as a tool for smart contract implementation. Data is stored and communicated between participating parties in a transparent manner.[21] The distributed ledger provides protection from loss through accident or malevolence, and the chain creates an immutable transaction record.[22] This imputes an element of traceability that assists with transparency and the identification of fraudulent activities, as was demonstrated in the Silk Road incident.[23] The inclusion of computer code in the data stored has also been considered 'ideal for implementing "smart" contracts'.[24] Further analysis of the suitability of blockchain technology is beyond the scope of this article; however, it is noted as a relevant consideration in the context of broader smart contract implementation.[25]

[18] In a 2018 submission to the Senate, the Digital Transformation Agency stated that 'for every use of blockchain you would consider today, there's a better technology'. See Finance and Public Administration Legislation Committee, Parliament of Australia, *Official Committee Hansard* (Parliamentary Transcript, 23 October 2018) 19 <https://parlinfo.aph.gov.au/parlInfo/download/committees/estimate/6cc84198-059e-4de7-95b6-c1479d5e2584/toc_pdf/Finance%20and%20Public%20Administration%20Legislation%20Committee_2018_10_23_6694_Official.pdf>.

[19] Arachchi (n 1) 40, 48.

[20] See Mike Orcutt, 'Once Hailed as Unhackable, Blockchains Are Now Getting Hacked', *MIT Technology Review* (Web Page, 19 February 2019) <https://www.technologyreview.com/2019/02/19/239592/once-hailed-as-unhackable-blockchains-are-now-getting-hacked/>. There are also various instances in which blockchain technology has facilitated illegal activities, for example the Silk Road scandal. See David Adler, 'Silk Road: The Dark Side of Cryptocurrency', *Fordham Journal of Corporate and Financial Law* (Blog Post, 21 February 2018) <https://news.law.fordham.edu/jcfl/2018/02/21/silk-road-the-dark-side-of-cryptocurrency/>.

[21] Thomson Reuters, Law Relating to Banker and Customer Update: Update Summary August 2019 (online, 16 August 2019) [4.3384].

[22] Ibid.

[23] Adler (n 20).

[24] Thomson Reuters (n 21).

[25] See David Gerard, 'The Australian National Blockchain: Centralised IBM "Smart Contracts" for Lawyers—With No Code Yet, Only Concept', *David Gerard* (Blog Post, 20 November 2018) <https://davidgerard.co.uk/blockchain/2018/11/20/the-australian-national-blockchain-centralised-ibm-smart-contracts-for-lawyers-with-no-code-yet-only-concept/>.

E *Why Smart Contracts?*

Szabo's conception of smart contract objectives is indicative of the potential benefits of the technology. Some of the key commercial attractions of smart contracts are their potential to:

- streamline the contracting process by facilitating collaboration in contractual negotiations and reducing oversight burdens during the execution phase of the contract;
- reduce transaction costs by mitigating reliance on intermediaries, for example in relation to execution of payment; and
- simplify enforcement procedures by obviating the need for litigation.[26]

In practical terms, smart contract technology is considered to bring gains in efficiency in the automation of commonplace contractual terms and processes, such as the calculation and payment of tariffs, duties and other payment terms.[27] Smart contracts also derive benefits from their basis on a blockchain platform, including 'the security, permanence and immutability that a blockchain offers'.[28]

Despite these benefits, many of which will only be realised in their entirety upon mainstream implementation, a number of challenges are posed to the legal industry by the advent of smart contracts. Some of these challenges are common to any form of technological disruption within the legal profession, the type of change that is 'often regarded as resulting in 'new, less trained people' but 'increasingly capable systems'.'[29] It has been considered that lawyers and legal education will be required to adapt to maximise the benefits of technologies such as smart contracts. Recommendations for up-skilling lawyers in this regard include familiarising them with simple smart contract technologies and basic coding.[30] This arguably requires education that is both independently driven and imbued in law school curricula.[31] Despite this, there is a general consensus that lawyers will not be required to be trained computer scientists understanding the ins-and-outs of blockchain technology, but rather will simply benefit from some form of interdisciplinary knowledge.[32]

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[26] Mik (n 15) 270.
[27] Finance and Public Administration Legislation Committee (n 18) 19.
[28] Levi and Lipton (n 7).
[29] Melican et al (n 4) 439.
[30] Ibid 440.
[31] Ibid 434.
[32] Lyria Moses and Anna Collyer, 'Technology and the Law' (2018) 92(8) *Australian Law Journal* 589, 590.

F *Legal and Regulatory Implications*

There are various legal and regulatory issues resulting from mainstream smart contract implementation that have been the subject of extensive academic consideration.[33] Whilst a thorough analysis of these issues is beyond the scope of this article, specific considerations will be discussed briefly here in the interests of informing the enquiry into selected use cases in Part III.

The legal implications of smart contracts, including their conformity with existing principles of contract formation, are likely dependent on the form of implementation.[34] There are two main practical models for smart contract design currently proposed in literature, each with its own challenges.[35] Firstly, the entire agreement may be represented wholly through code.[36] This creates issues for contracting parties with different levels of understanding of the coded language and is subject to limitations associated with programming languages, meaning this approach is largely only applicable to simple, highly deterministic agreements.[37] The second model, which is consistent with the current ANB approach, involves preserving the natural language contract alongside the smart contract,[38] with varying degrees of integration possible.[39] The most basic design would involve an agreement concluded wholly in writing, with certain limited functions such as payment automated through code.[40] More advanced methods of integration would include first producing the contract in natural language and translating as far as practical to code, or vice versa.[41] These designs introduce the risk of a mistake or mismatch between the agreement and executing code,[42] creating issues in contractual interpretation.

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[33] See, for example, Arachchi (n 1); Philippa Ryan, 'Smart Contracts Relations in e-Commerce: Legal Implications of Exchanges Conducted on the Blockchain' (2017) 7(1) *Technology Innovation Management Review* 10, 10; Alexander Savelyev, 'Contract Law 2.0: Smart Contracts as the Beginning of the End of Classic Contract Law' (Working Paper No 71, National Research University Higher School of Economics, 14 December 2016) <https://wp.hse.ru/data/2016/12/14/1111743800/71LAW2016.pdf>.
[34] See Ryan (n 33) 15; Arachchi (n 1) 45.
[35] Ibid.
[36] Arachchi (n 1) 46.
[37] Ibid.
[38] Ryan (n 33) 15; Lidgate and Morgan (n 6).
[39] Arachchi (n 1) 45–6.
[40] Ibid 45.
[41] Ibid 45–6.
[42] Ryan (n 33) 15.

Whilst many of the issues arising from these models may be resolved through trust protocols inherent to blockchain technology,[43] comprehensive consideration of existing contract law and regulatory responses will be required, either in anticipation of, or in response to, the implementation of the ANB. As stated, whilst there has been relatively extensive academic consideration on this subject internationally,[44] analysis will be limited in this article to those specific considerations arising from the discrete use cases discussed in Part III.

G *A Tangible Example—Supply Chain Tracking*

The technicalities associated with smart contracts are perhaps best understood by reference to one of the oft-cited use cases for the technology, supply contracts. Industry members have acknowledged the use of blockchain technology in supply chain tracking.[45] Conceptually, in this application the smart contract operates as the epicentre of a 'blockchain-based supply chain network', in which information is passed between the platform, contracting parties, financial institutions, payment and delivery services in the 'financial flow' and 'material flow' phases of supply.[46] The use of smart contract technology streamlines phases of the contract by integrating the various parties to the supply chain through the central blockchain platform, which acts as the 'brain' of the supply chain.[47] Through smart contract design, supply chain events such as payment conditional upon delivery may be automated.[48]

A trial run by Sydney-based company AgriDigital on a food supply chain has been cited by CSIRO as a demonstration of the applicability of smart contract technology.[49] The trial involved delivery of grain from a grower to a buyer in accordance with the governing contract between the parties, executed by the smart contract operating from AgriDigital as the central server. The trial begins with the grain being loaded onto a truck and transported to the buyer's site. When arriving at the site, the truck passes a weighbridge and sampling station. The weighbridge records the gross weight of the truck, including the grain, whilst the sampling station selects a sample of grain that is subsequently processed in an adjacent lab for quality assessment.

[43] Ibid 16.
[44] See above n 33.
[45] Law Council of Australia (n 16) 33; Lidgate and Morgan (n 6).
[46] Henke and Schulte (n 1).
[47] Staples (n 17) 11.
[48] Ibid.
[49] Ibid 19.

Quality is determined with reference to industry standards and is used to define price per ton of this particular batch of grain. Together with gross weight, an upper bound of the price can be calculated, that being the total price of the grain delivery in the event that the buyer purchases the entire shipment carried by the truck. This dataset of gross weight, quality and price is then sent to the central server, AgriDigital, which creates a blockchain transaction containing the data. The 'transaction' is supplied with the respective amount of digital currency ('AgriCoin', for the purpose of this trial) to cover the upper-bound price. That is, the smart contract account is credited with digital currency reflective of the buyer's obligation to pay automatically upon satisfaction of conditions precedent, namely delivery of the grain. The amount acts as escrow pending completion of the transaction. This phase of the transaction utilises a programming function of the smart contract that confirms the price calculation, verifies there is sufficient digital currency to cover the transaction and stores the values in local storage.

It is at this point that physical execution of the agreement between grower and buyer occurs by way of delivery. The truck unloads the agreed quantity of grain at the buyer's site. Upon leaving the buyer's site, the truck passes a second weighbridge, where the weight of the empty truck, the 'tare weight', is recorded. Once again, this data is transmitted to AgriDigital and another blockchain transaction is created. At this point, a smart contract function calculates net weight, being gross weight less tare weight. The price for the delivered grain is then recalculated as net weight multiplied by price per ton and a title for this quantity of grain is created that represents ownership of the grain. As delivery has occurred, confirmed by data sent from the second weighbridge, the final price is transferred to the grower and grain title is transferred to the buyer. Associated levies and royalties are automatically deducted and the ownership of AgriCoin and grain title is updated by the time the truck leaves the buyer's site.[50]

Post-trial, CSIRO stated:

> The main goal of the trial was to show that the truck's appearance on the weighbridges triggered all system interactions, which was achieved. Steps that are yet to be automated are: (i) establishing that the weighbridges fulfill the conditions (having been inspected by authorities within the past 12 months and not recalibrated), and (ii) automated generation of the quality assessment message, which is currently entered manually by a technician in the sampling station's lab.[51]

[50] Ibid. For traditional settlement systems, bank messages for payment and a receipt for the grain title are generated.
[51] Ibid.

The trial is indicative not only of the potential applications of smart contract technology, but of the immediacy with which it may begin to impact commercial legal practice. Smart contracts have developed in the context of business ventures designed with specific commercial outcomes in mind, such that the law and, in turn, members of the legal profession will be required to adapt.[52]

II RISK MANAGEMENT THEORY AND APPLICATIONS

Contracts are inherently risk management devices designed to apportion risk and responsibilities between parties. Their implementation generally has the effect, intended or otherwise, of transferring or reducing risks arising in the course of a transaction in the interests of commercial efficiency. Smart contracts in particular have developed as a means of optimising execution of common commercial agreements. In this respect, many of the intended applications of the technology involve the automation of common contractual terms, such as payment and enforcement, so as to minimise transaction costs and mitigate risks associated with non-compliance.[53] It is therefore pertinent to consider the specific risk management capabilities of smart contracts derived from the automation of these terms as a significant benefit of smart contract implementation.

A *Risk Management Theory*

Risk management may be defined as 'the process of identifying and understanding a risk and determining an appropriate methodology regarding the treatment of that risk to minimise or eliminate that risk.'[54] Literature describes this as a process of determining objectives, identifying risk, and evaluating and considering 'risk treatment devices', culminating in implementation and review.[55]

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[52] Lord Thomas, 'Law Reform Now In 21st Century Britain: Brexit and Beyond' (Speech, Sixth Scarman Lecture, 26 June 2017) [39]. John Thomas, Lord Chief Justice for England and Wales, presented the view that in a changing digital economy 'legislative change will be needed to deal with new forms of contract such as the Blockchain and smart contracts'.

[53] Lidgate and Morgan (n 6).

[54] Christopher Kerin, 'Risky Business: Risk Management Cruises Into the 21st Century' (2008) 24(2) *Building and Construction Law Journal* 94, 94.

[55] Ignacio Cienfuegos Spikin, 'Risk Management Theory: The Integrated Perspective and its Application In the Public Sector' [2013] (21) *Estado, Gobierno y Gestión Pública* 89, 104.

Modern risk management theory is concerned with two broad approaches to risk: risk control and risk financing.[56] Risk control involves minimising the risk of losses through techniques such as avoidance and reduction.[57] Risk financing concerns ensuring availability of funds to meet losses arising from risks that remain after risk control techniques are implemented, through either retention or transfer of that risk.[58] These are two concepts of particular relevance to contracts generally, as well as the automation of terms via smart contract programming. Risk transfer is inherent to common contractual clauses involving allocation of liability and the subsequent distribution of losses. Risk reduction is comprised of those techniques that reduce the likelihood of loss occurring (loss prevention) or the potential severity of those losses (loss control),[59] both of which are arguably facilitated by the automation of key contractual terms such as payment and certification pursuant to a smart contract.

1 *Classification of Risk Types*

The types of risk considered in this article may be classified as commercial risks, including both financial and economic risks.[60] Of these sub-categories, financial risks include loan risk, asset-backed risk, credit risk, foreign-investment risk, liquidity risk, market risk and operational risk.[61] Economic risks include interest-rate risk, inflation risk and exchange-rate risk.[62] It is noted that the model for modern risk management theory will largely be taken as a settled basis for the core discussion of smart contracts as risk management devices.[63]

B *Risk Management Capabilities of Smart Contracts*

The risk management mechanisms facilitated by smart contracts is an area of interest that has, to date, been considered only in isolated use cases. Nonetheless, it is an aspect of implementation from which commercial parties would appear to derive particular benefits due to the pre-emptive

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[56] Emmett J Vaughan and Therese M Vaughan, *Fundamentals of Risk and Insurance* (John Wiley & Sons Inc, 2013) 17.
[57] Ibid.
[58] Ibid.
[59] Ibid 18.
[60] Judit Oláh et al, 'Analysis and Comparison of Economic and Financial Risk Sources in SMEs of the Visegrad Group and Serbia' (2019) 11(7) *Sustainability* 1, 3.
[61] Ibid.
[62] Ibid.
[63] See above n 56 and accompanying text. See also Vaughan and Vaughan (n 56) 15 for discussion of modern risk management theory as the merging of the disciplines of decision theory, risk financing and risk control.

qualities of the technology, as well as its basis on a blockchain platform with the associated trust protocols.[64] The absence of comprehensive academic literature on this topic means that discussion of the seemingly congruous application of risk management theory to smart contracts will largely be novel. These risk management benefits may be considered on a microeconomic or transactional level, as well as on a broader operational level.

1 *Transaction-specific Risk Management*

In theory, the automation via smart contracts of common contractual processes carries significant benefits in the management of various risk types. On a transaction-specific level, contract risk (being, collectively, those risks arising from entry into a contractual agreement, including liability and default risk) would appear to be mitigated through the pre-emptive nature of smart contracts, which may be automated to monitor and enforce contract performance, facilitating the early identification of risk.[65] The trust protocols that characterise blockchain also aid in mitigating contract and counterparty risk.[66] It is these qualities that align smart contract implementation with risk control techniques in modern risk management theory, namely risk reduction concerned with loss prevention and control.[67]

This is perhaps best understood practically with reference to the supply chain trial discussed in Part I. In this example, two aspects key to the self-executing nature of the agreement are: firstly, verification of delivery as a condition precedent for payment; and, secondly, automation of payment itself.[68] Automated verification of delivery reduces oversight burdens and mitigates operational and other transaction-specific risks associated with agreements where payment is dependent on factors such as quality and timing of delivered goods. This also enables early identification of risk, facilitating pre-emptive risk management action. Automation of payment contingent on verification of delivery produces more obvious risk management qualities in the reduction of contract or default risk. This is facilitated by the smart contract, which acts as a deposit account in which nominal digital currency is held to cover potential transaction costs.[69]

[64] Ryan (n 33) 16.
[65] Florian Idelberger et al, 'Evaluation of Logic-Based Smart Contracts for Blockchain Systems' (Conference Paper, Rule ML International Symposium, 6 July 2016) 167; Vaughan and Vaughan (n 56) 7–8.
[66] See below n 89 and accompanying text.
[67] Vaughan and Vaughan (n 56) 18.
[68] Staples (n 17) 19.
[69] Ibid.

The risk management capabilities of smart contracts have also been recognised in relation to more complex commercial agreements, for example in securities trading. By automating payment terms, clearing and settlement may become near-instantaneous, eliminating a number of transactional risks including systemic and counterparty or default risk.[70] The degree to which this holds true is contingent on qualities of the blockchain such as its supposed 'trustlessness'.[71] The ability of procedures to self-execute with minimal external input creates a 'trustless' environment, in which the storage of smart contracts on the blockchain mitigates the need for trust between parties or use of a trusted third-party. Instead, trust is placed in the technology.[72] This leads to an interesting change in the risk-apportionment dynamics between parties and may reduce counterparty risk given the blockchain's role in both 'creat[ing] and confirm[ing]…[the] state of affairs' surrounding the transaction, independent of either party or any intermediary.[73]

2 *Operation-level Risk Management*

Broader risk management benefits of smart contracts have also been recognised in the reduction of operational risks.[74] This is particularly evident in the manner in which smart contracts 'self-regulate' in monitoring performance, reducing oversight burdens for firms with large-scale operations involving many similar transactions, or multiple instances of the same transaction.[75]

Blockchain technology itself has also been considered to introduce a form of institutional risk management in areas such as copyright law that benefit from the creation of centralised registers.[76] With reference to risk management theory, risk reduction and transfer, identified above as two of the main tools in the arsenal of risk management techniques, are arguably facilitated by the blockchain.[77] Loss prevention, as one of the two tenants of risk reduction, would appear to be a key benefit of the platform's trust protocols, with certification processes lending themselves to reducing the number of cases in which loss, or default, occurs.[78] Whilst the precise

[70] Boadle (n 2) 335.
[71] Mik (n 15) 275–6.
[72] Ibid 276.
[73] Ibid 275.
[74] Idelberger (n 65) 169.
[75] Ibid.
[76] Annabel Tresise, Jake Goldenfein and Dan Hunter, 'What Blockchain Can and Can't Do for Copyright' (2018) 28(4) *Australian Intellectual Property Journal* 144, 156.
[77] Vaughan and Vaughan (n 56) 18.
[78] See below n 89 and accompanying text. See also nn 158–60 and accompanying text for an example in the context of financial markets.

manner in which the ANB will operate upon inception is unclear, the suggestion in the AgriDigital trial that digital currency be held in the smart contract account to cover potential transaction costs may also operate as either:

(1) a risk reduction mechanism, enabling control of losses; or
(2) a risk transfer mechanism, with the third-party holding the funds under an escrow arrangement bearing legal responsibility for overseeing payment.[79]

Ultimately, the use of a trusted third-party (the blockchain) to operate the smart contract account and facilitate payment reduces risk of fraud and default risk. Whilst it may be said that the benefits derived from this are minimal given the improbability of default in any one transaction, the true value may be realised on an operational level in which, across a pool of many transactions, the risk of default is very real.

More specific risk management benefits become apparent when considering particular use cases for smart contract technology, as discussed in Part III.

C *Smart Contracts—A Risky Business?*

Smart contracts have also been considered to create risk in some sectors. The need for insurance to protect contracting parties from risks inherent to the technology, such as smart contracts failing to perform terms as agreed, is a relevant concern.[80] Risk allocation mechanisms have also been recommended to deal with risks of corruption or cyber-attack due to the digital platform on which smart contracts operate.[81] Whilst these risks are by no means insignificant, they are arguably inherent in any major technological advancement and the emergence of industries such as cyber insurance offers a means of addressing risk allocation concerns for contracts reliant on technology for their operation.

D *The Role of Risk Management in the Development of Smart Contracts*

Risk management theory provides a conceptual framework with which to analyse the potential benefits of smart contracts. The risk management capabilities of the technology appear clear in

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[79] Tresise, Goldenfein and Hunter (n 76) 146.
[80] Levi and Lipton (n 7).
[81] Ibid.

theory, however will likely only be elucidated upon implementation in mainstream commercial practice. On a microeconomic level, transaction-specific risk management benefits are derived from the pre-emptive qualities of smart contracts and the automation of key contractual processes, as well as from their basis on the blockchain. These benefits, whilst seemingly minute and situation-specific, may be extrapolated to the operation of large firms engaging in many instances of transactions of a similar nature, providing operational benefits of far greater import.

III USE CASES

A *Identification of Use Cases*

Smart contract technology and associated literature have developed within a framework of anticipated use cases, many of which share common characteristics. Identifying the indicia of appropriate use cases may play an important role in smart contract development. This is particularly so given the view that the primary question associated with implementation is not what obligations *can* be expressed in code, but rather what obligations *should* be expressed in code.[82] In the absence of authoritative commentary on this point, the following are proposed as basic unifying features of anticipated use cases:

(1) the ease with which automation of processes associated with key obligations can be achieved; and
(2) the value of the commercial outcomes produced by automation of these processes.

1 *Ease of Automation*

The ease with which self-execution of key contractual processes may be achieved is a technical question more appropriate for discussion in the context of smart contract coding practices. For the purpose of this article, basic conceptions of smart contract automation may be considered as a process of simple logic executed through code that says 'if A, then do B'.[83] From a commercial perspective, such logic is comparable to agreements based on conditions precedent, rendering smart contracts applicable to a number of simple transactions including betting and online shopping.

[82] Mik (n 15) 289.
[83] Arachchi (n 1) 45; Lidgate and Morgan (n 6).

2 *Commercial Value*

Smart contract development has been driven by the potential value of commercial outcomes produced, both in terms of economic efficiency and the facilitation of collaborative legal practice. Literature on the subject goes beyond more basic applications of the technology to consider aspects of mainstream legal and commercial operations that derive value from both automation and information-sharing. Perhaps the most illustrative of these applications is in relation to supply contracts, discussed in Part I. Other oft-cited use cases include intellectual property licensing,[84] financial trading,[85] leasing (facilitating automated payments, for example rent and return of bonds),[86] real-estate title registration and identity verification.[87] Commonality across identified use cases is clear in that many involve data control, authentication procedures or title transfer—areas benefiting from increased transparency and security.[88] These concepts are referable to the trust mechanisms inherent in blockchain protocols and properties such as asymmetric encryption, with the reliability of cryptographic signatures as a secure form of identification able to resolve issues of integrity and authority in transacting.[89]

This Part will canvass the benefits and complexities of smart contract implementation with reference to three discrete use cases: supply contracts, insurance contracts and financial markets. Risk management theory will be drawn on as a framework for assessing purported benefits, whilst legal and practical issues common across applications will be identified with reference to theory discussed in previous sections.

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[84] Tresise, Goldenfein and Hunter (n 76) 146, 151.
[85] Boadle (n 2) 333; Lidgate and Morgan (n 6).
[86] Size (n 14) 580–1.
[87] Lidgate and Morgan (n 6).
[88] Ibid.
[89] See Arachchi (n 1) 44; Benjamin Geva, 'Disintermediating Electronic Payments: Digital Cash and Virtual Currencies' (2016) 31(12) *Journal of International Banking Law and Regulation* 1, 11. Blockchain platforms such as Bitcoin and Ethereum operate using a method of asymmetric encryption whereby participants are assigned a pair of keys: one private, which is to be kept confidential; and one public, which is derived from the private key. The relationship between the two keys is mathematically infeasible to determine. Using modular arithmetic, large prime numbers are able to be produced quite simply, however the process of reversing the modular operation to find the original prime number, known in mathematics as the "discrete logarithm problem", relies on trial and error, rendering decryption mathematically infeasible.

B *Supply Contracts*

As referenced in Part I, supply contracts have been recognised by industry members, including the ANB consortium, as a candidate for smart contract application, particularly in large-scale supply chain tracking.[90] This is due to the capacity for blockchain technology to integrate contracting parties, financial institutions, payment and delivery service providers—a potential source of commercial value that has rendered supply chain tracking the flagship use case for proponents of the ANB.[91] Further benefits are derived from the automation of supply chain events such as payment conditional upon delivery so as to streamline phases of execution.[92] The AgriDigital trial discussed in Part I illustrates the reality of these benefits. In particular, efficiencies would appear to be derived from the facilitation of information flow confirming delivery (as a condition precedent for payment), the automation of quality assessment (which in turn determines price) and self-execution of payment.[93] These mechanisms, enabled by the smart contract operating at the heart of the transaction, provide clear commercial and economic benefits, reducing oversight burdens and providing for verification procedures that create certainty between the relevant stakeholders.[94]

Some challenges are also presented by the implementation of smart contract supply chains, including the integration of on-ledger and off-ledger activities, which is an issue inherent to applications involving physical transactions such as the supply of goods. This requires that information such as acknowledgement of delivery be conducted via a data feed trusted by all stakeholders,[95] a common issue in smart contract implementation given the purpose of minimising intermediary involvement in transactions.

1 *Risk Management Applications*

The application of smart contracts to supply chain tracking demonstrates the risk management capabilities of the technology, as considered briefly in Part II.[96] Namely, there would appear to be significant scope for smart contracts to facilitate risk control in the supply chain. The automatic

[90] Law Council of Australia (n 16) 33; Lidgate and Morgan (n 6).
[91] Henke and Schulte (n 1); Staples (n 17) 11.
[92] Staples (n 17) 11.
[93] Ibid.
[94] Arachchi (n 1) 40.
[95] Ibid 44-45.
[96] See above Part II(A)–(B).

verification of performance and payment upon satisfaction of conditions precedent reduces risk of default. As discussed in Part II, the mechanism whereby digital currency is held in the smart contract account by a trusted third-party under an escrow arrangement may also operate as a means of risk reduction or transfer.[97] The benefits of these mechanisms would be magnified for parties conducting many similar transactions, or multiple instances of the same transaction, given the realisation of default risk across a pool of many transactions.[98]

2 *Legal Implications*

The legal implications associated with supply contract applications are mainly concerned with issues of contractual interpretation. The use case raises issues in determining compliance with terms of the contract. On the one hand, the verification mechanisms involved may provide certainty as to the timing and nature of performance. However, the inherent dichotomy between off-ledger (or 'physical') and on-ledger performance may create inconsistencies between the actual and recorded status of execution.[99] The issues this causes will largely be transaction-specific and may be mitigated by, where possible, minimising time-lapses between the physical event and entry on to the ledger.

3 *An Illustration of Insolvency*

An area in which smart contract implementation may carry far-reaching consequences across applications is in insolvency law. This may be illustrated with reference to the AgriDigital supply chain trial outlined in Part I. In theory, the escrow arrangement between the contracting parties and third-party service provider (the blockchain) may provide for greater protection concerning execution of payment, as the third-party would presumably assume legal responsibility for payment delivery.[100] This arrangement may, however, also have the effect of altering priorities in the event of insolvency of the transferor. It is feasible that the transfer of digital currency to the smart contract account signalling the obligation of future payment upon satisfaction of conditions precedent may be construed as a form of security over the amount owed in favour of the transferee. To demonstrate the consequences under such a construction, consider circumstances

[97] See above n 79 and accompanying text.
[98] See above Part II(B)(1)–(2).
[99] Arachchi (n 1) 44–5.
[100] Tresise, Goldenfein and Hunter (n 76) 146.

in which the relevant transaction is an insolvent transaction, in the sense that it either causes insolvency or is entered into during insolvency.[101] Such a transaction may then be voidable if occurring within the relation back period,[102] in which case a creditor's claim is contingent on their priority status. In this respect, with unsecured creditors disadvantaged in the prioritising of debts,[103] the consequences for creditors under a smart contract of considering the digital currency held by the smart contract account as a form of security are significant and carry the potential to alter priorities.

4 *Conclusions*

It is evident that smart contracts create new legal challenges in relation to supply chain applications, whilst also mitigating legal risks arising from various phases of execution.[104] There is widespread recognition in both academic and industry circles that the application of smart contract technology to supply contracts carries significant benefits in both economic and commercial terms.[105] As a result, the law and regulation alike will likely be required to react to implementation in mainstream practice, leaving it open to speculation in the short term as to the nature of these responses.

C *Insurance Industry Applications—Claims Processing and Policy Adjustment*

Given the particular benefits derived from the application of smart contracts to operations involving a large number of small transactions with similar characteristics, or alternatively multiple instances of the same transaction,[106] it is perhaps predictable that the technology has drawn attention in the field of insurance. Referring to factors common to current identified use cases, including ease of automation and commercial value derived from the application, the readily automatable nature of simple insurance policies renders the application of smart contracts highly appropriate.[107] On commercial value, smart contracts, in theory, enable optimisation of insurance

[101] *Corporations Act 2001* (Cth) ss 588FA–588FC.
[102] Ibid s 588FE.
[103] See ibid ss 554E, 556.
[104] Staples (n 17) 11.
[105] Ibid; Henke and Schulte (n 1); Mik (n 15) 277–8.
[106] See above Part II(B)(2).
[107] For example, motor vehicle insurance. See Angelo Borselli, 'Smart Contracts in Insurance. A Law and Futorology Perspective' (2019) *Social Science Research Network* 3318883:1-44, 7.

processes, reducing administration costs and improving customer experience, a point discussed further below.[108]

1 *Industry Recognition—Benefits and Challenges*

Industry members have recognised the application of smart contracts in automating claims payment processes and policy adjustments.[109] An example of automated claims processing has been considered in relation to motor-vehicle insurance policies, the most basic conception of which would have the amount due under the policy automatically credited to the policyholder's account in the event of an insured loss.[110] Administering these processes through blockchain technology creates the possibility for integrating policies directly with other developing innovations, such as those dubbed 'InsurTech', including applications designed to analyse car damage in real time.[111]

Factors rendering smart contracts readily applicable to the insurance industry include:

(a) the clear parameters as to payment;
(b) the relatively low potential for disputes arising due to the low-cost nature of coverage involved; and
(c) the general simplicity of claims and policy adjustment processes under the majority of policies.[112]

The commercial value derived from the application is also potentially significant. The economic efficiencies produced by automating simple consumer policies, which form the bulk of insurance written, may result in lower costs to both the insurer and the insured.[113] This would be realised in reduced administration costs due to the self-execution of basic processes such as automated policy adjustments based on pre-determined events.[114] Importantly, given the majority of

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[108] Norton Rose Fulbright, 'The Future of Smart Contracts in Insurance', *Norton Rose Fulbright* (Web Page, September 2016) <https://www.nortonrosefulbright.com/en-au/knowledge/publications/88244592/the-future-of-smart-contracts-in-insurance>.
[109] Ibid.
[110] Borselli (n 107) 7.
[111] Ibid; PwC, 'Opportunities Await: How InsurTech is Reshaping Insurance' *PwC* (Report, June 2016) <https://www.pwc.com/gx/en/financial-services/assets/fintech-insurance-report.pdf>.
[112] Norton Rose Fulbright (n 108).
[113] Ibid.
[114] Ibid.

insurance operates on the consumer level, the potential for smart contract use to improve customer experience and interaction with the insurance product is another purported benefit.[115]

A challenge common to general smart contract implementation is the difficulty in representing the nuance of contractual drafting in code. An example in the field of insurance is seen in provisions based on the principle of 'good faith', such as the right of the insurer to avoid the contract in the event that the policyholder has acted fraudulently in 'overinsuring' the subject property.[116] Nuances of insurance contracts such as disclosure obligations, which are often conditions precedent for payment under the policy, as well as the unpredictability of underwriting decisions and regulatory factors that affect the policy, create complexity in automating the agreement from the outset.[117] In this respect, it would be expected that a hybrid structure between coded and natural language contract be adopted so as to enable the flexibility afforded by natural language expression.[118] A practical issue also arises in that overcoming these complexities will require significant investment by industry members.[119] As noted above, the repetitive nature of the bulk of transactions at the consumer level and the potential value gained in expediting these processes may attract the required expenditure.

Initial anticipated uses are primarily concerned with short-term risks,[120] including property catastrophe risks and applications in cargo, contingency, aviation or agriculture insurance.[121] This is largely due to the simplicity of the transactions involved and the benefits gained from improved information flow as a result of integrating parties through the blockchain platform.[122] These benefits appear particularly clear in the case of individual policyholders. The implementation of 'smart' processes may relieve the disclosure burden for the insured, as well as the reliance by the insurance company on the insured for information in this respect.[123] An example currently contemplated by Lloyd's is 'smart flood insurance'. In this example, a tamper-proof flood sensor integrated into the blockchain ecosystem would expedite claims processes by reducing the

[115] Ibid.
[116] Borselli (n 107) 20.
[117] Norton Rose Fulbright (n 108).
[118] See above nn 34–42 and accompanying text.
[119] Norton Rose Fulbright (n 108).
[120] Ibid.
[121] Lloyd's, 'Triggering Innovation: How Smart Contracts Bring Policies to Life' (Emerging Risks Report, 2019) 7.
[122] Ibid 18.
[123] Ibid.

amount of information required from the insured in the event of a claim, whilst also facilitating calculation of more accurate premiums.[124]

Smart contracts also have anticipated applications in transactions involving insurance-linked securities. A trial run by Allianz in 2016 tested blockchain-based smart contracts in a mock natural catastrophe swap transaction.[125] The trial reportedly demonstrated the acceleration in processing and settlement of payments, which is of particular importance in markets for cat bonds and swaps given the volatile nature of the underlying risks.[126] These types of benefits would appear to represent a source of commercial value that would be magnified by the industry-wide application of smart contracts given the uniform nature of the transactions involved.

2 *Risk Management*

Smart contracts hold significant potential in meeting the risk management goals of both insurers and the insured. In general terms, Lloyd's has recognized the ability of smart contracts to facilitate transactions that might otherwise be prohibitively costly by mitigating default risk.[127] Further benefits include the mitigation of risks stemming from delay or human error in the underwriting process.[128]

From the perspective of insurance companies a major risk is that of adverse selection, which often arises from information asymmetry between the insurer and insured.[129] Such risks may be mitigated by the information flow facilitated by smart contracts and blockchain technology. An example provided by Lloyd's is in relation to insurance claims arising from catastrophic events such as a wildfire.[130] In this case, systems collecting data including indicators of wind, smoke, and floating embers, along with appropriate metrics for frequency and severity, would clarify the extent of the risk for the insurer across the class of affected individuals.[131] Optimisation of these systems would carry potential flow-on effects in facilitating risk management from the insured's perspective, with the insurer, in theory, able to provide more

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[124] Ibid.
[125] Jonathan Gould, 'Allianz Expects Blockchain Tech to Expedite Cat Bond Deals', *Insurance Journal* (Web Page, 15 June 2016) <https://www.insurancejournal.com/news/international/2016/06/15/416971.htm>.
[126] Ibid.
[127] Lloyd's (n 121) 13.
[128] Gould (n 125).
[129] Vaughan and Vaughan (n 56) 43.
[130] Lloyd's (n 121) 31.
[131] Ibid.

appropriate responses. For example, upon receipt of data indicating the presence of a peril or hazard, an automatic notification could be generated according to a basic coded smart contract provision to the effect of 'if A, then B', where: A represents a determinant of the risk faced by the insured, such as geographical proximity to the peril or hazard; and B represents the automatic notification, for example via email, relevant to the management of the risk.[132] Sample notifications provided by Lloyd's, with varying levels of specificity, include:[133]

- 'We are aware this event may have affected you, we wanted to touch base with you to check if you need assistance.'
- 'Water levels in the river are projected to overtop and flood the property. Do you have a plan to move your car collection? If not, do you need assistance?'

Whilst this may appear to be a superficial means of improving customer service, it carries potentially significant consequences in the field of personal risk management. Individuals suffer from specific vulnerabilities that render initial responses to sources of risk vital.[134] Information flow facilitated by the smart contract enables early risk identification in the interests of risk avoidance and reduction.[135]

3 *Legal Implications*

The legal implications of smart contracts in insurance are similar to those raised in general. Issues of contractual interpretation are identified where there is divergence between execution of the smart contract and what the parties have intended.[136] A separate issue raised is that of privacy, both on and off-ledger. Implementation of smart contracts in insurance on the consumer level would require agreement to the terms of use of the blockchain platform, including the information stored there. Equally, anticipated integration with other 'InsurTech' that may involve the use of smart devices in a person's home to gather relevant data also raises significant privacy issues.[137]

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[132] Ibid 24–35.
[133] Ibid 35.
[134] Vaughan and Vaughan (n 56) 17.
[135] Ibid 17–18.
[136] Lloyd's (n 121) 24, 43.
[137] Ibid 18. See above discussion of 'smart flood insurance': Part III(C)(1).

The highly-regulated nature of the insurance industry may hinder or, at the very least, shape smart contract implementation. For example, one of the benefits of smart contract use in insurance would appear to be the centralised collection of all necessary 'risk information' about the insured on the blockchain platform.[138] This theoretically expedites the underwriting process by simplifying the information-gathering phase and reducing reliance on the insured's application or insurance agent's recommendations based on contact with the insured. It is suggested the purest form of smart contract marketplace design optimising commercial efficiency in this respect is one in which 'neither customer nor insurer identifies themselves, and don't need to because the necessary risk information about the insured is on the blockchain, and pay-out by the insurer is guaranteed by the smart contract'.[139] Such a model, however, is likely inconsistent with current regulatory requirements including the best interest duty, 'know-your client' rules, and anti-money laundering regulation.[140] Time will tell whether mainstream use of smart contracts in the insurance industry will successfully integrate with existing regulation. However, what is certain is that the technology carries significant potential to change insurance practices from the perspective of both consumers and insurers.

D *Financial Markets*

One of the hallmarks of the modern commercial environment is the emergence and expansion of 'fintech' across a broad range of sectors.[141] Fintech represents the application of 'financial technology' designed to compete with traditional methods utilised in the delivery of financial services.[142] The fintech industry in Australia has attracted significant investment and is mainly comprised of many small startup companies, funded by larger corporations with vested interests in the products developed.[143] Blockchain technology, and the use of smart contracts to facilitate the underlying transactions,[144] is an example of fintech that has drawn attention from corporations, governments and regulators alike due to its applications in banking and finance.[145] In this respect,

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[138] Ibid 36.
[139] Ibid.
[140] Ibid.
[141] Ian Pollari and Amanda Price, 'Australian Fintech Landscape', *KPMG Australia* (Web Page, 11 September 2018) <https://home.kpmg/au/en/home/insights/2017/08/australian-fintech-landscape.html>.
[142] FinTech Australia, 'What is FinTech?', *FinTech Australia* (Web Page, 2019) <https://fintechaustralia.org.au/learn/>.
[143] Pollari and Price (n 141).
[144] Boadle (n 2) 335.
[145] Ibid 333.

the application of smart contracts to financial markets represents one of the key growth areas for the technology.

1 *Industry Recognition—Benefits and Challenges*

ASIC has to date recognised the use of smart contracts in foreign exchange trading, securities settlement and debt issuance as discrete applications in the financial sector.[146] It has also been considered that smart contracts may provide significant value in financial markets including retail and wholesale payments, capital markets, trade finance and transaction banking, as well as in securities markets trading, clearing, custody and settlement.[147]

Blockchain technology has been identified as an alternative to current certification systems employed in financial markets. The value of blockchain in this respect would appear to be in its potential to simplify the complexities of post-trade clearing and settlement processes. This may be manifested in a reduction in intermediary involvement and regulatory oversight, as well as the degree of manual operation required to reconcile the records of the respective parties in this process.[148] In 2016, the ASX engaged fintech company Digital Asset Holdings LLC to replace the Clearing House Electronic Subregister System ('CHESS') with a blockchain-based alternative.[149] Cited outcomes upon successful implementation include:

(a) creation of a common record of asset holdings between competing financial institutions;
(b) mitigating the need for manual adjustment of potentially divergent records between the parties; and
(c) automated tracking of the execution, clearing and settlement phases of transactions.[150]

It is the commercial efficiencies achievable by streamlining post-trade processes that have attracted investment by financial institutions and intermediaries due to the costs associated with meeting regulatory standards in this transaction-phase.[151] Mitigating associated complexities

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[146] Arachchi (n 1) 40, citing Australian Securities and Investments Commission, 'Evaluating Distributed Ledger Technology', *Australian Securities and Investments Commission: Information Sheet 219* <https://asic.gov.au/regulatory-resources/digital-transformation/evaluating-distributed-ledger-technology/>.
[147] Boadle (n 2) 333.
[148] Ibid 334.
[149] ASX, 'CHESS Replacement: New Scope and Implementation Plan', *ASX* (Consultation Paper, April 2018) 4 <https://www.asx.com.au/documents/public-consultations/chess-replacement-new-scope-and-implementation-plan.pdf>.
[150] Boadle (n 2) 334–5.
[151] Ibid 335.

through blockchain and smart contract technology would therefore reduce expenses and increase overall profitability of transactions for financial institutions,[152] particularly when applied to large quantities of similar transactions, as discussed above in relation to applications in insurance.

The specifics of the potential benefits derived are perhaps best understood through an illustrative example provided by Boadle in the context of a generic securities trade between buyer and seller.[153] Processes capable of automation may be considered in terms of the execution, clearing and settlement phases of the trade. Prior to execution, the smart contract may provide for certification of the seller's title over the securities, as well as the buyer's financial capacity to purchase the securities (by a logic process comparing total trade price to the amount of funds in the buyer's designated linked account, for example).[154] Following the execution phase, another smart contract process may register title in the securities through an external database, such as the ASX subregister (currently maintained through CHESS) or the issuing party's sponsored subregister.[155] In this respect, clearing and settlement may be near-instantaneous, significantly mitigating systemic and default risk arising from delays between transaction phases.[156] This has been considered to provide significant benefits to both transacting parties and intermediaries, as well as reducing regulatory oversight requirements—features that will lead to long-term reductions in transaction costs.[157]

2 *Risk Management Applications*

As indicated above, automation of post-execution processes in financial markets carries the potential to render clearing and settlement near-instantaneous processes, which in turn would reduce both systemic and default risk inherent to financial market transactions.[158] Default risk, in particular, would be mitigated in those transactions undertaken with immediate execution intended.[159]The argument for the potential reduction in systemic risk is as follows. The automation mechanisms described impact on two primary transaction processes: firstly certifying

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[152] Ibid.
[153] Ibid.
[154] Ibid.
[155] Ibid; ASX Settlement Corporation, 'CHESS: Clearing House Electronic Subregister System', *ASX* (Brochure, 2011) 4 <https://www.asx.com.au/documents/research/chess_brochure.pdf>.
[156] Boadle (n 2) 335.
[157] Ibid.
[158] Ibid 336.
[159] Ibid.

the ability of both parties to transact; and secondly executing trades for immediate delivery. In this way, the potential for the financial failure of a discrete number of central counterparties to cause a string of transactions to fail, with the obvious associated macroeconomic impacts, is drastically reduced.[160] On the face of it then, the application of smart contract and blockchain technology in financial markets would appear to carry significant risk management benefits. On both a market-wide and firm-specific level, implementation carries potential for risk control through the avoidance and reduction of specific risks inherent to transactions carried out on financial markets.

3 *Legal Implications*

Challenges facing smart contract implementation in financial markets include the ability, from both a regulatory and practical perspective, of parties to conduct transactions through the blockchain without the need for intermediaries from relevant financial institutions to act on their behalf.[161] It has been suggested that this could be achieved through certification procedures embedded in the blockchain that verify the ability of parties to transact, for example by requiring that the buyer demonstrate sufficient funds to meet the transaction price, and that the seller confirm their title to the assets in question.[162] This relies on principles such as the 'trustlessness' of the blockchain whereby trust in counterparties or intermediaries is replaced by trust in the technology.[163]

Having parties provide mutual consensus as to the prima facie validity of the transaction may assist in bridging the gap with current banking and finance regulation.[164] This view is consistent with literature that has considered that despite initial incompatibilities, blockchain technology applied to financial markets may present long-term benefits to regulators who adopt this technology, increasing efficiency whilst enabling co-ordination with international

[160] Ibid.
[161] Ibid 335.
[162] Ibid.
[163] Mik (n 15) 275–6. See above Part II(B)(1).
[164] Boadle (n 2) 336.

counterparts.[165] In this sense, smart contract compatibility may be facilitated by developing regulatory technologies—a process that is already underway.[166]

E *Concluding Remarks on Use Cases*

The above use cases are demonstrative of the potential applications of smart contract technology across legal and commercial sectors. Various common issues are evident, possibly the most pertinent of which is the need for trusted third parties to facilitate smart contract transactions. This is largely a matter of construction of the ANB platform in Australia and the implementation of trust protocols inherent to blockchain technology, including asymmetric encryption by which the reliability of cryptographic signatures as a secure means of identifying participants plays an important role in fostering trust in the platform.[167] A further theme common across use cases is the applicability of smart contracts to circumstances in which there are a large quantity of similar transactions benefiting from automation due to the simplicity of execution. What is also apparent, however, is the need for nuanced approaches, both in regulation and smart contract design, across sectors to ensure successful integration of the technology due to the clear absence of a 'one-size-fits-all' approach to smart contract implementation.

IV CONCLUSIONS

This article has sought to canvass key themes and issues arising from the implementation of smart contracts in mainstream commercial legal practice. Given the technical nature of the subject matter there is a clear necessity to deal with the 'nuts and bolts' of smart contracts in both a commercial and legal sense so as to facilitate engagement with the process of implementation in practice. Building on this foundation, a number of practical and theoretical issues are elucidated as common themes in smart contract development.

Consideration of the risk management applications of smart contracts in commercial practice provides a theoretical grounding for practical benefits associated with implementation, beyond general notions of 'efficiency' and 'innovation' —buzzwords often associated with fintech

[165] Ibid 337, Boadle recognises that these benefits are already evident in partnerships such as the innovation hub established by ASIC and the UK Financial Conduct Authority.
[166] For example, the ASX is moving from the existing 'CHESS' settlement system in favour of distributed ledger technology, which is recognised as smart contract compatible. See ASX (n 149) 4.
[167] See above n 89 and accompanying text.

and other applications of this kind. Rather, in the case of smart contracts there appear to be real benefits derived from automation of common contractual processes, namely in the integration of risk control techniques into the fabric of the contract. This is illustrated by discussion of the selected use cases, each of which further raise discrete practical and legal issues associated with implementation.

What is evident is the considerable industry drive behind the development of smart contracts. As an innately interdisciplinary construct with significant scope for assimilating law, commerce and information technology, the introduction of smart contracts into the mainstream legal lexicon may be jarring for a profession steeped in traditional practices. The signs are, however, that there are those in the vanguard ready to embrace 'a new way of doing old things'.