Blockchain 2030: A Look at the Future of Blockchain in Australia

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April 2019

Blockchain 2030

A Look at the Future of Blockchain in Australia

CSIRO DATA 61

Report prepared by Alexandra Bratanova, Dinesh Devaraj, Joanna Horton, Claire Naughtin, Ben Kloester, Kelly Trinh, Ingo Weber and David Dawson

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Finally, we are grateful to Melissa Johnston and Dmitry Bratanov from Queensland University of Technology for their help with the design and 3D printing of the scenario model.

CURRENCY CONVERSION

All dollar values indicate AUD figures unless specified otherwise. AUD figures were converted from other currencies wherever it was methodologically sound to do so. Past and present conversions were done using a yearly average exchange rate for the relevant year, whereas forecast value conversions were done using 2018's average exchange rate since November 2017.

Foreword

Yohan Ramasundara
President, ACS

Andrew Johnson
Chief Executive Officer, ACS

Few technologies in recent memory have been as polarising as blockchain, with positions divided into camps of 'blockchain evangelists' and 'blockchain sceptics'. The distributed ledger technology – originally developed for the Bitcoin cryptocurrency – has been billed as holding the potential to revolutionise the internet and change the very nature of trust.

Even as the frenzy around Bitcoin has died down, blockchain has started to be deployed across Australia by start-ups, government agencies and large corporates. Exciting start-ups like AgriDigital are deploying it for the purpose of provenance tracking. Major financial institutions like the Commonwealth Bank are deploying it as a trusted B2B fintech platform. The government has created blockchains that store smart contracts for use by businesses and individuals.

ACS' December 2018 ***Blockchain Innovation – A Patent Analytics Report*** outlined that blockchain patent filings have grown 140% or more each year since 2013. Australia ranks sixth globally with 49 patent families in blockchain, with patents divided into two broader functional categories:

- Applications – solving problems in payments and transaction systems, financial services, business administration, and shopping and commerce.
- Data processing – solving problems in encryption and security, networking and data transmission, data manipulation, management and interrogation.

In undertaking this body of work, we wanted to investigate our instincts that investments in blockchain did not necessarily represent the growing capabilities of the technology, but more the excessive hype surrounding it.

By doing this, we are applying the Gartner Hype Cycle lens, which suggests that any new technology initially generates a massive amount of hype and inflates expectations before almost invariably being followed by a 'trough of disillusionment', where it fails to meet hyperbolic expectations.

This report has been initiated to determine whether we have entered that trough of disillusionment, and to inform how Australia can become a world leader, being that catalyst for blockchain to enter a plateau of productivity.

We would like to thank the Data61 Foresight team for undertaking this investigation, and consulting with ACS and other blockchain experts domestically and internationally through a series of interviews and a validation workshop, to provide an evidence-based insight into plausible futures, and inform our technology, business and government leaders on enablers that can be enacted for Australia to become a global leader in blockchain.

Contents

Executive summary

Blockchain technology is a distributed ledger technology whereby a database is distributed across numerous users, and changes to the database are validated by consensus among the users. While it is best known as the platform for Bitcoin, blockchain technology can be widely applied to improve business processes, increase transparency, and drive the creation of new jobs and industries.

Over the last decade, blockchain technology has grown in popularity and use, and has already begun to disrupt existing markets in Australia and around the world. The opportunities blockchain presents have been invested in, studied, explored, and considered, in almost all sectors of the economy. Blockchain has attracted significant public and private investment, and introduced previously non-existent products and services across multiple industries.

Despite its potential, there is significant uncertainty regarding future adoption of blockchain technology in Australia. For instance, there are unknowns around blockchain's capacity to work at scale while remaining decentralised, and protect confidentiality whilst also being transparent. The extent to which the public will trust decentralised systems is also uncertain. These uncertainties raise the question: can blockchain progress beyond the hype to deliver tangible, high-value applications and a thriving industry for Australia, or will blockchain amount to little more than a market bubble?

Using the Gartner Technology Hype Cycle (see Figure 1), this report investigates plausible futures for the adoption of blockchain technology in Australia out to 2030, with a particular focus on Australia's emerging blockchain industry and workforce. Using strategic foresight methodologies, it aims to identify critical risks, challenges and opportunities for Australia's blockchain industry and assist stakeholders in developing informed strategic responses to these potential futures. Two specific techniques under the umbrella of strategic foresight are employed in this report—horizon scanning and scenario planning. These techniques are used in combination to craft and communicate a narrative about the future of blockchain adoption in Australia.

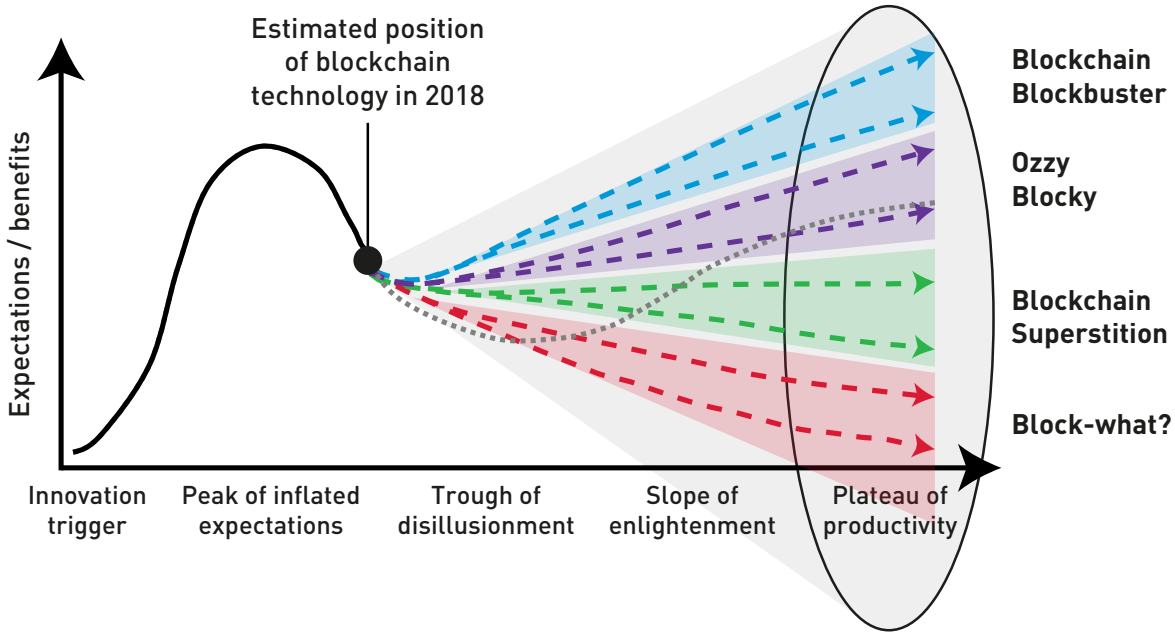


FIGURE 1. PLAUSIBLE FUTURE SCENARIOS FOR BLOCKCHAIN, MODELLED AGAINST THE GARTNER TECHNOLOGY HYPE CYCLE

WHERE ARE WE AT, AND WHERE ARE WE GOING?

To understand the future, we need to understand the present state of the Australian blockchain industry. An analysis of 138 blockchain activities in Australia shows a general upwards trajectory, with most of this activity coming from small-to-medium-sized businesses in New South Wales and Victoria. Further analyses of the current state of the blockchain workforce point to a clear skill gap, with demand for blockchain-related skills rapidly increasing, despite the limited supply of skilled talent from information and communication technology domains.

This report also identifies future trends that are likely to influence the development and adoption of blockchain in Australia over the coming decade. These include the following:

- Supported by increasing computational power, blockchain technology is becoming more sophisticated, efficient and user-friendly. However, it shows signs of limited scalability. Current high levels of energy consumption by public blockchains with proof-of-work consensus mechanisms, as well as broader digital infrastructure and cyber security concerns for the technology in general, may prove problematic for future blockchain adoption.
- Alongside the rise of platform businesses and the 'sharing economy', there is growing interest and investment in blockchain as a decentralised, peer-to-peer solution with the potential to deliver significant cost savings. While there is booming global demand for blockchain developers, a short supply of talent may limit future growth of blockchain-related products, services and industries.
- Blockchain presents opportunities for more transparent and efficient governance methods, but also increased risks associated with scams and illegal activities. The Asia-Pacific region holds key blockchain export opportunities for Australia, along with increased competition for both talent and technology development.
- In parallel with rising economic inequality, trust in centralised institutions is eroding. Many people now have lower trust in social and traditional media, banks and governments to report the truth, protect privacy, and act in the interests of everyday people. Given this context, blockchain and other decentralised technologies may be increasingly preferred to traditional intermediaries.

SCENARIOS FOR BLOCKCHAIN TECHNOLOGY ADOPTION IN AUSTRALIA

The trends raise key uncertainties: to what extent will blockchain technology advance? Will social trust shift decisively away from traditional institutions and towards decentralised systems? Will the blockchain offer significant cost efficiency compared to legacy systems? This report explores eight scenarios for future adoption of blockchain technology in Australia out to 2030 (see Figure 2). The scenarios are designed to challenge current perspectives, define and explore key uncertainties, and provide a common set of shared narratives for industry, government and community stakeholders.

FUTURE STRATEGIC IMPLICATIONS AND ACTIONS

These trends and scenarios highlight key risks, challenges and opportunities for future blockchain adoption in Australia over the coming decade. This report explores the implications of these findings for future strategic decisions concerning the Australian blockchain industry, including:

- Leveraging Australia's areas of competitive advantage in blockchain technology by (i) developing the appropriate skills mix, (ii) growing the information and communication technology talent pool, (iii) addressing the blockchain knowledge gap, and (iv) resolving digital infrastructure bottlenecks.
- Successfully transitioning Australian industries and businesses by (i) meeting the regulatory challenge, (ii) assisting businesses with the transition, (iii) adopting a rolling strategy approach, (iv) developing a plan to manage cyber security, and

(v) using research and data to drive decision-making.

This report provides multiple views of the future of blockchain adoption in Australia and the impact this could have on existing and emerging industries and businesses. By understanding the potential risks that the future could hold—as well as the opportunities that blockchain technology could provide for the Australian economy—government and industry can make more informed decisions that best position the nation for decades to come.

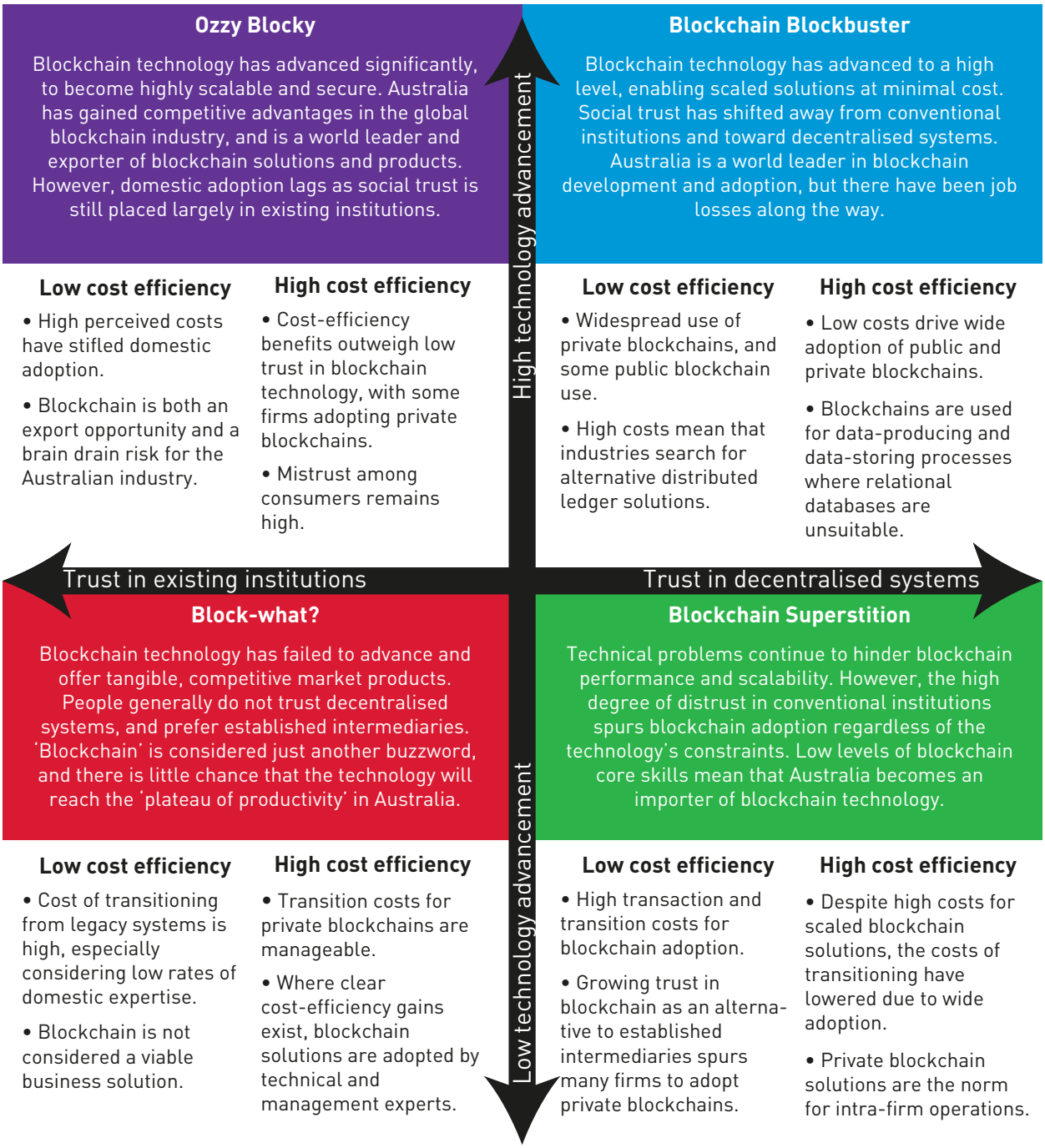


FIGURE 2. PLAUSIBLE FUTURE SCENARIOS FOR BLOCKCHAIN ADOPTION IN AUSTRALIA

01

INTRODUCTION: BLOCKCHAIN BEYOND BITCOIN

IN BRIEF: WHAT IS BLOCKCHAIN?

As a distributed ledger technology (DLT), blockchain is a system of electronic record keeping, which is supported by a consensus-maintaining distributed database. Blockchains consist of sequential records (transactions) that are organised into groups (blocks) before being added to the ledger. A new block is added to the chain if it is validated by consenting parties in the network. The Bitcoin cryptocurrency was the first widely adopted implementation of a blockchain. Since then many other blockchain platforms have emerged offering an ever increasing variety of features and applications.

Blockchain has arguably become the most hyped technology of recent times (see Figure 3). Over the last decade interest in blockchain technology has grown enormously, catalysed recently by the surge in cryptocurrency prices and market capitalisation (see Figure 4). Since these spikes, new applications of blockchain technology have been developed, new industries and government regulations have emerged, and demand for the blockchain engineering workforce has grown worldwide.

Blockchain technologies and systems have been investigated and trialled in a wide range of industries around the world.[5,6] There are potential applications in both existing and emerging industries[7,8]—from provenance, registries[2] and energy trading[9,10] to blockchain for courts[11]

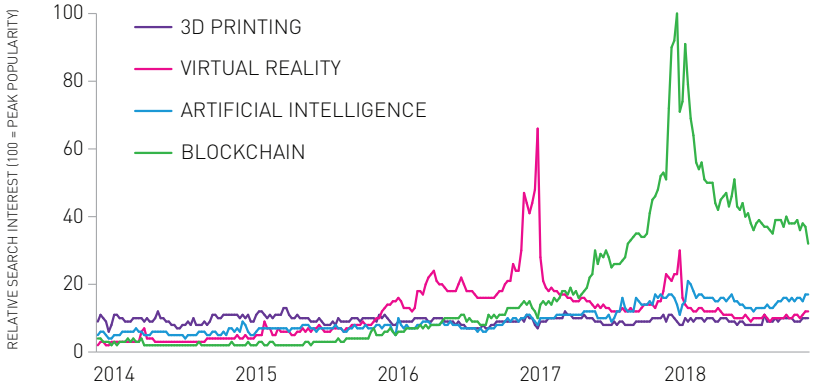


FIGURE 3. INTEREST IN BLOCKCHAIN COMPARED TO OTHER NEW TECHNOLOGIES BY GOOGLE USERS
Source: Google Trends

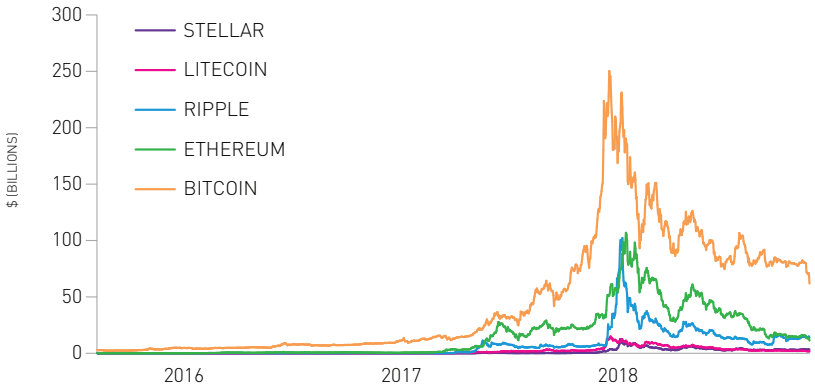


FIGURE 4. MARKET CAPITALISATION OF SELECTED CRYPTOCURRENCIES
Source: Coindesk[22] and RBA Exchange rates[23]

and spacecraft systems.[12] Smart programmable money facilitated by distributed ledger technology (DLT) could open up new horizons for global trade[13,14] and become the next step in the evolution of monetary systems.[15] Blockchain became a priority topic on the agenda of international forums (e.g. World Economic Forum[16]) and national industry organisations (e.g. Australian Digital Commerce Association[17]). The analysis of Australian blockchain activities (see Chapter 3) demonstrates that Australia is home to a number of innovative blockchain developments and has potential to grow its competitive advantage and develop a thriving domestic blockchain industry.

However, blockchain technology is still relatively immature and applications are niche.[5] Blockchain has facilitated new cyber security attacks, scams, privacy concerns, market disruption and major regulatory challenges.[2,5,18,19] Challenges such as data portability, privacy and private key security, user savviness and safety,[20] and accuracy of data on blockchains are yet to be resolved. A growing body of literature indicates that investments in blockchain might not necessarily represent the growing capabilities of the technology, but rather reflect the excessive hype surrounding it. This hype has also polarised the discussion about blockchain's potential, with positions divided into 'blockchain sceptics' and 'blockchain evangelists'. Sceptics tend to think that blockchain cannot succeed or will have minimal benefits (if not costs) to individuals, organisations and society in the future.[21] Blockchain evangelists believe blockchain will radically transform the global economy for the better.[16] Each position has its strengths and drawbacks; while blockchain has great potential to deliver economic and social benefits, there are significant unknowns around its future development and risks to its application.

The Gartner Technology Hype Cycle is often used to represent the stages of maturity and adoption of emerging technologies and applications.[24] Blockchain is currently progressing through its 'peak of inflated expectations', and over the next decade could transition onto its 'plateau of productivity' (see Figure 5). As the hype around blockchain wanes, a suite of new, high-

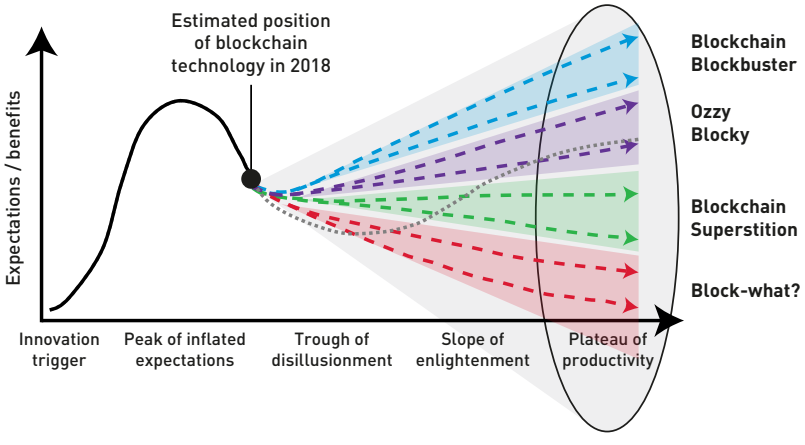


FIGURE 5. PLAUSIBLE FUTURE SCENARIOS FOR BLOCKCHAIN, MODELLED AGAINST THE GARTNER TECHNOLOGY HYPE CYCLE

value applications could begin to emerge, but there are significant uncertainties around this future development and its impact on the Australian economy.

Building on previous blockchain research conducted by Data61 and the Australian Government,[1,2] this report explores plausible futures for blockchain technology uptake in Australia over the coming decade. It combines qualitative strategic foresight methods (see Appendix A) with quantitative analysis to explore future industry and workforce trends and better understand how blockchain could impact the Australian economy. This report aims to assist government and industry stakeholders in navigating the uncertainty around blockchain and making informed strategic responses that maximise the technology's potential.

The report begins with a brief explanation of what blockchain is (Chapter 2) and a current profile of blockchain activities in Australian industries and the labour force (Chapter 3). Chapter 4 presents a horizon scan of the technological, environmental, economic, social and geopolitical trends likely to shape the future of blockchain adoption. Drawing on these trends, Chapter 5 identifies a set of scenarios for the future of blockchain uptake. The report concludes with implications that these plausible futures raise for future policy and strategic decision-making (Chapter 6).

WHAT'S NEW?

In early 2017, Data61 published two major strategic foresight reports on distributed ledger technology.[1,2] However, the past two years have seen substantial changes in the environment for blockchain development and adoption both globally and nationally. This report seeks to further explore plausible futures for blockchain in the context of this changed environment. The report's novel features include:

- A focus on blockchain labour and industry.
- An emphasis on recent events and data.
- A series of current trends likely to shape the future uptake of blockchain technology.
- A novel set of eight scenarios, derived from structured strategic foresight methodology[3,4] and exploring a 10-year time frame.
- Shaping scenarios around three axes of uncertainty determined through a horizon scan and stakeholder consultations.

02

Overview of blockchain

Blockchains fall under the broader umbrella of distributed ledger technologies (DLTs). DLTs are shared databases or ledgers, where read/write access is distributed across numerous computers (referred to as 'nodes' in the network). The resulting database is stored in multiple locations, meaning that a DLT allows many nodes to append and view the database simultaneously. By contrast, in a centralised database, write access is granted to one person or organisation and the database is stored centrally.[1]

Blockchains are a particular type of DLT. At their core is a shared database that is organised as a list of blocks, with the constraint that an additional block of data is appended to the ledger only if a majority of nodes 'agree' that it is valid. Agreement between multiple nodes about the validity of a block is derived via a 'consensus mechanism', of which there are several types. The new block is cryptographically chained to the previous block that was added to the blockchain, which was chained to the block before it, and so on, all the way to the first block (the genesis block). Hence the name 'blockchain'.[25,26]

The usefulness of blockchains comes from their decentralising and trust-producing potential. The consensus mechanism enforces validity to create trust and a copy of the database is distributed and synchronised amongst numerous nodes. A falsified ledger would be detected and rejected by other nodes as being invalid. By contrast, centralised databases are updated and stored by a single node, making the data subject to tampering, falsification or systems failure. Only the central node can confirm the validity of data or if it is corrupted or lost, and corrupted/lost data cannot be retrieved without a backup.

The first widely adopted blockchain was implemented in Bitcoin, which was first defined in a 2008 white paper authored by the pseudonymous Satoshi Nakamoto.[27] This paper built upon a peer-to-peer system for consensually maintaining a distributed ledger, and provided a solution to the 'double-spending problem' for digital currencies (i.e. if digital currencies are made up of ones and zeros, how do you prevent someone from duplicating and re-using these numbers after each spend?). Without the need for a trusted intermediary (e.g. a bank), a network of participants enforcing consensus rules can verify transactions and the integrity of the ledger. The network was 'public', meaning that anyone could participate.

Consensus mechanism: A means of reaching a consistent state in a distributed system, in which a majority of agents in the system ultimately agree about a state, provided they follow the rules of the consensus mechanism. The rules are transparent and reaching consensus includes validating the proposed state.

In a proof-of-work consensus mechanism, the valid state is selected as the one with the most 'work' attached, where 'work' is an unforgeably costly process such as computing the result of an arduous mathematical puzzle.

In a proof-of-stake consensus mechanism, agents 'stake' capital to partake in state updates and are incentivised to act in the best interests of the network. The valid state is selected as the one with the most votes for its validity, where votes are granted in proportion to the 'staked' capital each agent controls.

In a permissioned (private) blockchain, a predefined set of privileged members, defined by the blockchain creator, play a special role in the consensus mechanism and may have other special rights to write and/or read to and from the blockchain.

In a private blockchain, any participation — including participating in consensus, writing to the chain, or even reading from the chain — is controlled by a central party issuing permissions to do so.

In a permissionless (public) blockchain any full node can read and write from the chain, and participate in the consensus process.

However, some blockchains where not everyone can participate in the consensus process are still referred to as public (e.g. Ripple and Stellar). These could be thought of as 'public but permissioned'.

Later implementations of blockchains include Ethereum and Hyperledger Fabric and other recent platforms.[26] Many of these blockchain platforms allow adopters to deploy computer programs on them, called 'smart contracts'. Smart contracts are computer programs that represent an agreement which is automatically executable and enforceable.[26] With this added capability, second-generation blockchains have become versatile enough to support complex real-world applications. These include tracking goods along supply chains or securing multi-party transactions, where, for example, settlement and title transfer happen in one transaction.

Today, the term 'blockchain' is broadly used to refer to many technologies that build on the approach originally proposed by Nakamoto. These technologies commonly allow multiple untrusted parties to keep shared records that are consistent and immutable, and to append updates to records without the need for a central authority. They do so using well-specified rules which have strong (often crypto-economically secured) guarantees of enforcement. Different types of blockchains represent different trade-offs between trust, scalability, functionality and efficiency. For example, many opt for a private ledger over public network participation with a greater level of trust required for nodes to participate.[25]

The unique ability of blockchains to establish a single, canonical source of truth without any central authority opens up a range of potential uses. While currency is the most established and best-known example, blockchains can be used to maintain any kind of record of ownership (e.g. of physical assets) in a decentralised manner. Blockchains could also be used to record, transact and transfer virtual assets. In a purely digital realm, actions in one sphere (e.g. an online game) can be directly contingent on actions occurring on the blockchain.

Many assets (e.g. shares in a company) are virtual representations of information, sustained by human belief and legal frameworks that belief has written into existence. Blockchains provide a way for multiple parties, who are willing to agree on certain beliefs, to come together and coordinate records without needing individual trust. Blockchain also enables new forms of distributed software architecture, where networks of untrusted (and sometimes even corrupted) participants can securely establish agreements on shared states for decentralised and transactional data without a central authority.

Why now? The evolution of social and economic trust

Blockchain is fuelling a qualitative evolution from the first generation of the internet (i.e. internet of information) to the second (i.e. internet of value).[28] The internet of information enabled parties previously unknown to each other to search, collaborate on and exchange information. The lower transaction costs that came with the first generation reduced barriers to entry for many businesses. But these advantages were accompanied by problems of trust between unknown parties across the globe; there was no way of guaranteeing the identity of participants or the quality of information they provided.

Many countries are experiencing growing distrust in institutions. Indeed, in 2018, an analysis of trust in institutions found 20 of the 28 countries (including Australia) surveyed were classified as distrusters.[29] But what is driving this loss of trust in institutions? Trust in institutions started dropping during the 2008 global financial crisis and has continued to decline as a result of rapid globalisation and technological change, the effects of which have not been equally shared across society.[30,31] Recent scandals involving intermediaries, including the Australian banks[32] and Facebook[33], have also fuelled public distrust and privacy concerns.

These problems of trust are likely to have hindered the true potential of e-commerce and other internet-related activities. The second generation of the internet should provide better guarantees about participant identity and information quality, enabling the effective exchange of value between otherwise distrusting participants. DLTs, which have the ability to automate the three functions of a trusted third- party intermediary (validating, safeguarding and preserving transactions)[1], seem like a natural step in the new stage of trust evolution.

Regulating blockchains

While blockchains have been trialled across a wide range of industries, various barriers to their implementation have been encountered. These include regulation, legal enforceability, systems compatibility and usability.[34] It is challenging to develop and implement clear regulatory and taxation regimes for blockchain, as blockchain is a dynamic industry with adopters spanning across organisations, industries and jurisdictions. Countries are trialling different regulatory approaches to crypto-assets and blockchain in a search for a balanced solution between innovation support and consumer and business protection, as indicated at a discussion on crypto-assets at the at the G20 Leaders' Summit in Buenos Aires in November-December 2018.[35] For more examples of discussions on crypto-assets and blockchain regulation, see Appendix B.[36-42]

03

CURRENT PROFILE OF AUSTRALIAN BLOCKCHAIN INDUSTRY AND SKILLS

To understand the future of the blockchain industry in Australia, we need to understand its contemporary state. At present, there are limited data on blockchain activities in Australia, and indeed globally, making it difficult to identify current trends. This report presents novel data compiled from an analysis of current blockchain activities in Australia, including organisational actions aimed at implementing or developing blockchain innovation to yield a blockchain-related product (see Appendix C for further details). It reflects a cross-section of 138 Australian blockchain activities with information available in the public domain as of August 2018.

Blockchain activity in Australia

There has been an increase in Australian blockchain activities since 2010 (see Figure 6). Over 50% of activities are undertaken by blockchain firms and start-ups (e.g. PowerLedger, CivicLedger, AgriDigital and Shping) or larger companies with active blockchain projects or trials (e.g. Australia Post, Australian Securities Exchange, and Commonwealth Bank of Australia). Some activities also account for a consortia of organisations working on collaborative projects (e.g. the partnership of IBM, Westpac and ANZ,[43] and Australian National Blockchain initiative[44]). The majority of Australian blockchain activities focused on a single application product (50.7%), with other activities associated with greater productisation (18.1%) or providing blockchain-related services (31.2%).

New South Wales (NSW) had the greatest share of blockchain-related activities, followed by Victoria and Queensland (see Figure 7). Although the majority of activities were recorded within capital cities, there were some examples of regional blockchain activities. For instance, over 30 businesses in the Central Queensland towns of Agnes Water and Seventeen Seventy (1770) are now accepting cryptocurrency as a form of payment, designed to appeal to international tourists in the niche market of crypto-funded travel.[45] Similarly, blockchain-related jobs are concentrated in NSW and Victoria, but this distribution has widened in recent years (see Figure 8).

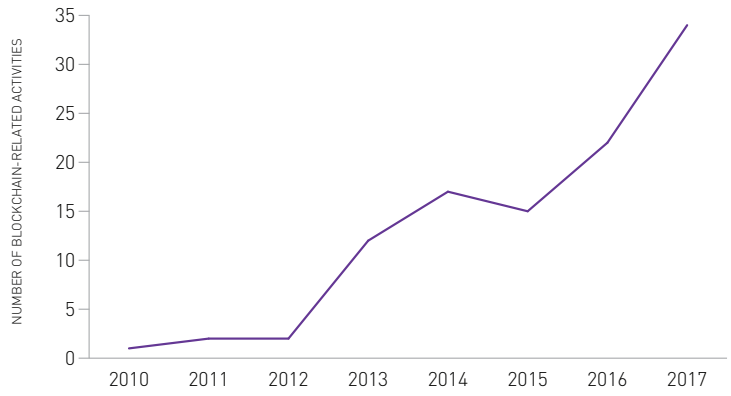


FIGURE 6. NUMBER OF BLOCKCHAIN ACTIVITIES IN AUSTRALIA BY STARTING YEAR
Source: Data61 Australian blockchain activities dataset

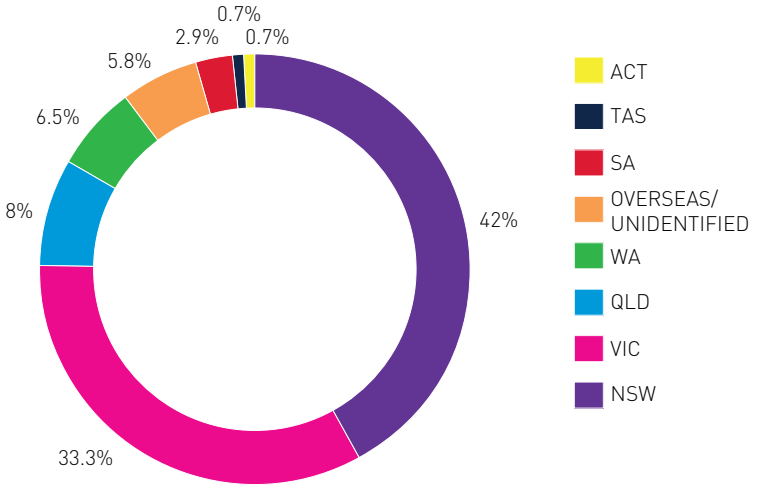


FIGURE 7. NUMBER OF BLOCKCHAIN ACTIVITIES IN AUSTRALIA BY STATE AND TERRITORY
Source: Data61 Australian blockchain activities dataset

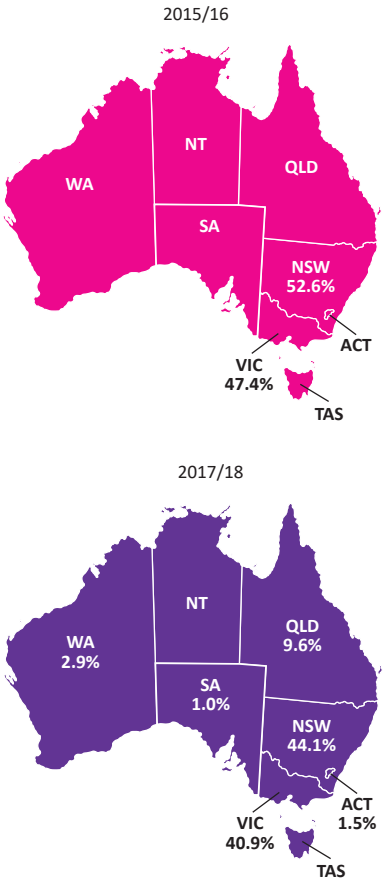


FIGURE 8. DISTRIBUTION OF BLOCKCHAIN-RELATED JOB ADVERTISEMENTS BY STATE AND TERRITORY
Source: Burning Glass Technologies[46]

Industry profile of blockchain activity

The leading industry for blockchain activities in Australia is financial and insurance services, followed by professional, scientific and technical services, and retail trade (see Figure 9). The dominance of the financial and insurance services in blockchain adoption can be partly explained by the nature of financial services, and blockchain's application in digital currency and Bitcoin. Over half of all blockchain activities in financial and insurance services (51%) and professional, scientific and technical services (52%) are facilitative.

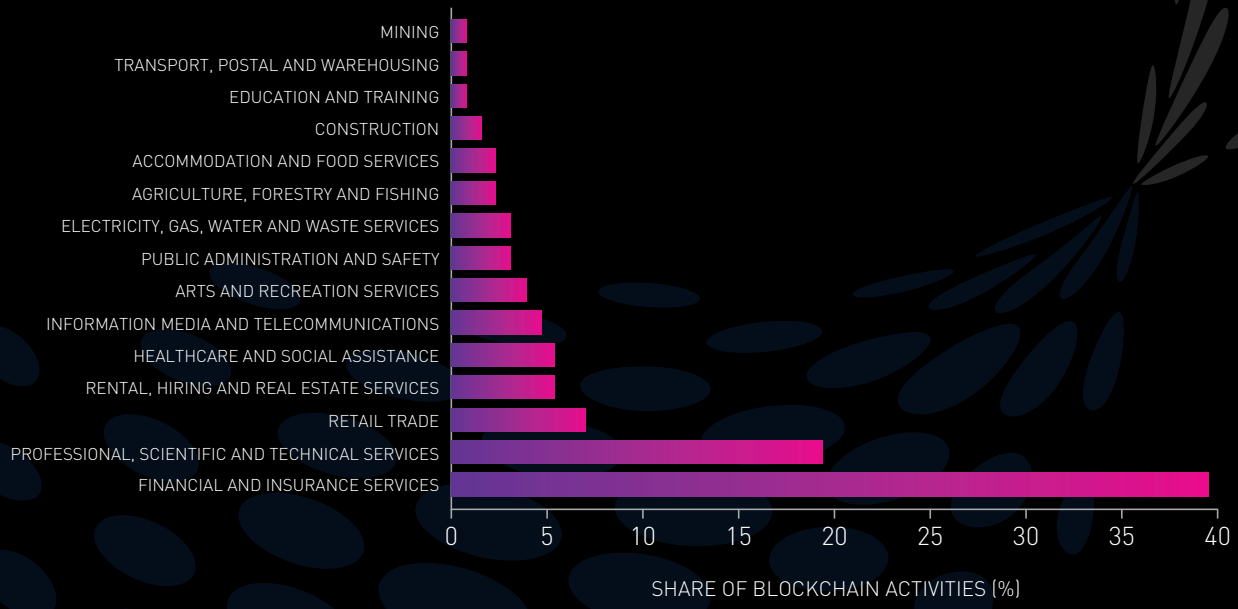
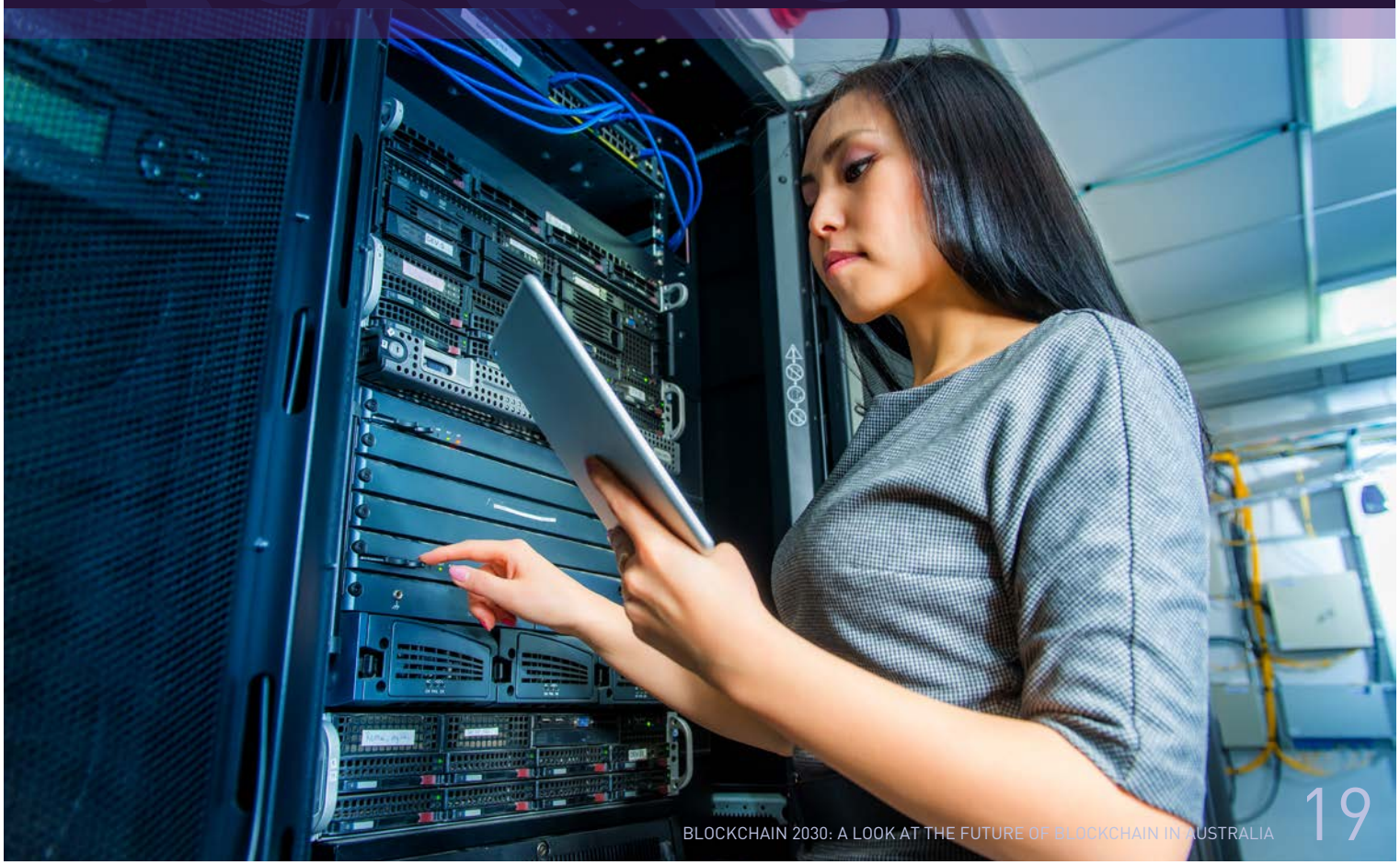


FIGURE 9. SHARE OF AUSTRALIAN BLOCKCHAIN ACTIVITIES BY INDUSTRY
Source: Data61 Australian blockchain activities dataset



There were no examples of blockchain activities identified in other industries such as manufacturing, wholesale trade, and administrative and support services. There could be novel opportunities for blockchain application products and innovations to seize a first-mover advantage in these industries. Around 93% of blockchain activities have been undertaken by small-to-medium-sized organisations with 1 to 200 employees (see Figure 10). Indeed, a growing share of start-ups in Australia identify with the blockchain industry—up from 3.4% in 2016 to 8.1% in 2018.[47,48]

Analysis of blockchain activities also demonstrates that Australia is home to a number of world-first blockchain applications in: bonds operations,[49,50] smart programmable money,[13] a national blockchain system[44] and international standards,[51] as well as industry-specific trials in energy,[9] agriculture[52,53] and the public sector.[54] For a more detailed summary of some high-profile use case of blockchain, see Appendix D.

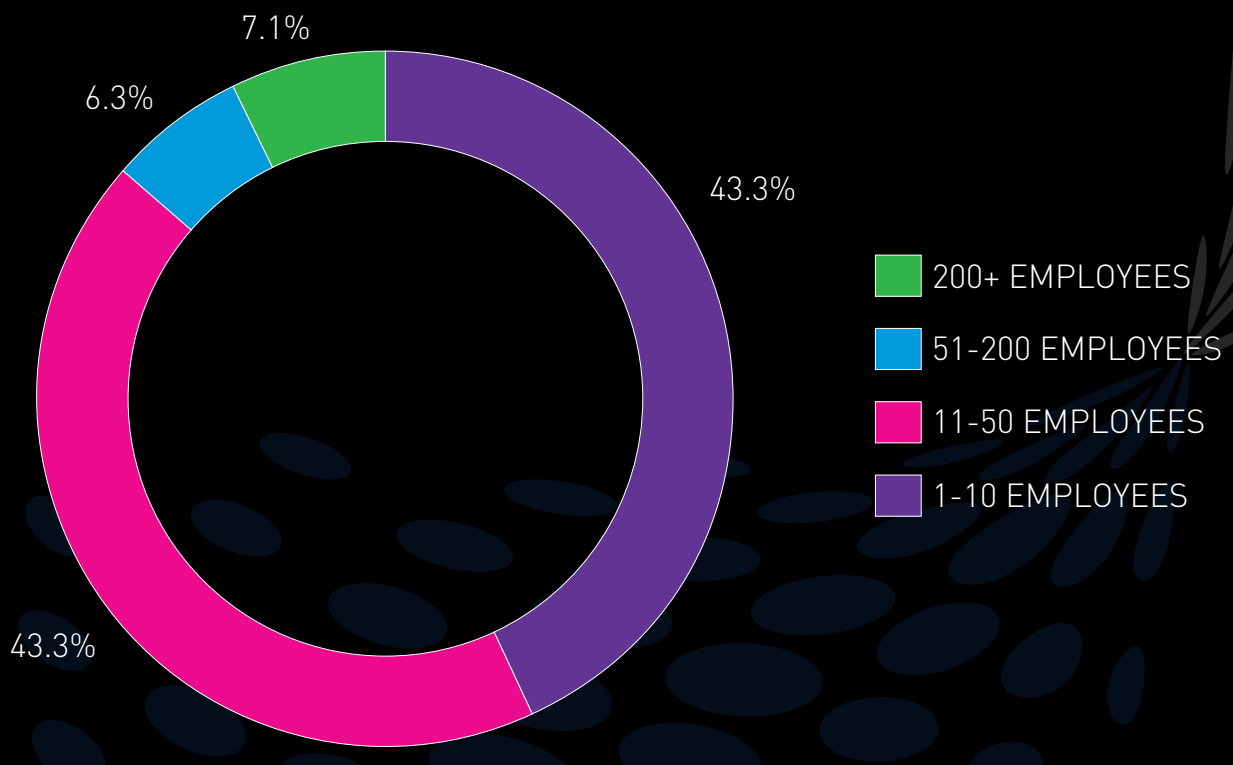


FIGURE 10. SHARE OF AUSTRALIAN BLOCKCHAIN ACTIVITIES BY COMPANY SIZE
Source: Data61 Australian blockchain activities dataset

The workforce of blockchain professionals

DEMAND FOR BLOCKCHAIN-RELATED SKILLS

Since the emergence of blockchain technology, the demand for blockchain-related skills has been growing globally.[55] Using online job advertisement data from Burning Glass Technologies (see Appendix C for details on methodology), Data61 analyses revealed that the number of blockchain-related job advertisements has grown rapidly in Australia over the past three years (see Figure 11). This indicates an increased demand for workers in blockchain in the Australian workforce. Analyses of US data from online job advertisements shows a similar, rapid increase from 500 job advertisements in 2014 to 3,958 in 2017.[56] The majority of Australian job openings in 2017–18 were in computer systems design and higher education sectors (see Figure 12).

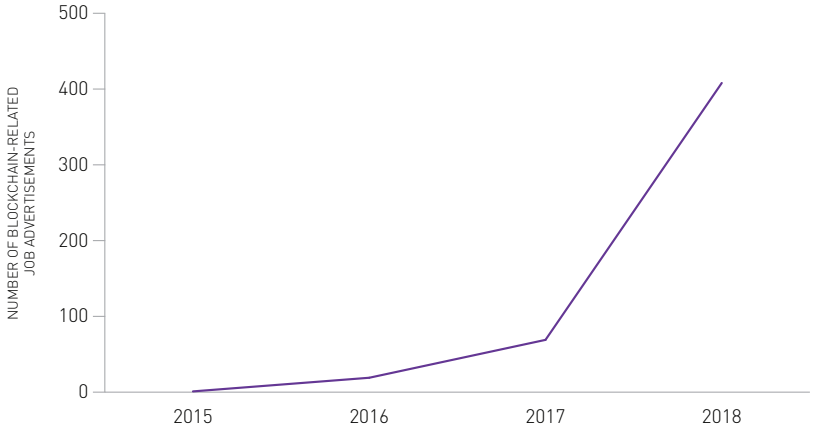


FIGURE 11. NUMBER OF BLOCKCHAIN-RELATED ONLINE JOB ADVERTISEMENTS IN AUSTRALIA
Source: Burning Glass Technologies[46]

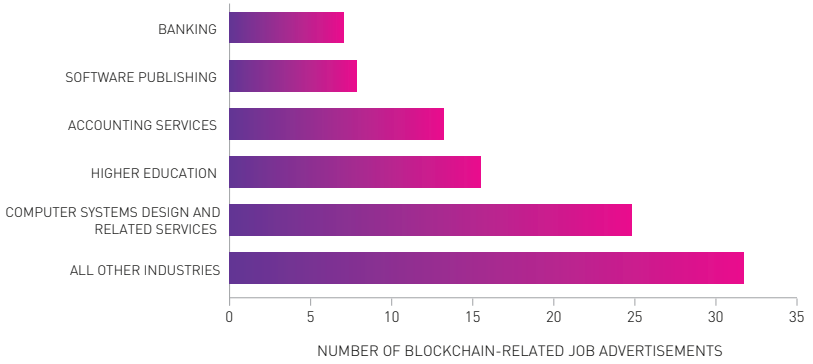


FIGURE 12. DEMAND FOR BLOCKCHAIN SPECIALISTS BY INDUSTRY
Source: Burning Glass Technologies[46]

The top five technical skills required for blockchain-related jobs are based on knowledge of mathematics and programming: JavaScript, artificial intelligence, machine learning, the Internet of Things and software engineering. However, analysis shows that blockchain specialists are also required to demonstrate complementary enterprise skills, including research, communication, problem solving, creativity and writing skills (see Figure 13).

The majority (97%) of blockchain jobs require at least a bachelor's degree. The higher education qualification requirement translates to a wage premium for blockchain professionals too. Almost 60% of blockchain-related jobs pay more than AUD$100,000 per year, compared to around 45% of professional jobs (see Figure 14). However, there is no evidence that blockchain developers have a wage premium compared to those in jobs with a comparable skillset, for instance, data scientists or software engineers.

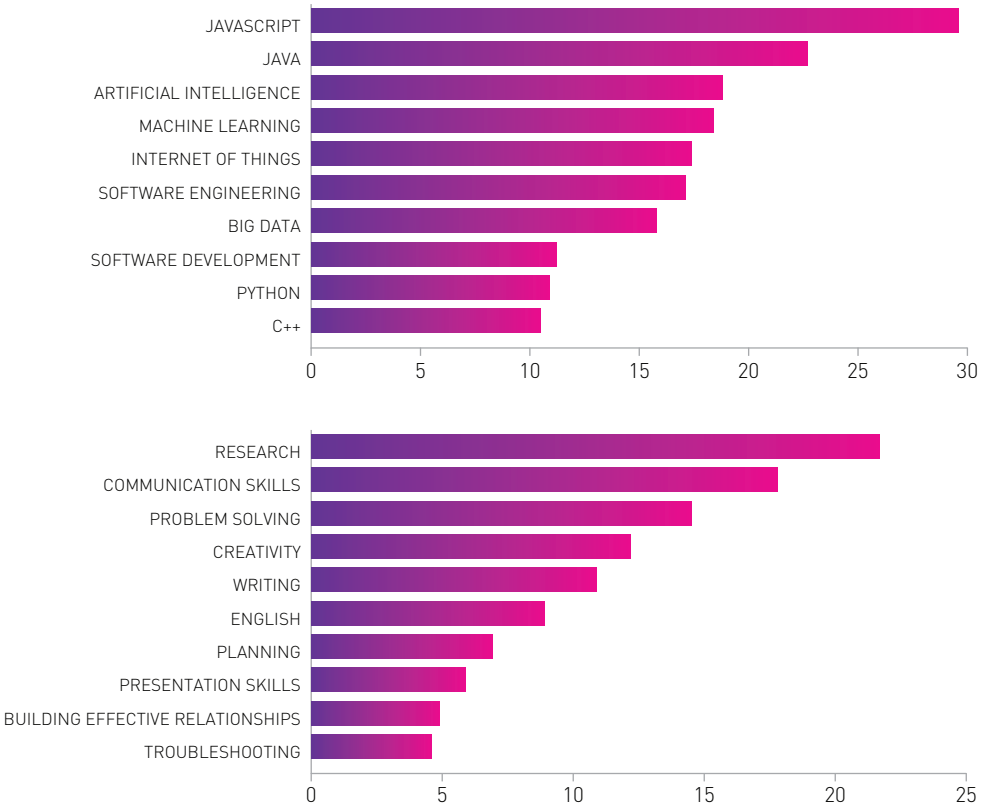


FIGURE 13. THE TOP 10 SPECIALISED TECHNICAL SKILLS (TOP) AND COMPLEMENTARY ENTERPRISE SKILLS (BOTTOM) REQUIRED FOR BLOCKCHAIN-RELATED JOBS
Source: Burning Glass Technologies[46]

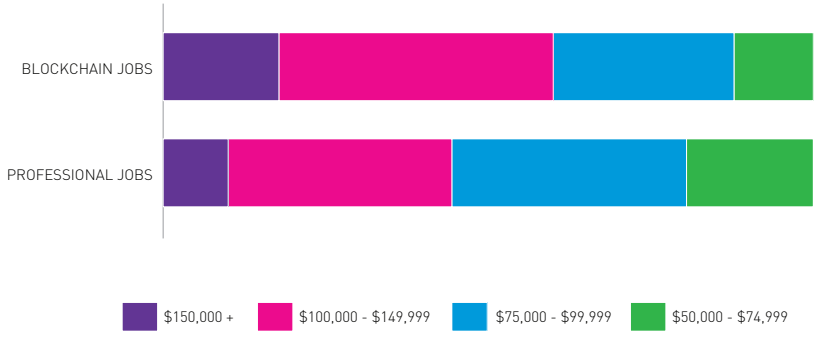


FIGURE 14. SALARY DISTRIBUTION OF JOBS IN BLOCKCHAIN AND OTHER PROFESSIONAL JOBS
Source: Burning Glass Technologies[46]
Note: Professional jobs are defined as jobs requiring at least a bachelor's degree

SUPPLY OF BLOCKCHAIN-RELATED SKILLS

The supply of blockchain-related skills has also increased along with demand. According to LinkedIn, since October 2013 there has been a 28-fold increase in the number of people citing cryptocurrency skills on their profiles (and a 5.5-fold increase in citing Bitcoin skills).[57] But this supply is not keeping pace with demand; one analysis suggests that there are 14 job openings for every blockchain developer.[58]

A lack of skilled workers with blockchain-related skills could impact future development and uptake of blockchain technology in Australia.

Australia currently has around 470,000 people in occupations using skills such as software development, computer networking, and information and communications technology (ICT) management.[59] With additional support and training, these workers could arguably transfer their skills into blockchain-related roles.

Relative to other countries though, Australia accounts for a small proportion of ICT graduates, with Singapore, Finland and New Zealand having larger shares (see Figure 15). Data from the Organisation for Economic Cooperation and Development (OECD) Programme for International Student Assessment also suggests that Australian high school students perform at a lower level than their peers in mathematics (see Figure 16).

Some Australian universities (e.g. RMIT and the University of Technology Sydney) have recently begun offering blockchain-related courses and modules, and the University of New South Wales also plans to follow suit and offer two new blockchain courses in 2019.[62,63] Despite this though, most of the training options for blockchain are provided online by providers such as Coursera, Edx and Udemy,[64-66] or single universities (e.g. University of Nicosia[67]).

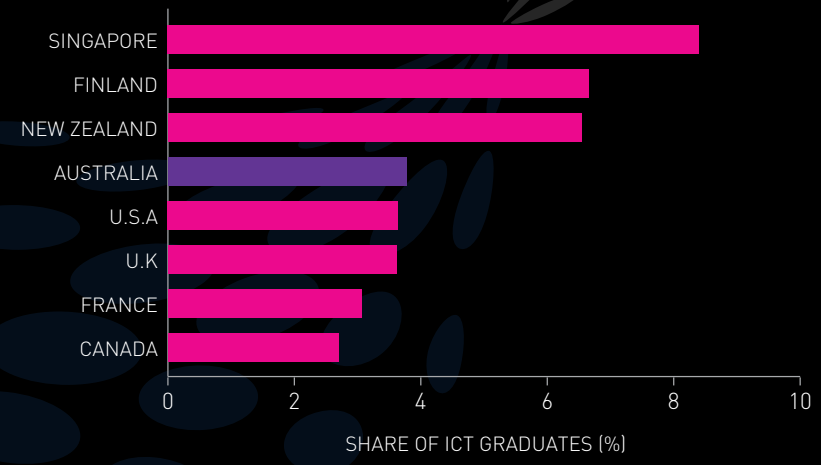


FIGURE 15. SHARE OF TERTIARY GRADUATES WITH INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) QUALIFICATION BY SELECTED COUNTRIES IN 2015
Source: UNESCO Institute of Statistics[60]

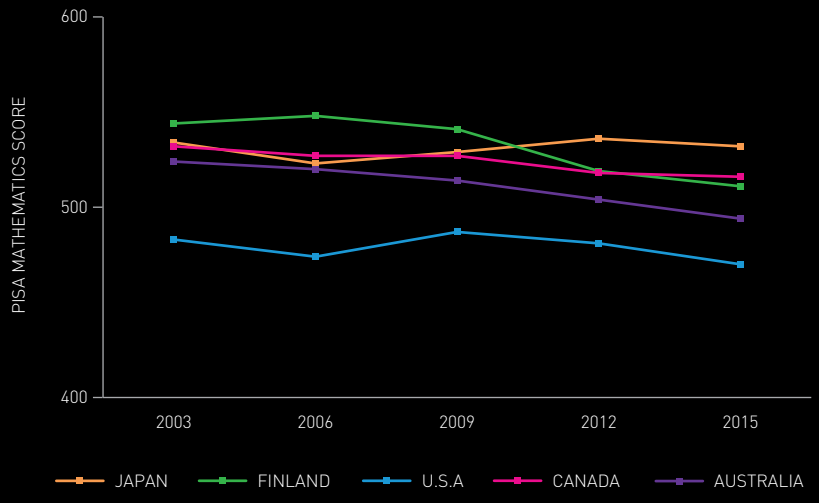


FIGURE 16. PROGRAMME FOR INTERNATIONAL STUDENT ASSESSMENT (PISA) PERFORMANCE OF HIGH SCHOOL STUDENTS IN MATHEMATICS BY SELECTED COUNTRIES
Source: OECD data for PISA[61]

04

FUTURE TRENDS SHAPING BLOCKCHAIN IN AUSTRALIA

This chapter explores the emerging trends shaping how blockchain is adopted and applied, and its impact on the Australian economy over the coming decade. These trends were informed by consultations with key industry and government representatives, along with a broad horizon scan of technological, economic, environmental, social and geopolitical literature. They draw on local, national and global examples of patterns of change that will likely impact blockchain adoption in the Australian economy and economies around the world. This evidence base was used in developing plausible future scenarios for blockchain adoption in Australia out to 2030 (see Chapter 5).

Technological and environmental trends

Computing power, memory and data storage capabilities continue to grow. In line with Moore's law, the density of transistors in computer chips has doubled every two years up to 2012 (see Figure 17). This has decreased the cost of computer power and enabled greater processing speed and memory capacity.[68,69] There are predictions that this trend could taper off in the next decade, as further shrinking of transistors becomes less technically feasible and economically desirable.[70,71] However, new technological developments suggest that there are other ways to continue increasing computing power and driving down costs associated with data processing and storage[72-74], including emerging off-chain storage solutions.[75] Growth in data storage and computing power could fuel future blockchain opportunities.

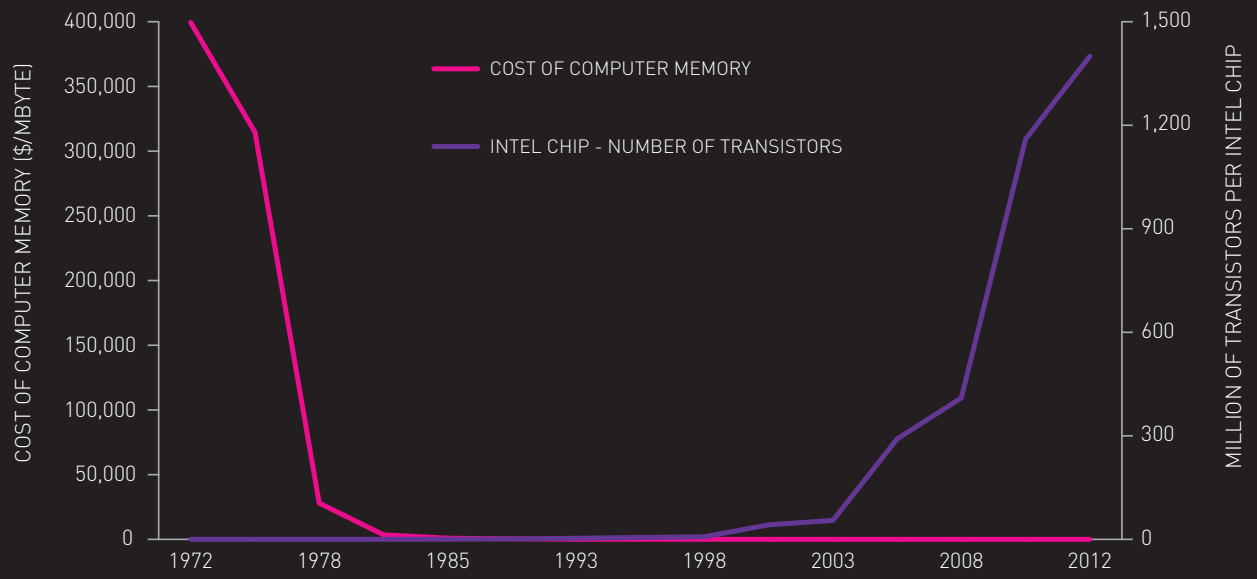


FIGURE 17. NUMBER OF TRANSISTORS PER INTEL CHIP AND COST OF COMPUTER MEMORY
Source: Intel Chips Timeline (2012),[68] Memory Prices (1957-2018)[69]

Growing internet connectivity opens new avenues for blockchain, but may be limited by digital infrastructure. Between 1993 and 2016, the global share of individuals using the internet grew from 0.3% to 45.9%, almost half of the world's population.[76] Increased internet connectivity allows for greater application of digital technologies, including blockchain. Availability, reliability and affordability of internet connectivity are essential for storing, mining and validating operations in a blockchain. Australia's broadband network falls behind global standards; however, in 2017 its average connectivity speed placed it 50th worldwide and ranked it in the middle of its Asia–Pacific neighbours (see Figure 18).

Blockchain technology is advancing. New developments signal that scalability for blockchain technology may be on the horizon; for instance, SegWit, an update to the Bitcoin Core software, increased transaction throughput by around 40%.[78] Throughput of new blockchain systems is also rapidly increasing; the Australian Red Belly Blockchain[79,80] can now handle 660,000 transactions per second on 300 machines,[81] compared to 2,000 transactions per second globally on the VISA network.[82] Scaling solutions such as Lightning Network[83], a second layer operating system on top of the blockchain, also raise the possibility of orders-of-magnitude scaling for public blockchains while largely retaining decentralisation. Forfeiting some decentralisation has also allowed for greater scaling. For instance, blockchains leveraging different consensus algorithms have been shown to handle much greater transaction loads (see Figure 19). Further advances in blockchain software and hardware will likely drive adoption and innovations.

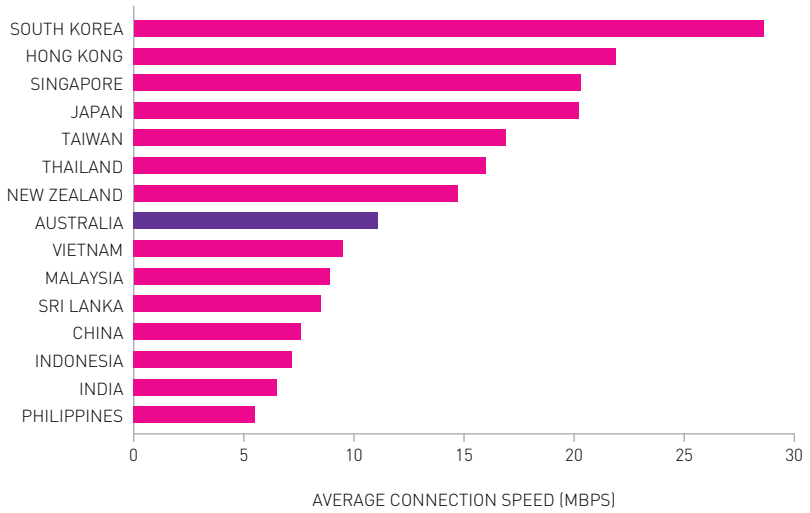


FIGURE 18. AVERAGE INTERNET CONNECTION SPEED ACROSS ASIA-PACIFIC COUNTRIES IN 2017
Source: Akamai[77]

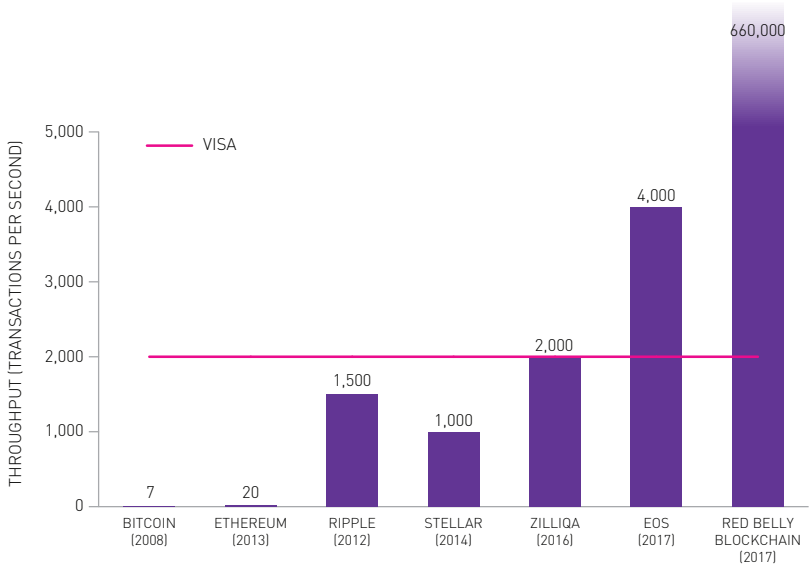


FIGURE 19. NUMBER OF TRANSACTIONS PER SECOND ACROSS DIFFERENT BLOCKCHAIN SYSTEMS
Source: Blocksplain,[71,84] Stellar,[85] Zilliga,[86] Red Belly Blockchain[80] and Coincodex[87]

Energy costs associated with Bitcoin mining are skyrocketing. Despite improvements in the energy efficiency of Bitcoin mining hardware,[88] it still consumes significant amounts of energy (see Figure 20),[88] and all Bitcoin mining energy consumption in Iceland is comparable to the total consumption of all households.[89] Researchers demonstrate that between 2016 and 2018, on average, mining one dollar worth of crypto-assets (Bitcoin, Ethereum, Litecoin and Monero) took more energy than it did to conventionally mine one dollar worth of copper or gold.[90] The 'low-hanging fruits' of mining energy cost reductions have already been picked, for example, by concentrating mining in regions with low electricity prices and in close proximity to energy-generating facilities including hydropower stations.[91] Further efficiencies might be gained by using the excess heat generated from mining computers (e.g. Bitcoin space heaters[92]). However, global environmental concerns around energy consumption could limit future blockchain adoption worldwide.[93]

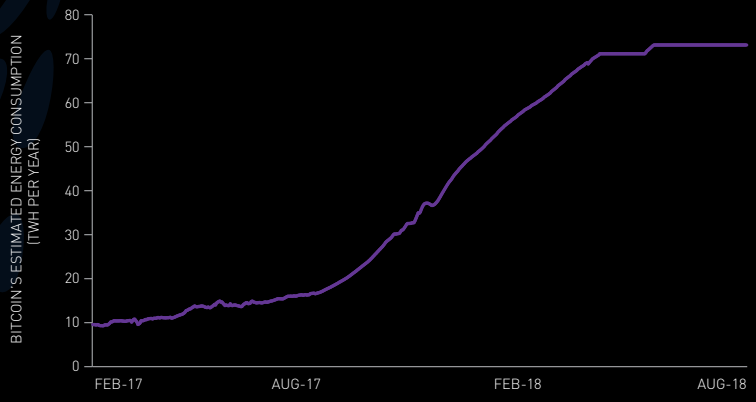


FIGURE 20. BITCOIN'S ESTIMATED ENERGY CONSUMPTION
Source: Digiconomist[94]

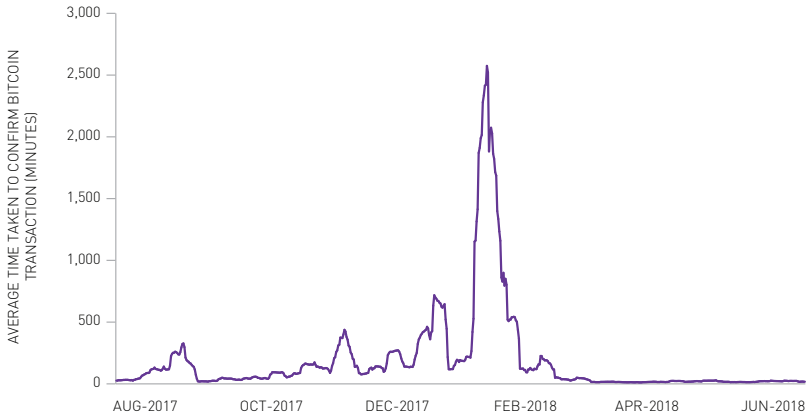


FIGURE 21. AVERAGE CONFIRMATION TIME FOR BITCOIN
Source: Blockchain[95]

Transaction costs on major blockchains can vary substantially. The time taken to confirm Bitcoin transactions in the first six months of 2018 was highly volatile, varying from 12 minutes to almost 43 hours per transaction, but this has since improved (see Figure 21). The spikes in demand can cause network congestion and slower processing times. For instance, in December 2017, the popularity of CryptoKitties—an online crypto-game that trades virtual collectable kittens—halted the processing of 30,000 transactions in the Ethereum network.[96] As the slowing hype pushes down the price of cryptocurrencies like Bitcoin, it is estimated that miners only break-even on operating costs when the price of Bitcoin is around AUD$9,700.[97] Below this price, it is unprofitable to mine.

New protocols and crypto-economic incentives (e.g. fees, mining rewards, alternative consensus reaching systems such as proof-of-stake[98]) may improve the scalability of blockchains using proof-of-work algorithms in the future. However, further technological advancement will be required for blockchain technology to feasibly provide high-speed and low-cost transactions at scale.

Cyber security is a growing concern (and opportunity) for blockchain businesses.

The number of cyber attacks in Australia continued to rise in 2018 (see Figure 22). Blockchains are not immune to this risk. In fact, the hype around blockchain technology, as well as its rapid growth, development and innovation, arguably makes many blockchain applications an easier target for cyber attacks. There has been a suite of reported attacks in recent years, including data exfiltration of the wallets and users' keys. For instance, in January 2018, Coincheck lost roughly AUD$584 million in NEM coins, making it one of the largest losses of cryptocurrency through a security breach.[18,100] As blockchain technology matures, so too does the cyber security risk,[18] with some cybercrime methods applying specifically to blockchain. For example, a malicious Google Chrome plug-in mined cryptocurrency coins without device users realising it.[18] Some estimates suggest that crypto-hacking has grown into an industry worth AUD$266 million in annual revenue in 2018.[101] At the same time, the rise of cybercriminal activity creates new market opportunities for cyber security firms and service providers to offer secure blockchain activity solutions.[101]

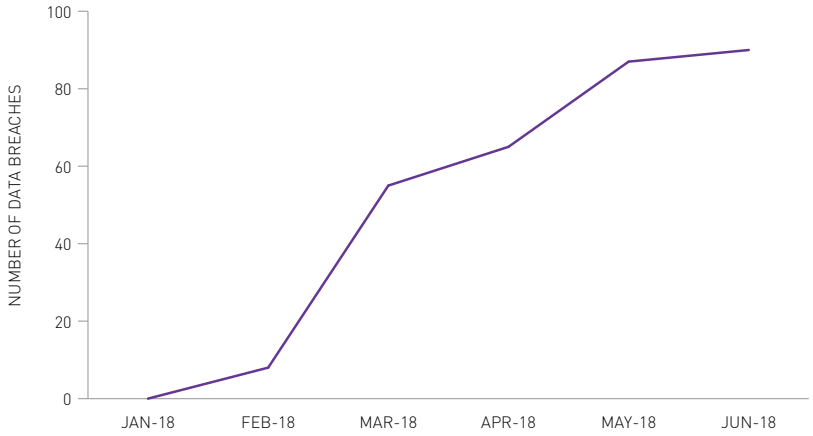


FIGURE 22. NUMBER OF DATA BREACHES REPORTED UNDER THE NOTIFIABLE DATA BREACHES SCHEME IN AUSTRALIA
Source: Office of the Australian Information Commissioner[99]

The emergence of a dominant blockchain design could accelerate future developments.

When a product design acquires over 50% of the market for a significant period of time, it is considered the 'dominant design'.[102] The presence of a dominant design helps to standardise the market, as Microsoft and Apple have done for personal computing. At present, there are no dominant blockchain designs. Future dominant blockchain solutions will need to overcome the challenges of scalability, speed, flexibility and interoperability. Once a dominant design emerges and is widely accepted, it could serve as an industry standard and reduce adoption costs through cumulative learning.

Economic trends

The peer-to-peer economy is growing. The peer-to-peer economy is providing new opportunities to connect buyers with sellers, and employers with employees. Popular marketplaces such as Freelancer, Upwork, Kaggle, Etsy and Madeit allow people to both outsource tasks and connect with sellers for a wide range of products and services. The peer-to-peer marketplace has also enabled new business models to emerge; for instance, in transport, new app-based mobility services like Uber, Lyft and Ola have come online. The proportion of people aged 14 years and older using Uber in Australia alone has grown from 5.1% in 2016 to 18.4% in 2017.[103,104] The decentralised nature of peer-to-peer economies could facilitate uptake of future blockchain solutions, and also indicates the preparedness of businesses and consumers to adopt decentralised solutions.

Global blockchain funding is growing. All-time cumulative venture capital funding in blockchain has grown at an accelerated pace, up from AUD$1.9 million in 2012 to AUD$7.6 billion as of November 2018.[105] Similarly, both the number and cumulative sum of ICOs has shown exponential growth from 2014 to 2018 (see Figure 23). Increased funding for blockchain could be a precursor to innovation and adoption. However, some researchers see the hype around ICOs as analogous to a gold rush,[106] and predict that blockchain's accelerating funding growth will level out in future, with investors seeking real returns from venture capital recipients and ICO issuers.

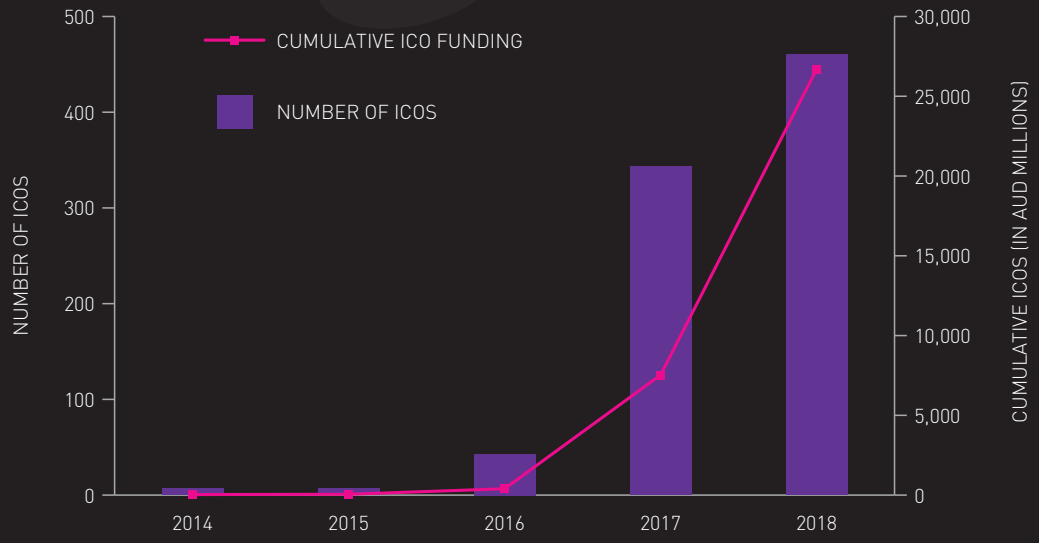


FIGURE 23. NUMBER OF INITIAL COIN OFFERINGS (ICOS) AND CUMULATIVE ICO FUNDING GLOBALLY (UP UNTIL NOVEMBER 2018)
Source: Coindesk ICO Tracker[107]

Flexible workforce arrangements are on the rise. The workforce is becoming more flexible as emerging generations of workers increasingly demand flexible working environments.[108,109] Flexible working arrangements are also enabled by technology, with enhanced connectivity providing opportunities for people to work as mobile, portfolio workers and earn a living based on their outputs rather than having a fixed place of employment. The popularity of these employment models is evident from the increased number of co-working centres,[110] but also in the increasing share of part-time workers in Australia (see Figure 24). Management of flexible working arrangements could reflect a potential use case for future blockchain, in providing assurance around digital identity and payments for individual contractors.

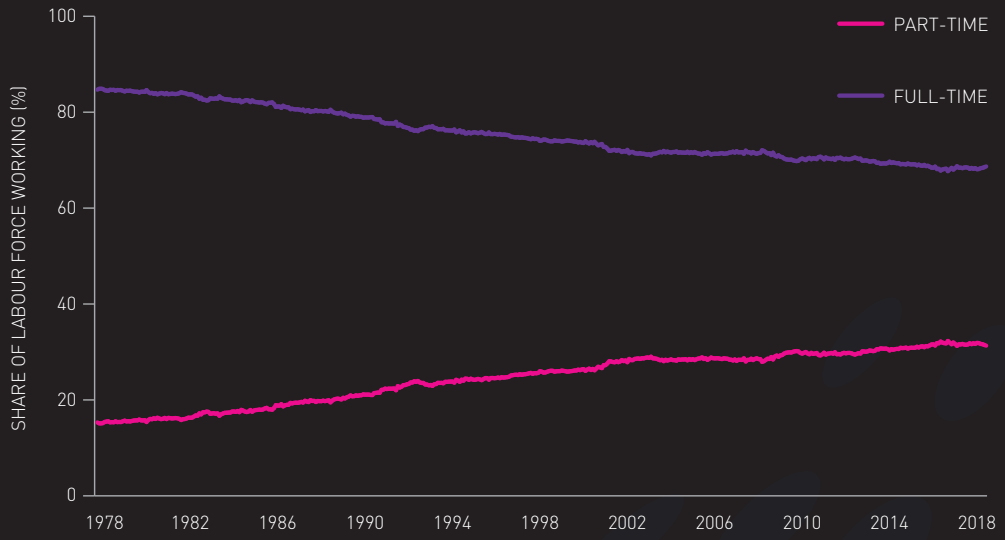


FIGURE 24. SHARE OF FULL-TIME EMPLOYEES AND PART-TIME EMPLOYEES IN AUSTRALIA
Source: Australian Bureau of Statistics[111]

Australia has become a net exporter of ICT services, but there is still much potential for growth. Australia ranked in 13th place out of a selection of 16 countries worldwide in terms of its share of exports classified as ICT exports, which totalled $3.2 billion in 2016–17.[112] Australia's position lags behind other countries on ICT services as a share of total exports; in 2016, ICT comprised only 1.0% of Australia's total exports, compared to 12.0% in Israel and 3.2% in the United Kingdom.[112] Australia has also become a net exporter of ICT services, with ICT services exports higher than imports in 2016–17 following a period of being a net importer. However, while the proportion of ICT-related exports has improved in Australia, up from 12th place in 2011[112], the pace of change has been slow.[112] Blockchain, along with other growing technology domains like artificial intelligence, robotics and cyber security, could provide new ICT services export opportunities for Australia.

Blockchains could help reduce business costs, particularly in banking. According to Accenture estimates, a blockchain-based database system in banking could cut central finance reporting costs by 70%, with a 50% reduction in business and central operational costs and 50% of compliance costs.[113] These cost efficiencies arise from more streamlined data sharing, improved quality, and greater transparency and auditability of transactions.[113] Analyses by Santander also suggest that DLT could cut the banks' infrastructure costs by $15–20 billion annually by 2022, via savings on cross-border payments, securities trading and regulatory compliance.[114] The cost savings provided by blockchain could fuel future adoption.

Entrepreneurs and start-ups could drive the future economy. In 2017, small-to-medium-sized enterprises created around seven million jobs and contributed 57% of Australia's gross domestic product.[115] Economy-wide, small-to-medium-sized enterprises also generate the largest share of new jobs.[116] Start-ups in the blockchain sector have been growing their share of the industry over time too. According to Startup Muster, 8.1% of start-ups in Australia associate their business with the blockchain industry, compared to 3.4% in 2016.[48,47] While start-ups and SMEs have the potential to drive growth in both the blockchain sector and the broader economy, there is also high risk within this space given the high start-up failure rates[117,118]. Blockchain start-ups are no exception - one study estimates that only 44% of blockchain start-ups survive 120 days beyond their ICO.[119] Effective innovation may therefore need to be backed by larger players.

Geopolitical trends

Growth in Asian economies presents opportunities and competition for Australia's blockchain industry. Driven by a growing Asian middle class,[120] the world's economic 'centre of gravity' — the average location of economic activity across geographies on Earth — is shifting eastwards, and is expected to fall between China and India by 2050.[121] These changes present opportunities for Australia to export goods and services to economies in the Asia-Pacific, as well as challenges due to increased competition for emerging markets. Global Market Insights estimates a 50% increase in the number of investments in blockchain-related start-ups from 2016–17, and that the blockchain industry will be worth AUD$21.28 billion by 2024.[122] One of the most promising regional market applications for blockchain is in remittances from migrant workers. The value of these remittances reached AUD$169 billion in 2016 and is projected to continue growing (see Figure 25), with the region containing seven out of ten of the top-receiving countries.[123] The United Nations Sustainable Development Goals aim to reduce remittance fees to less than 3% by 2030,[85] but the average was 7.5% in 2017,[123,124] making this a potential area for cost-reducing blockchain solutions.

China is dominating the global cryptocurrency market. China is the world leader in mining hardware development and production, with Bitmain, a Chinese chip maker for Bitcoin mining, earning as much as AUD$3.9 billion in 2017—a figure on par with longstanding US chip giant Nvidia.[125] Bitmain derives its revenue from hardware sales and from extensive cryptocurrency mining operations.[126] The majority of mining pools also reside in China[127]. Moreover, China is home to the largest share of blockchain-related patents, with 1,581 patent families filed in 2018, compared to Australia, which was ranked 6th with 84 patent families.[128] China's strengths in cryptocurrency could pose strong competition for the Australian cryptocurrency industry in the future. Furthermore, the centralisation of mining could be used to manipulate the crypto-markets and deter blockchain adoption by harming the perceived decentralisation benefits of blockchain.

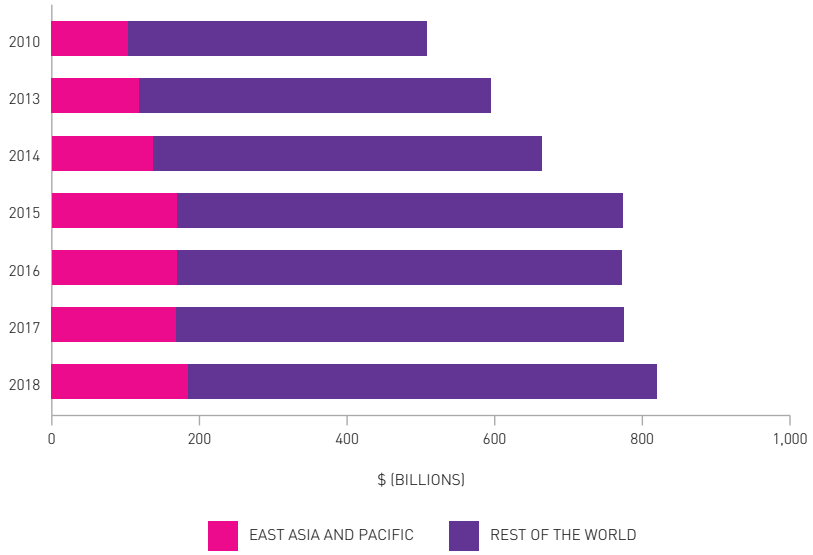


FIGURE 25. ESITIMATED REMITTANCE FLOWS TO EAST ASIA AND PACIFIC, COMPARED TO THE REST OF THE WORLD
Source: World Bank[123] and RBA exchange rates[23]
Note: 2017 and 2018 values represent future projections

Supply of and demand for skilled talent is increasing in the Asia-Pacific region. By 2020, the OECD estimates that 40% of higher education graduates will come from China and India.[129] Australian employers are also increasingly demanding workers with higher skill levels (see Figure 26). As the supply of overseas talent increases, competition in the workforce could intensify in the coming years. On the other hand, the Asia-Pacific region could provide employment opportunities for Australian workers in emerging technology domains, including the blockchain industry. For instance, the Asia-Pacific region is rapidly becoming the financial technology centre of the world,[130] with Singapore already having one of the world's highest concentrations of FinTech accelerators.[131] Taking advantage of business opportunities in the region will require international collaboration and cross-border consumer protection regulations.[130]

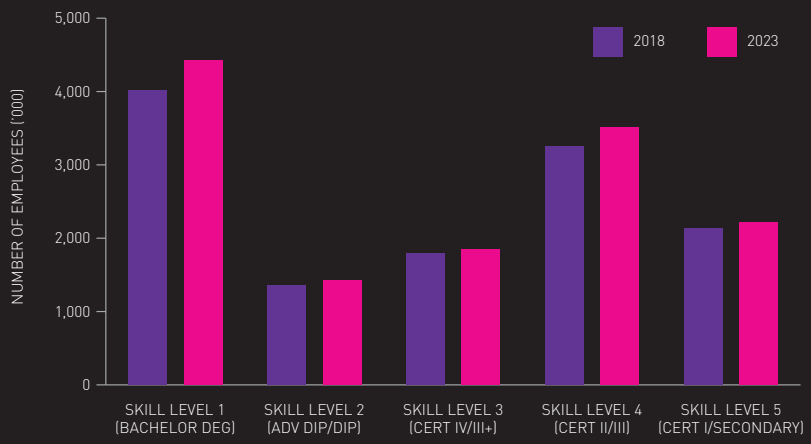


FIGURE 26. NUMBER OF EMPLOYED PERSONS IN AUSTRALIA BY SKILL LEVEL
Source: Australian Government Department of Jobs and Small Business[132]
Note: Skill Level 1 (Bachelor's degree or higher qualification), Skill Level 2 (Advanced Diploma or Diploma), Skill Level 3 (Certificate IV or III, including at least 2 years on-the-job training), Skill Level 4 (Certificate II or III), Skill Level 5 (Certificate I or secondary education)

E-government applications are growing, with some using blockchain technologies.

E-government practices have become more common, with the average E-Government Development Index score—a measure of readiness and capacity of governments to use ICT to deliver public services—for United Nations economies growing from 0.47 to 0.55 between 2013 and 2018. The Australian Government was placed second in 2018, with a score of 0.93 (range = 0, lowest to 1, highest).[133] Estonia has led the way with its use of blockchain for public services, including registries in areas such as security and commercial code, and legislative, judicial and national health systems.[134] With more public services going digital, demand for blockchain innovations in government could grow in the future, including in voting practices.

Social trends

It is increasingly difficult to distinguish fact from fiction. 'Post-truth' was the Oxford Dictionary's 2016 Word of the Year,[135] and there has been a spike in the word's use in the wake of major geopolitical events such as Brexit and the election of Donald Trump. Post-truth is evidenced by the increasing appeal to emotions and personal beliefs for the swaying of public opinion, rather than objective facts and logical argument.[136] Social media platforms such as Facebook could strengthen post-truth conditions, possibly fostering echo chambers of partisan opinions and the use of targeted political advertisements based on individual political views.[137] Blockchain consensus protocols can aid in gaining a consensus view of truth, and could function to safeguard the truth whilst providing adopters with their own record of the 'truth'.

Income has become more unequal in Australia and in most other OECD countries. Between 2005 and 2016, the Australian Gini coefficient—a measure of the distribution of income and wealth across the population—grew from 0.31 to 0.32 (range = 0, perfect equality to 1, perfect inequality).[138] There has been disproportionate income growth between poor and wealthy households in Australia, with the lowest quintile seeing less than 5% growth between 2004 and 2014, compared to the highest quintile (40% growth).[139] Given rising inequality has been associated with declining social trust,[140] there may be opportunities in the future to use blockchains to address distrust in intermediaries or social inequalities.[141]

The digital divide is widening in Australia. Australia-wide scores on the Australian Digital Inclusion Index—a measure of digital inequalities based on digital access, affordability and ability—have been improving (see Figure 27). These increases have been driven by improvements in all three digital domains, but the greatest improvements have been seen in digital access (i.e. access to the internet).[142] However, key digital divides across Australian society have been widening over this period, for instance, the gap between younger and older Australians, and the gap between metropolitan and regional/rural areas across Australia.[142] Levels of digital inclusion could impact the extent to which some segments of the Australian community can adopt and participate in blockchain innovations.

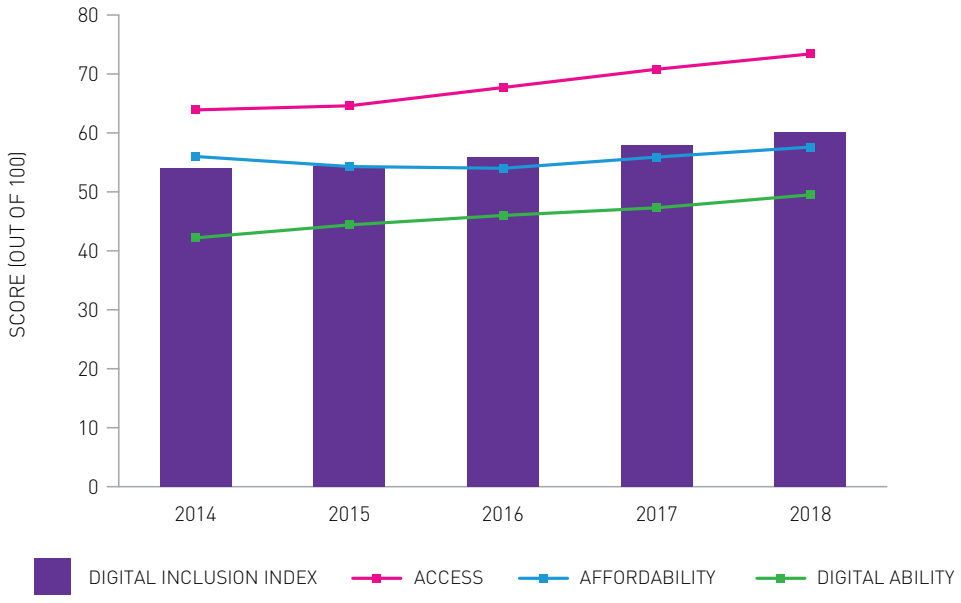


FIGURE 27. DIGITAL INCLUSION SCORES AND SUB-INDEX SCORES FOR ACCCESS, AVAILABILITY AND DIGITAL SKILLS IN AUSTRALIA
Source: Thomas et al.[142]

Consumer demand for provenance is high. Tracking the ownership and handling of physical assets in supply chains has been identified as a use case for blockchain technologies, providing assurance around the provenance of those goods.[2] There are a number of noteworthy Australian examples of provenance-based blockchain business, including AgriDigital, Everledger and BeefLedger. Of 1,220 Australian consumers surveyed in 2015, the majority reported that country of origin labelling is important or very important to them (see Figure 28), and 54% would be willing to pay an extra 5% in their weekly food budget for country of origin labelling.[143] These findings indicate the importance of provenance in consumer purchases, which could fuel further blockchain innovations for supply chains in Australia and abroad. But provenance use case for blockchain could also depend on the usability of blockchain solutions and the quality of data on the blockchain.

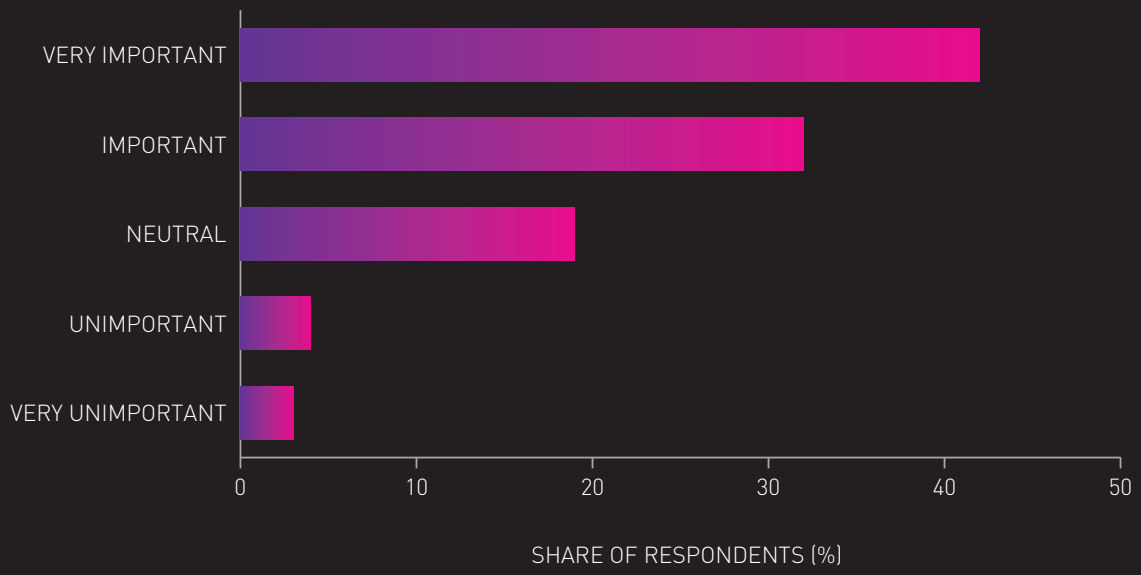
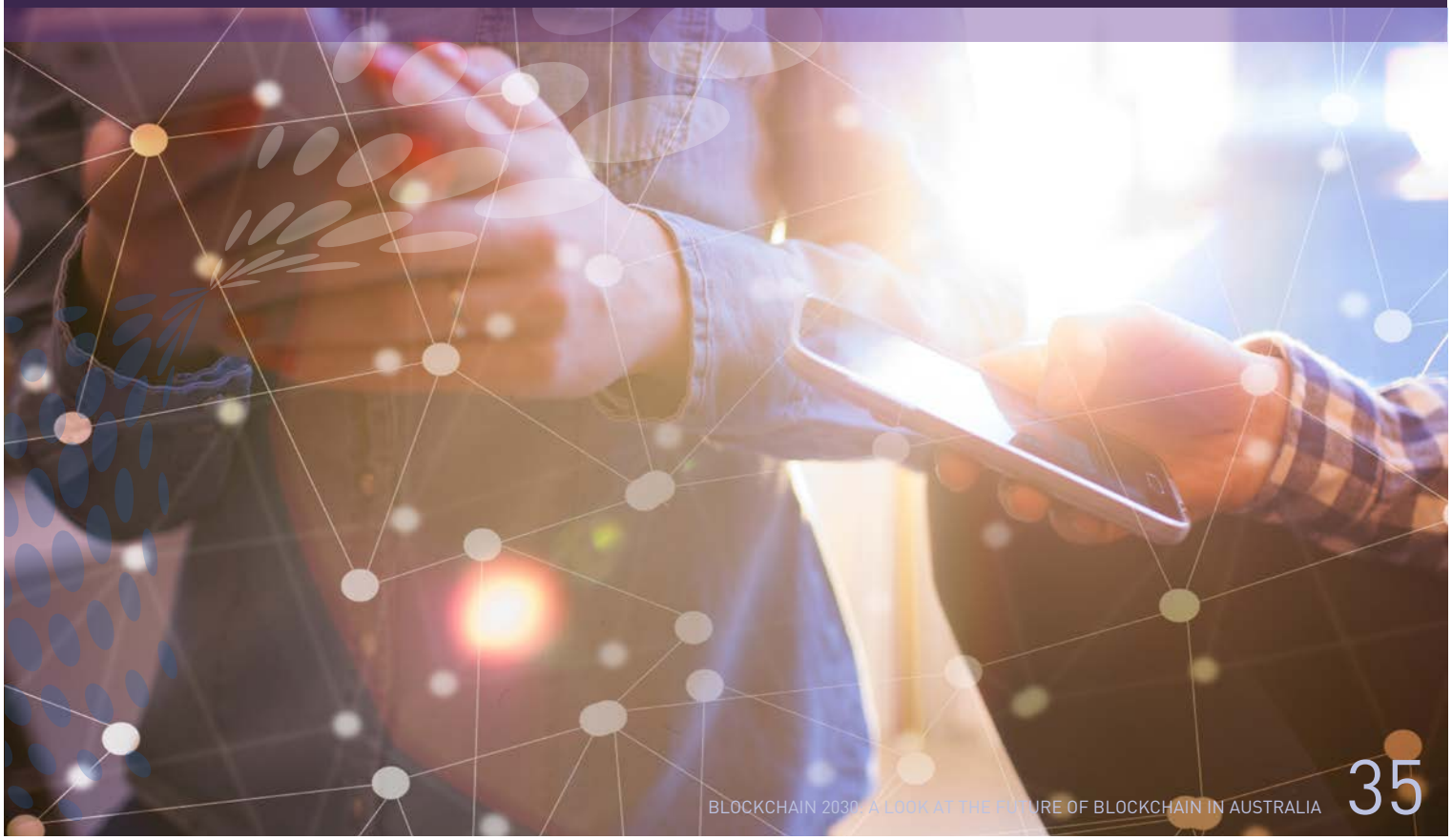


FIGURE 28. CONSUMER RESPONSES WHEN POSED WITH THE QUESTION: 'HOW IMPORTANT IS COUNTRY OF ORIGIN LABELLING FOR CONSUMERS?'
Source: Colmar Brunton[143]



Privacy concerns could drive future blockchain applications. A 2014 survey found that 61% of Australian internet users were concerned about the potential for new technologies to invade their privacy.[144] Moreover, the Office of the Australian Information Commissioner found that 48% of respondents saw online services and social media as the greatest risk to their privacy and one-third had experienced a problem in the way their personal information was handled in the preceding year.[145] Growing privacy concerns could incentivise blockchain adoption, particularly given the potentially privacy-preserving features of public blockchains.[146,147] Permissioned blockchains can also maintain privacy by closing database access to authorised users only when the pseudonymity of unpermissioned blockchains could be insufficient.

There is a growing gap between supply and demand of science, technology, engineering and mathematics skills in Australia. ACS Australia's Digital Pulse estimates that Australia will need 100,000 more technology workers by 2023.[112] This demand is driven by the growing adoption of digital technologies across the economy, and as shown in Chapter 3, this growing demand for skilled workers is also evident in the Australian blockchain industry. Access to talent will be a key component in growing Australia's blockchain industry, and indeed, its other technology-enabled industries. The majority of enrolments in non-school qualifications, however, are in non-STEM (science, technology, engineering and mathematics) related fields (see Figure 29), posing a potential risk for Australia's future supply of blockchain-related skills.

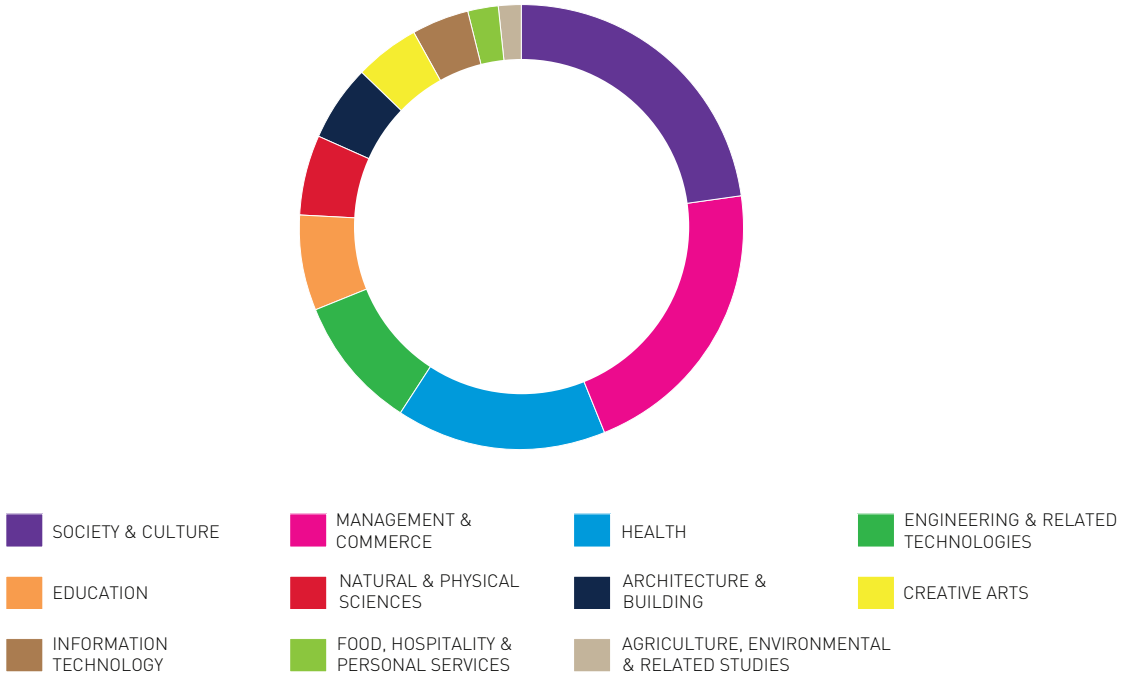


FIGURE 29. CURRENT ENROLMENTS FOR NON-SCHOOL QUALIFICATION IN AUSTRALIA IN MAY 2018 BY FIELD OF STUDY
Source: Australian Bureau of Statistics[148]

Gender gaps in science, technology, engineering and mathematics (STEM) fields are not closing. Females are still under-represented in a wide selection of STEM-related fields; they make up only 16% of university and vocational education and training (VET) STEM graduates, 17% of STEM professors and 40% of junior STEM academics.[149] Moreover, female graduates are more likely to be in biology and agricultural degrees (51–59%) over information technology and engineering degrees (13-14%).[149] Despite these gender imbalances, organisations such as 'Women in Blockchain Global' are helping to support women in the blockchain industry. Failing to address these gender gaps could hinder access to talent and progress in the Australian blockchain industry in the future.

05

Future scenarios for blockchain adoption

The trends identified in this report highlight a range of factors that could impact the future of blockchain adoption. But these factors do not point towards a single future. Some trends will reflect opposing forces, generating areas of critical impact and uncertainty for the future of blockchain adoption. In scenario planning, these domains of critical impact and uncertainty can be treated as continuums (or axes), which combine to yield future scenarios. These scenarios aim to provide a simplified model of a much more complex reality that can help to inform future decision-making.

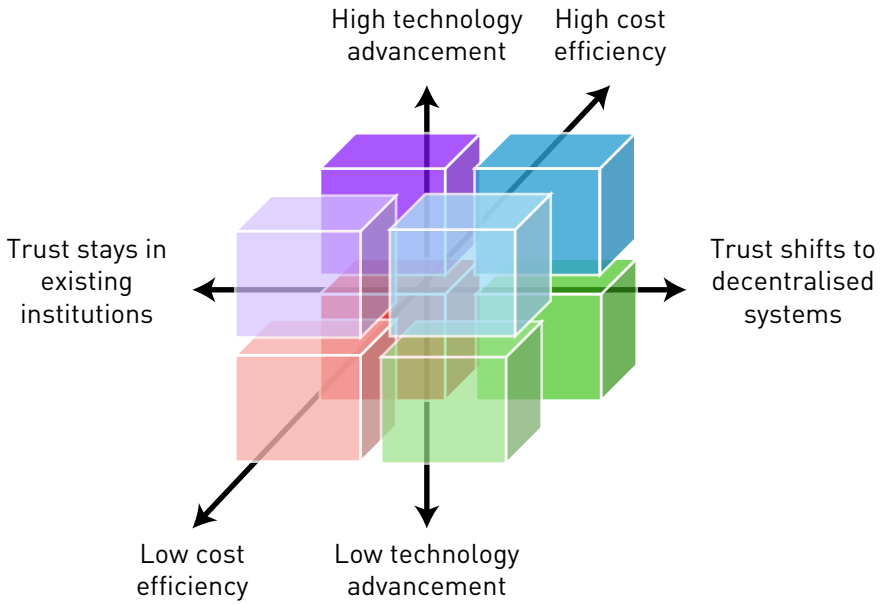


FIGURE 30. SCENARIO AXES FOR THE FUTURE OF BLOCKCHAIN ADOPTION IN AUSTRALIA

To account for the complexity and diversity of plausible blockchain futures, this report identified three axes of critical impact and uncertainty for the future of blockchain adoption. The intersection of these axes gave rise to four scenario groups, each containing two scenarios (see Figure 30). These scenarios capture the subtleties of labour and industry impacts and help illuminate how in combination the three areas of uncertainty could shape the future of blockchain in Australia. Informed by consultations with key government, academic and industry stakeholders, the axes were identified as:

TECHNOLOGY ADVANCEMENT

Will it be feasible to scale blockchain technologies and resolve the conflicts of confidentiality vs transparency, and decentralisation vs scalable consistency? Or will blockchain applications remain limited by these constraints?

SOCIAL TRUST

Will social trust shift from existing institutions to decentralised peer-to-peer systems, some of which may draw upon blockchain algorithms? Or will governments, industries and communities continue to place their trust in established intermediaries?

COST EFFICIENCY

Will it be cheaper to implement and operate blockchain systems over legacy software systems? Or will the costs associated with operating and integrating blockchain solutions with other systems be too high to deem blockchain a viable option?

Axes of critical impact and uncertainty

Technology advancement axis

As the use of blockchain increases, some of the conflicts within blockchain technology (e.g. between confidentiality and transparency, and scalable consistency and decentralisation) become more pressing. Blockchain systems also become increasingly high-profile and attractive targets for cybercrime. This axis captures the uncertainty regarding whether blockchain technology is able to advance significantly, or whether it is fundamentally limited by technical constraints.

LOW ENDPOINT: LOW TECHNOLOGY ADVANCEMENT

A future where blockchain technology regresses from its current state was not considered plausible. As such, even at the low endpoint of this axis, there has been some advancement from today. Blockchain storage capabilities have improved due to the uptake of off-chain data storage solutions,[75] as have transaction processing times and energy efficiency due to new consensus algorithms. However, these improvements are still insufficient to manage the volume of transactions on the blockchain at global scale, and transaction costs remain high. Computational capacity limits could act as a major barrier to blockchain technological advancement, as computing power growth according to Moore's law is likely to slow down in the next decade.[70,71,150] There are already signs of an approaching limit to computational capacity of major systems, including volatile Bitcoin transaction times,[95] and the cases of Ethereum network congestion.[96] Regulatory failures could also be a factor driving this future if regulatory reform does not take place fast enough to allow for technological innovation.

HIGH ENDPOINT: HIGH TECHNOLOGY ADVANCEMENT

Current trends in computing power show consistent growth, which is leading to reduced costs, faster processing speeds and greater memory capacity.[68,69] Despite the potential slowing of Moore's law, new innovations demonstrate great potential for continually improving computing power.[72-74] In this future, blockchains are capable of providing scalable, trusted, decentralised solutions with high levels of confidentiality, transparency and consistency. Technological constraints (storage, processing time, verification and mining) have largely been overcome or mitigated, some via technological developments already observable in 2018; for instance, blockchains with transaction speeds exceeding those of the VISA network,[81,82] or second-layer operating systems that improve scalability.[83] These and other technologies have continued to advance, making technically scalable blockchains possible by 2030.

Social trust axis

This axis explores the evolution of social trust in blockchain systems. In recent years, declining levels of trust in institutions[30,31] have coincided with the increasing popularity of online, internet-mediated services (e.g. news, social networks, financial systems and public services). This has also accompanied the rise of decentralised peer-to-peer platforms and indicates a changing landscape of social trust.[151] However, it is still highly uncertain whether Australian businesses and communities will trust the complex and often opaque mechanisms behind decentralised ledgers and platforms more than established institutions, such as banks, governments, media and real estate agencies. This axis captures this uncertainty.

LOW ENDPOINT: TRUST STAYS IN EXISTING INSTITUTIONS

This endpoint illustrates a future with minimal change compared to 2018. By 2030, people use some peer-to-peer platforms for basic transactions, but in general still prefer to deal with the same trusted intermediaries as they did in 2018 for all major matters (e.g. big banks, well-known e-commerce companies and mainstream social media platforms).

This future is plausible given the increasing number of reported scams associated with cryptocurrencies,[152] as well as the general association of blockchain with illegality stemming from the use of Bitcoin to conduct illegal activities.[153] Public distrust is also likely to be fuelled by the low levels of 'blockchain literacy'; a 2017 study found that 59% of respondents had not heard of blockchain and 80% did not understand it.[154]

HIGH ENDPOINT: TRUST SHIFTS TO DECENTRALISED SYSTEMS

At this endpoint, the trust that was once placed in established intermediaries has now shifted to decentralised models based on distributed computing. This future may be brought about by a number of factors, including the growing popularity of platform businesses as alternatives to centralised models.[155] The sharing economy is estimated to grow from AUD$15.5 billion in 2014 to AUD$446 billion by 2025.[156] Distrust of centralised intermediaries could also catalyse this future; between 2017 and 2018, Australians showed a marked decline in trust of non-government organisations, businesses and government, down 4%, 3% and 2% respectively.[157] Recent scandals involving major intermediaries, including many Australian banks[32] and Facebook[33], have also brought issues of trust and privacy to the fore. Such incidents could continue to drive consumers to seek out decentralised solutions, thereby boosting blockchain innovation and adoption.

Cost efficiency axis

This axis considers the cost efficiency of blockchain technology relative to legacy software systems in 2030, in terms of the transition and operation costs. Transition costs, including staff training, are those associated with developing blockchain solutions and integrating them with legacy systems. In economics terms, these are short-term fixed costs. Operation costs are variable and include those required to run the machines, monitor, process and add transactions. Such costs could include the cost of equipment, electricity and overheads, as well as environmental costs.

LOW ENDPOINT: LOW COST EFFICIENCY

This endpoint describes a future where blockchains do not reduce costs as much as anticipated relative to legacy systems. Transitioning to blockchain from legacy systems has been costly, largely because labour shortages for skilled blockchain developers have driven up wage costs. Such skill shortages are already evident in 2018, with 14 job openings for every blockchain developer.[58] Operational costs have also remained high, with the mining fees required to cover costly mining hardware[26] and significant energy consumption[89] contributing to limited cost efficiency.

HIGH ENDPOINT: HIGH COST EFFICIENCY

At this endpoint, blockchain applications offer significant cost efficiency for government, businesses and the general public. Current trends indicate the plausibility of this future state, with research suggesting that blockchain could radically reduce reporting, operational, compliance and infrastructure costs in the banking[113,114] and public sectors. In line with current improvements in the energy efficiency of mining hardware[88], new consensus algorithms and energy-preserving innovations[92], this future would see continued reductions in operational costs.

Plausible blockchain adoption scenarios

Scenarios are plausible and evidence-based narratives about the future, which extend the consequences of current trends forward in time. Because there are critical uncertainties about the future of blockchain adoption in Australia, multiple scenarios are possible. The following eight scenarios were developed to explore plausible futures for blockchain adoption in Australia out to 2030. These scenarios propose future trajectories for blockchain adoption based on its current predicted position in the Gartner Technology Hype Cycle (see Figure 31). Rather than predicting or forecasting the future, each scenario presents a snapshot of a different future, driven by various combinations of trends along the three axes. These scenarios are designed to challenge the thinking of industry, government and community stakeholders, and provoke discussion of plausible 'sunny' and 'rainy' days ahead for blockchain adoption in Australia.[2]

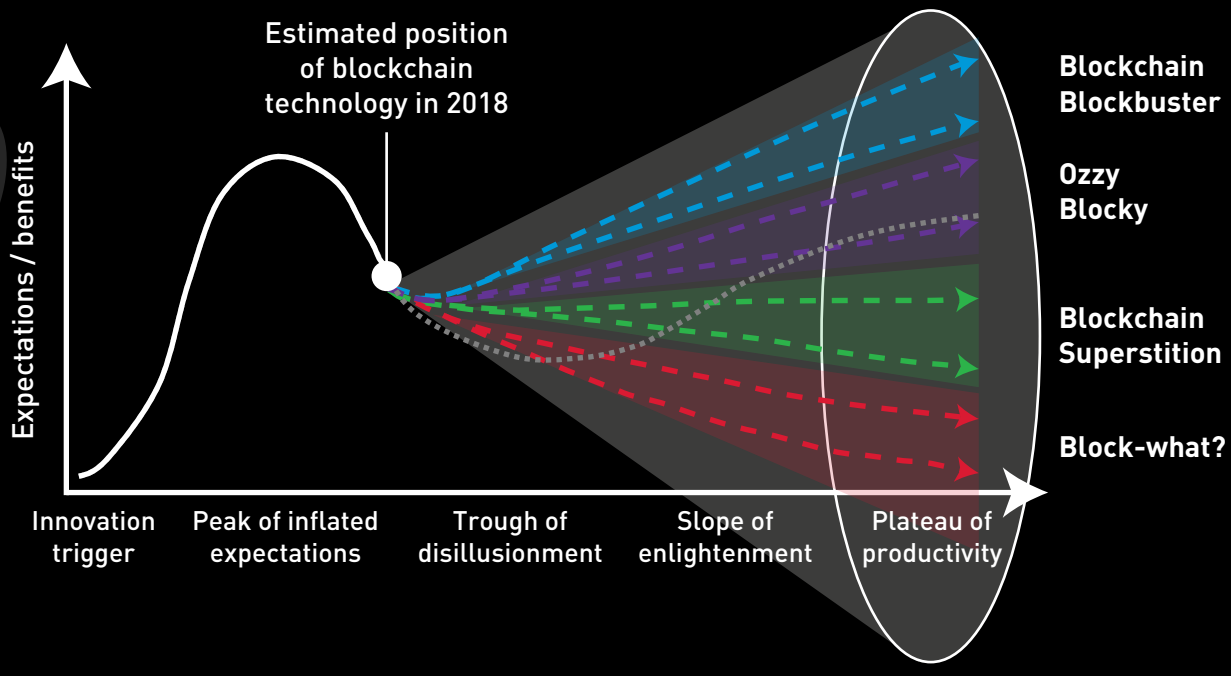
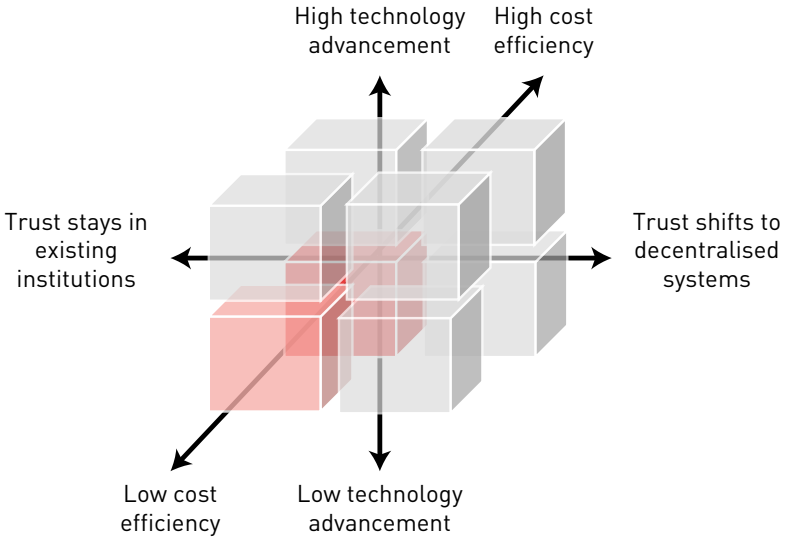


FIGURE 31. PLAUSIBLE FUTURE SCENARIOS FOR BLOCKCHAIN ADOPTION IN AUSTRALIA OUT TO 2030, ALIGNED WITH THE GARTNER TECHNOLOGY HYPE CYCLE

SCENARIO GROUP I: BLOCK-WHAT?



This scenario describes a future with low levels of technological advancement, where social trust is largely still placed in longstanding institutions. The benefit of hindsight has shown that the blockchain industry was overly hyped in 2018, and little more than a market bubble. Since then, the technology hasn't offered tangible, competitive market products, and several high-profile innovations turned out to be market failures. These events contributed to ongoing negative media coverage of blockchain applications, further limiting trust and adoption. 'Blockchain' is considered just another buzzword, and there is little chance that the technology could reach the 'plateau of productivity' in Australia.

What do these scenarios mean for labour, industries and export?

BLOCKCHAIN LABOUR AND SKILLS IMPACT

The number of blockchain developers with core technology skills

LOW — HIGH

The number of blockchain adopters with a mixture of technology skills, soft skills and industry knowledge

LOW — HIGH

The number of blockchain users from broader community with blockchain literacy skills

LOW — HIGH

INDUSTRY IMPACT

Very little blockchain adoption across industries.

Disintermediation and disruption have been minimal. Intermediary organisations marginally improved their service and product offerings.

Despite blockchain's unpopularity, a few large-sized firms in the financial and insurance services industry adopt private blockchain tech to improve in-house operations.

EXPORT

No significant international trade of blockchain software and hardware is happening.

The use of blockchain for unsustainable and illegal economic activity, and the paucity of public-good applications of blockchain technology, has raised public suspicion about the broader value of decentralised solutions. Regulation has not kept pace with changes in the blockchain ecosystem, nor with the complexity of a global legislative environment. As a result, there has been an increase in blockchain-related scams, privacy breaches and accountability deficits which has deterred public and business adoption. The tension between transparency and privacy has not been eliminated by the pseudonymity of public keys in a blockchain, as most people no longer consider anonymity alone as sufficient privacy protection.

Large corporations have emerged as dominant players in the Australian blockchain industry at the expense of smaller businesses. Too much winner-takes-all competition has led to a lack of collaboration across the industry, stifling innovation. Nevertheless, a small number of companies have effectively adopted blockchain, mostly for intra-firm operations where clear efficiency gains are feasible. The financial and insurance services industry, for instance, is able to make some use of blockchains for international banking operations and money transfers. Blockchain has helped to decrease cost of remittances and worked towards the United Nations Sustainable Development Goals, although taxation issues are not yet completely resolved. Other industries also benefit from the heightened transparency of distributed ledgers; for example, some agriculture firms use blockchain to demonstrate the provenance of high-value products.

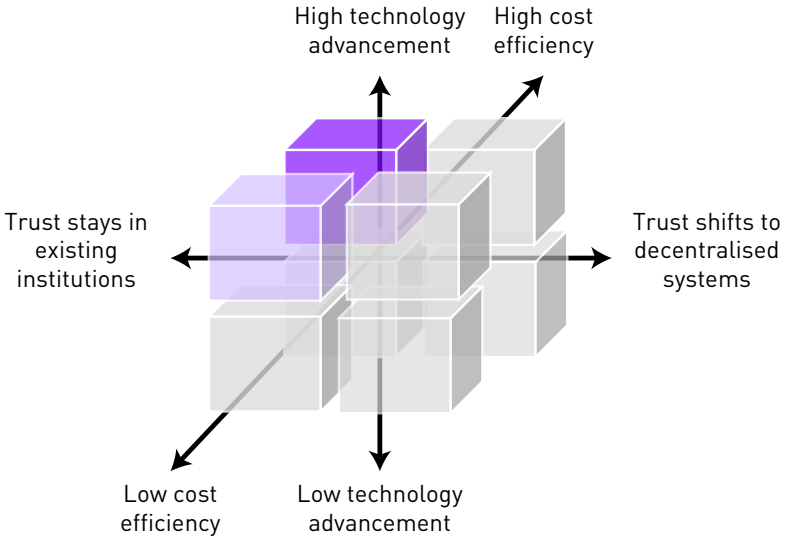
Despite these few examples, the blockchain solutions of 2030 still face unresolved technical hurdles when applied at scale. Australian digital infrastructure remains insufficient to run effective blockchain systems at an inter-organisational scale. Moreover, blockchain solutions are subject to numerous cyber security breaches, coding bugs and malicious actors intent on exploiting technical and legal loopholes or manipulating the market. The supply of blockchain-related skills has been insufficient to meet the increasing demand for blockchain developers, and many organisations have given up on blockchain entirely.

Since 2018, there has been a decline in the blockchain industry, exacerbated by capital flight due to unmet hyped expectations. Companies emerging from the peak of the hype (most notably, financial advisory services for cryptocurrencies) had almost no market left, and were forced to either fold or diversify into other markets. Although blockchain failed to meet expectations, its brief hype did have a positive effect on the offerings of traditional institutions. The threat of blockchain disruption forced intermediaries (e.g. banks and insurance companies) to improve their product and service offerings, and offer better cost efficiency, transparency and accountability in their operations.

SCENARIOS

LOW COST EFFICIENCY	HIGH COST EFFICIENCY
• Blockchain remains in the Gartner Hype Cycle's 'trough of disillusionment' due to its association with illegal activities, scams and privacy issues, as well as its inability to offer significant benefits compared with legacy systems. • There is a high cost of transitioning from legacy to blockchain systems, driven in part by the shortage of blockchain-related skills. • Blockchain still has low scalability compared with centralised databases, and the transaction costs therefore make it unappealing.	• Blockchain has reached the Gartner Hype Cycle's 'trough of disillusionment', but the cost efficiency promises of blockchain give some hope that the technology will continue moving towards the plateau of productivity. If this does occur, it is likely to take at least another decade. • There are many potential cost savings to be gained from the switch to blockchain-based systems, but adoption is still hindered by the numerous high-profile scams and illegal activities carried out on the blockchain. Some private blockchains are in operation, but are not widely known.

SCENARIO GROUP II: OZZY BLOCKY



In this scenario, blockchain technology has advanced significantly to become highly scalable and cybersecure. High levels of investment in blockchain technology, as well as concentrated efforts to upskill the workforce in blockchain, have given Australia a competitive advantage in the global blockchain industry. But domestic adoption lags, however, as social trust is still centred on existing institutions. People and businesses remain unwilling to fully trust distributed systems.

What do these scenarios mean for labour, industries and export?

BLOCKCHAIN LABOUR AND SKILLS IMPACT

The number of blockchain developers with core technology skills

The number of blockchain adopters with a mixture of technology skills, soft skills and industry knowledge

The number of blockchain users from broader community with blockchain literacy skills

INDUSTRY IMPACT

Both small start-ups and large firms developing blockchain hardware, software and education have led Australia's blockchain export growth.

Blockchain activities grew in the manufacturing, information media and telecommunications, and education and training industries. The financial and insurance services industry uses blockchains to smooth internal operations.

EXPORT

Australia has become a net exporter of blockchain technology.

Advanced manufacturing in IT has entered the blockchain exports sector, improving customised hardware and software.

Further development is seen in food provenance and cryptocurrency tourism.

Among the general population, there is widespread misunderstanding around what blockchain is and how it works at a technical level. To help fill this knowledge gap, intermediary firms emerge offering advisory services to help organisations transition from legacy to blockchain-based systems. This confuses the market, with many people left asking "isn't blockchain supposed to eliminate intermediaries?"

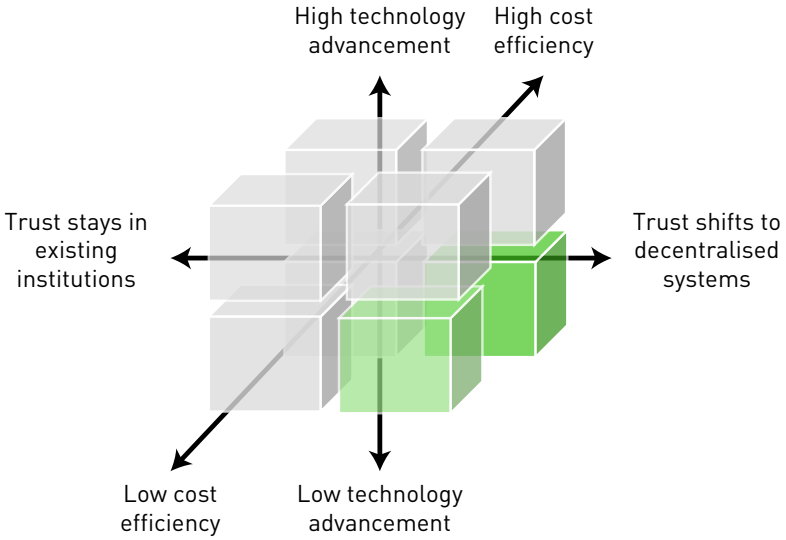
Large corporations have been the prime movers in blockchain innovation, and have helped to drive high levels of technological advancement. However, the relative absence of SMEs in the blockchain industry has contributed to scepticism regarding the decentralising potential of blockchain.

Given SMEs generally contribute disproportionately to job creation,[116] the dominance of large corporations in the Australian blockchain industry has stifled job creation opportunities for the industry, leading to only moderate employment growth. Demand for blockchain solutions globally has fuelled demand for Australian blockchain services exports. With limited domestic demand though, Australia has become a net exporter of blockchain technology, and this is highly beneficial to the nation's economy.

SCENARIOS

LOW COST EFFICIENCY	HIGH COST EFFICIENCY
• High transition costs discourage early adopters of the technology and hinder the wider adoption of blockchain across Australian industries. • A limited number of firms have adopted private blockchains for intra-firm use. Centralised intermediaries have been disrupted in some instances, but still operate for the large non-blockchain-adopting market. • Other countries find Australian blockchain solutions to be cost efficient and reliable, which opens up new technology export opportunities for Australia. • Increasing exports of the technology, coupled with low domestic adoption, brings the risk of a brain drain of talent from Australia's blockchain industry.	• The Australian blockchain industry has reached the expected productivity plateau, although domestic adoption rates are hindered by distrust in blockchain technology. • Cost-efficiency gains drive the adoption of technology across industries and firms; however, the level of adoption is still lower in Australia than in other economies. • This scenario is likely to eventually lead to a future with high trust and high technology advancement (e.g. 'Blockchain Blockbuster'). But this progression will likely take longer than a decade to establish trust in blockchain technology and educate users.

SCENARIO GROUP III: BLOCKCHAIN SUPERSTITION



This scenario explores a future where Australians are willing to import and adopt intra-firm blockchain solutions, despite a lack of advances in the underlying blockchain technologies. The high degree of distrust in conventional institutions, already observable in 2018, has continued to grow and fuelled blockchain adoption in 2030. This is despite technical problems around scalability, privacy, cyber security, transaction speed and digital infrastructure, which still hinder blockchain performance.

What do these scenarios mean for labour, industries and export?

BLOCKCHAIN LABOUR AND SKILLS IMPACT

The number of blockchain developers with core technology skills

The number of blockchain adopters with a mixture of technology skills, soft skills and industry knowledge

The number of blockchain users from broader community with blockchain literacy skills

INDUSTRY IMPACT

Industries whose blockchain activity grew made use of blockchain-enabled customer services that do not require scalability.

Some degree of disintermediation and disruption occurred, but it has not been substantial as scalability remains an unaddressed barrier to adoption.

Blockchain-enabled services are prominent in the public and private service sectors: public administration and safety, accommodation and food services, retail trade etc.

EXPORT

Australia is a net importer of blockchain technology.

The high trust characterising this scenario means that Australians could learn from importing blockchain tech, creating a possibility for developing the blockchain export sector.

There has been limited technological advancement in the areas of distributed micro-computing, storage, cyber security, and privacy-preserving capabilities. Blockchain-related skills have become more common within the Australian workforce, but the supply of talent is insufficient to support a growing and evolving blockchain industry. Some scaling success stories in the international blockchain industry, such as the widespread use of blockchain for remittance payments that was already emerging in 2018[158], have demonstrated the technology's potential. While the Australian blockchain industry gradually works to overcome technical issues, some domestic firms choose to import blockchain skills and technology from abroad.

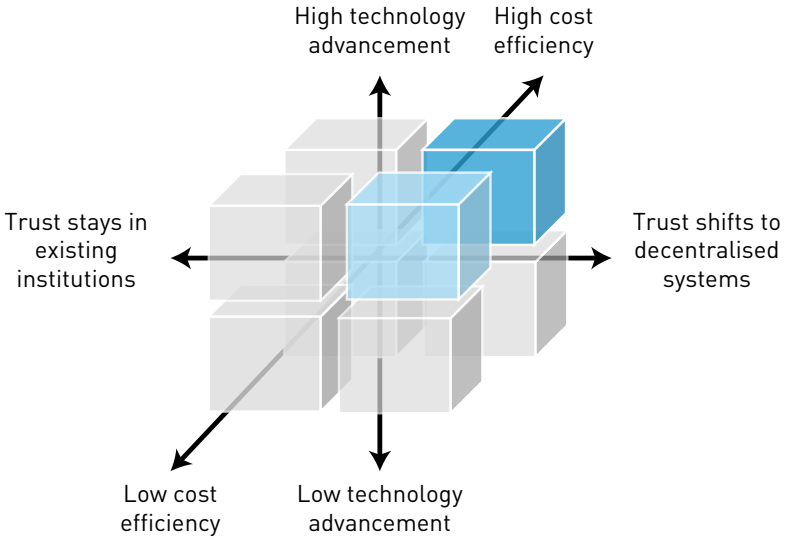
Blockchain is still a highly hyped technology. Distrust in established institutions, as well as the search for the next wave of productivity growth, have become the major drivers of blockchain adoption across Australian industries. Intra- and inter-firm ledgers are used to streamline operational processes, increase collaboration, and improve transparency and consumer trust. However, due to low-performing domestic technology, truly scaled public blockchains are not yet feasible for the Australia blockchain industry.

High domestic adoption of blockchain has led to some disintermediation at the firm level. The financial and insurance services sector has been significantly disrupted, as has the logistics industry. High-value agriculture has become a niche industry, with firms increasingly using blockchain to establish food provenance. This disruption has had notable economic benefits and helped fuel productivity in these traditional industries. But the lack of scaled public blockchains and the continuing need to import technology and skills from other countries has limited the economic and social value that could be provided by this industry.

SCENARIOS

LOW COST EFFICIENCY	HIGH COST EFFICIENCY
• Blockchain technology does not offer significant cost savings compared to traditional systems. Even though people have been willing to trust distributed ledgers, centralised databases are still better equipped for cases involving large volumes of data, and privacy-sensitive data. • The blockchain industry has introduced a range of new products and services. Since blockchain applications are not as cost efficient as people had hoped, disruption to existing industries is limited to 'low-hanging fruits', with many industries continuing with business as usual. • Where a high-performing decentralised technology solution is highly necessary, the technology is usually imported from abroad. • High trust in decentralised systems drives businesses and consumers to search for cost-efficient alternatives to blockchain. Other emerging DLT solutions offer better technology and cost performance.	• The Australian blockchain industry has reached the Gartner Hype Cycle's 'productivity plateau'. However, the cost efficiencies are realised mainly by private and smaller applications, which is less than would have been achieved if public blockchains were in use. • Private networks are small compared to public blockchains such as Bitcoin. They are still superior to traditional centralised databases in terms of their ability to improve productivity and streamline internal business processes.

SCENARIO GROUP IV: BLOCKCHAIN BLOCKBUSTER



This scenario combines high levels of advancement in blockchain technology with a significant societal shift in trust towards decentralised systems. These conditions have led to a future where blockchain solutions have been widely adopted by almost every industry, both in Australia and abroad. In 2030, 'Blockchain it!' has become the motto for addressing most business problems, just as 'Google it!' was an answer to many questions in 2018. Blockchain has become so fully integrated into society that it no longer appears in the news headlines; instead, it is simply a part of everyday life.

What do these scenarios mean for labour, industries and export?

BLOCKCHAIN LABOUR AND SKILLS IMPACT

The number of blockchain developers with core technology skills

The number of blockchain adopters with a mixture of technology skills, soft skills and industry knowledge

The number of blockchain users from broader community with blockchain literacy skills

INDUSTRY IMPACT

The financial and insurance services and professional, scientific and technical services industries paved the way for a home-grown blockchain revolution. Industries with highly privacy-sensitive data (e.g. health) were last to follow.

All industries have jumped aboard the blockchain bandwagon, as digital disruption and disintermediation led to a 'disrupt or be disrupted' sentiment.

Private and public blockchains are employed for smoothing firm operations, fostering collaborative consortia and coordinating public-good provision.

EXPORT

Australia has become a net exporter of blockchain technology.

Opportunities for export range from providing blockchain hardware, software and education; to blockchain-enabled energy trading, genetics and visa-free travel.

Australia has leveraged its competitive strengths in blockchain, including its government support for blockchain innovations and strong industry and research leadership, to become a world leader in blockchain innovation, adoption, talent and technology exports. The pool of blockchain skills in Australia has grown, enabling the implementation of scaled solutions at minimal cost. Many overseas blockchain professionals are attracted to Australia's high wage premiums and thriving blockchain industry. This, combined with advances in technology, has advanced adoption beyond private contexts and into public blockchains. Private or public, blockchain solutions have become the near-norm for many applications, including identity management, financial payments, and intra- and inter-firm coordination.

At the international level, DLTs have been rolled out for registries, voting, visas and immigration, and taxation and health records. Success of blockchain applications in the energy sector for distributed generation and off-grid energy exchange inspired other utilities to explore and adopt blockchain applications. The technological performance of blockchain has fulfilled expectations and demonstrated scalability, cyber security and performance sufficient for both domestic and international operations. Well-developed public education campaigns on blockchain have also helped to grow trust in decentralised systems. Simple and user-friendly solutions for identity management have emerged, and the general population has finally learnt to use crypto-credentials safely and securely.

Distributed ledger solutions have overseen the large-scale replacement of third-party intermediaries with computational consensus mechanisms. Former disrupters, like Airbnb, Uber and Airtasker, are themselves being disrupted by the more efficient and trusted solutions made possible through blockchain technology. For some industries, this has significantly impacted employment, with some workers finding it difficult to transition with these changes.

This scenario also features the emergence of dominant design, along with suitable standards for further blockchain adoption and interoperation. This has allowed SMEs, individuals and communities to participate in blockchain innovation. As well as fostering inter-organisational collaboration, blockchain has also increased competition between firms adopting blockchain to harness efficiency gains. Supply chains have been simplified, decentralised and improved. Facilitative blockchain intermediaries (e.g. exchanges, advisors and consultants) are no longer in high demand due to the availability of user-friendly, off-the-shelf blockchain solutions. The blockchain industry is still evolving from offering specific ICT products to offering customised blockchain solutions and services for transparency, efficiency and cost management within organisations and industries.

SCENARIOS

LOW COST EFFICIENCY	HIGH COST EFFICIENCY
• The Gartner Hype Cycle 'productivity plateau' has been reached, but substantial blockchain transition costs still constrain some industries and firms from adopting these solutions. • Blockchain solutions are not affordable for community and not-for-profit organisations. A 'blockchain divide' emerges between organisations that can afford to adopt blockchain and enjoy its benefits and those that cannot. • In the meantime, the search for cost-efficient decentralised ledger solutions continues. An alternative decentralising technology is already on the horizon, and will likely replace blockchain in the decade following 2030.	• Both private and public blockchains are in full operation. A wide range of blockchain solutions exist, from private firm blockchains to national and even transnational blockchains. • Transition costs are minimal, as widespread understanding of the technology has allowed rapid technological diffusion and innovation. • There are major efficiency and productivity gains across industries. Blockchain has allowed economies to move beyond the productivity plateau inherited from the beginning of the 21st century. • A shift from national currencies to cryptocurrencies is happening with more applications of smart money, however the full transition is still only on the horizon for Australia.

06

STRATEGIC IMPLICATIONS AND ACTIONS

The trends and scenarios presented in this report raise a number of important implications for the future of blockchain adoption in Australia and the development of its industry and workforce. These implications will impact and shape future policy and strategic decisions, and influence the extent to which the industry can mitigate future risks and harness emerging opportunities. Informed by consultations with key government and industry representatives, this chapter presents key actions for the Australian blockchain industry, focusing on how Australia can leverage its competitive advantage and facilitate broad industry adoption and application of blockchain technologies.

Australia's competitive advantage

Blockchain technology is global by nature and it is therefore crucial for Australia to consider its regional positioning and comparative advantages. The Asia-Pacific region is the source of several major opportunities for Australian export of blockchain-related goods and services. For instance, the growing population of higher income, health-conscious consumers in the region presents an opportunity for high-value agriculture firms to use blockchain in establishing food provenance.[159,160] The high prevalence of remittance payments[123] and mobile wallets[130,161] in the region also indicates a market opportunity for financial technology products using blockchains.

However, the rapid growth in technology investment and skills development within the Asia-Pacific means that Australia also faces significant global competition, including from regional leaders like Singapore, a global FinTech leader.[162] Building on Australia's existing strengths to develop new capabilities will be crucial to realise the potential of blockchain for Australian business, governments and communities. Australia's blockchain industry has a competitive advantage in a number of areas in having:

- Access to a fairly decentralised, fully dematerialised set of capital markets, making it easier to implement blockchain solutions relative to places like the US or EU.[163]
- Government funding for research into blockchain uses in the public sector.[164]
- A strong financial services industry that weathered the global financial crisis better than almost anywhere else in the world.[163]
- Research leadership in blockchain technology innovation, combined with an active start-up community. Australia is home to a number of leading blockchain initiatives, including the Australian National Blockchain, Melbourne's Blockchain Centre, PowerLedger, the Commonwealth Bank blockchain bonds, Civic Ledger, Everledger and AgriDigital.
- Global leadership in blockchain governance. Australia is chairing the International Standards Organisation group developing standards for blockchains and other distributed ledgers.[165]
- Relatively strong institutional adoption and collaboration, either between companies or public–private sector partnerships. For instance, Australian banks are working with distributed ledger start-up Ripple,[166] the Australian Government has partnered with IBM to develop blockchain solutions,[54] the Queensland Government is working with TravelbyBit to open the market for digital currency tourism,[167] Australia Post is partnering with Alibaba and Blackmores to use blockchain to trace food exports[168] and Australian Securities Exchange is adopting DLT in collaboration with Digital Asset.[169]

DEVELOPING THE APPROPRIATE SKILLS MIX

Widespread development and adoption of blockchain in Australia will require the right blend of technical knowledge and 'soft' (enterprise) skills. Organisational leaders and early adopters of blockchain will need to have strategies around investing in the technology, as well as upskilling and transitioning their workforce to develop and apply blockchain technologies. Community leaders and end users would benefit from basic 'blockchain literacy', or even a broader understanding of what the technology is and how it works. As the analysis of the current workforce profile of the Australian blockchain industry in this report has shown, complementary 'soft' skills will be just as critical as more specialised technical skills, and will likely help in encouraging more widespread adoption and understanding of potential use cases for blockchain and its key risks.

GROWING THE ICT TALENT POOL

Australia is lagging behind on a number of ICT indicators, including ICT graduates[60] and high-school STEM performance.[61] There will be growing demand for ICT talent, both in Australia and abroad, as consumer uptake of digital technologies continues to grow and as other technology-enabled industries like artificial intelligence, robotics, cyber security and the Internet of Things develop. Growing the ICT talent pool in Australia may involve a combination of strategies focused on education and training (e.g. developing new course offerings that assist existing workers transition to the emerging blockchain industry) and migration policies (e.g. incentives designed to attract global talent).

ADDRESSING THE BLOCKCHAIN KNOWLEDGE GAP

Research and stakeholder consultations undertaken for this project demonstrated a substantial gap in knowledge and understanding of blockchain, both within and outside of the ICT sector. There are both opportunities and challenges in this space. For instance, a lack of understanding around blockchain technologies could hinder future uptake, as demonstrated in the 'Block-what?' and 'Ozzy Blocky' scenarios. On the other hand, this knowledge gap can open up opportunities for new service industries focused on advising and assisting organisations in blockchain adoption, and introduce new markets for accredited Australian educational providers. Indeed, this report shows that around one-third of existing businesses in the Australian blockchain industry were classified as offering blockchain-related services.

RESOLVING DIGITAL INFRASTRUCTURE BOTTLENECKS

The availability of reliable and affordable digital infrastructure is a key factor determining the adoption and further development of blockchain and other digital technologies. Internet connectivity in Australia is well below average, being ranked 50th in the world for average connectivity speed.[77] Connectivity is typically worse in socio-economically disadvantaged areas,[170] and indices of digital inclusion are higher in Australian capital cities than in regional or rural areas.[142] Affordable and reliable access to the internet, either through a fixed broadband connection or via mobile, is a necessary prerequisite for participation in a blockchain network. Issues around digital infrastructure could limit future blockchain adoption in Australia and the development of the industry.

Furthermore, sufficient digital infrastructure is crucial for developing other digital technologies (e.g. Internet of Things, artificial intelligence, robotics, autonomous vehicles, big data) that are complementary to blockchain technology.[171-173] Technological convergence has a high potential impact on the national and global economy,[174] and should be facilitated via future infrastructure development and investment.

The transition period

Blockchain has the potential to transform the way we live, work, travel and communicate. Blockchain technology can provide important benefits, but may also present significant challenges and risks to overcome. Risks associated with blockchain include issues around cyber security and privacy, as well as the potential for decline in the industry and job losses. The transition to a future with high levels of blockchain adoption will require a revision of regulation, business processes, educational programs, and technology systems, as well as a mindset shift toward greater individual accountability in the absence of central authorities.[19,175]

MEETING THE REGULATORY CHALLENGE

Governments will need to play an active role in the transition, particularly in the areas of:

- Regulation, taxation and consumer protection.
- Reskilling the labour force.
- Determining the benchmark for blockchain applications.
- Supporting innovation.

The rapid growth and global nature of the blockchain industry implies a major challenge for regulators and the appropriate regulatory response will likely vary under each plausible future scenario. Remittances, food provenance and international registries are just a few examples of blockchain applications that cross national boundaries and regulations. Allowing blockchain applications to operate in a global environment without introducing risks to domestic consumers and businesses creates a challenge. Taxation and consumer protection regulations, along with technology standards[176] that can be adopted at the national and international level, may be needed. Australia could also appoint a national regulator to strategically oversee the emerging blockchain industry.

ASSISTING BUSINESSES WITH THE TRANSITION

Blockchain solutions can allow firms to reduce costs and improve productivity.[113] However, blockchain innovations can disrupt existing players in the market and increase price competition. In scenarios with higher blockchain adoption (e.g. 'Blockchain Superstition' and 'Blockchain Blockbuster'), we could see more frequent disruption of traditional industries in the future.

To mitigate these risks and assist organisations in transitioning to blockchain, there are four high-level questions to consider before implementing a blockchain solution:

- Knowledge – What does the technology has to offer? What problems need to be addressed?

- Alignment – How do the strategies and plans align with new technological solutions and market offerings?
- Preparedness – Are human capital and technological resources ready for the shift to blockchain? What risks, barriers to implementation, and unforeseen consequences might there be?
- Regulation and governance – What regulatory and compliance frameworks exist and how will your business operate and compete in this environment?

Overcoming the divide between blockchain sceptics and blockchain evangelists – and moving beyond the hype – might require that innovators and adopters shift their focus from 'What is blockchain?' to 'Why do we need the blockchain?'. This shift is already underway, but could be further progressed by the blockchain leaders both in public and private sectors. This will further facilitate the transition from the ICO 'gold rush' into targeted investment, open dialogue, benchmarking of the best use cases, and broader understanding of the potential benefits and costs of using blockchains with a problem-focused, open-minded and anticipatory approach.

UNDERTAKING ROLLING STRATEGIES

As an industry and field of research and development, blockchain has experienced significant ups and downs, driven in part by the dynamic nature of cryptocurrency. This means that a five- or ten-year strategy is unlikely to serve the industry well. Although strategic thinking is key to long-term success, short-term agility is equally crucial, especially for an emerging industry. As such, rolling annual strategies that align with a long-term plan but incorporate recent data and developments may be more appropriate to support the emergence and direction of the Australian blockchain industry.

DEVELOPING A PLAN FOR MANAGING CYBER SECURITY

As blockchain technology gains popularity, there is an increased need to protect such systems against malicious actors who may be motivated to compromise its operations.[18] The number of cyber attacks in Australia has consistently grown each year, and 2018 was no exception.[99] As with most technology, tailored risk assessment will be necessary at all stages of blockchain implementation and use, from the initial concept to the final product. Governments, businesses and other organisations should consider drafting and adopting cyber security and risk mitigation strategies as a key aspect of transitioning to blockchain-facilitated operations.

USING RESEARCH AND DATA TO DRIVE DECISION-MAKING

There are many unknowns around the future of blockchain adoption in Australia, but continued research and use of data in decision making will help provide intelligence and informed direction.
More research is required to understand the domestic uptake of blockchain technology and anticipate future developments. The implications of blockchain for the labour market is particularly important, and should be further explored as relevant data become available over the coming decade. For example, one avenue of future research could be to examine the supply and demand of blockchain specialists around the world, revealing the potential trajectory for skills demand in Australia over the next three to five years.

07

CONCLUSION

Last year marked the tenth anniversary since the concept of blockchain technology was publicly released in a white paper by Satoshi Nakamoto. Over the course of a decade, blockchain has grown significantly in popularity and use, attracted major investment, and introduced new products and services – from mining computers and software to advisory firms helping investors navigate the complex world of cryptocurrencies. The disruption caused by blockchain is irreversible.

However, a decade is a short period for technological change. The first working prototype for the internet was developed in the 1960s, but it took decades for the technology to take off with the invention of the World Wide Web in the 1990s.[177] Even with the accelerating pace of technological progress, blockchain technology is still progressing through the very early stages of development. Looking a decade forward, key uncertainties remain around whether blockchain technology can move beyond the hype to deliver tangible, widespread value, or whether it will amount to little more than a market bubble.

Using strategic foresight methods, this project aimed to explore emerging trends, uncertainties and scenarios impacting the adoption of blockchain technology in Australia over the coming decade. Given that the future is unknown and difficult to predict, this report investigated the impact of a range of plausible futures, and the opportunities, challenges and risks that these futures could present for the blockchain industry in Australia. The report incorporated a particular focus on the labour, industry and export impacts of these future scenarios.

To understand the future of the Australian blockchain industry, it is necessary to first understand its present state. To that end, this report presented novel data on Australian blockchain activities, examining the level and nature of blockchain activities undertaken by companies headquartered in Australia. These data reflect a growing but still immature industry, with a particular need to expand the domestic workforce to meet increasing demand for blockchain-related skills in the domestic and global labour markets.

But how will the next 10 years unfold, and what will the future of blockchain adoption in Australia look like? The answer to this question hinges on the development of a number of key uncertainties: will the technology be able to overcome technical constraints around scalability vs decentralisation, and confidentiality vs transparency? Will social trust shift towards decentralised technologies (including blockchain) and away from established intermediary institutions? Will blockchain be able to offer a cost-efficient solution for business, government and other organisations?

By exploring the intersection of these uncertainties, this report produced eight plausible, evidence-based scenarios for blockchain adoption in Australia out to 2030. The scenarios demonstrated the intersection between multiple technological, environmental, economic, social and geopolitical shifts, and how these changes could yield different futures for the blockchain labour force, industry and export market in Australia. Rather than predicting the future, these scenarios are designed to challenge current perspectives, define and explore key uncertainties, and provide a common set of shared narratives that can be used by industry, government and community stakeholders.

The scenarios raised key implications for future policy and strategic decisions concerning blockchain in Australia. The report concluded by exploring two major areas for future consideration: (i) Australia's competitive advantage in the global blockchain industry, and (ii) the transition period to a future with higher levels of blockchain adoption. It then outlined some possible future actions, in particular, the importance of growing the blockchain workforce and skills level was emphasised, as well as developing and improving supporting elements, such as digital infrastructure, cyber security strategies and regulatory frameworks.

Blockchain technology represents a major opportunity to improve organisational processes via increased speed, efficiency and transparency. At a broader level, it has the potential to create new industries, generate new jobs, and become an important driver of Australia's future economic growth. But its future adoption in Australia is uncertain. This report has explored the different facets of this uncertainty to take a nuanced, long-range view of the future, putting government, industry and community leaders in a better position to leverage opportunities, mitigate risks and make informed decisions in the decade to come.

Appendix A: Strategic foresight methodology

Strategic foresight is a well-established discipline which helps to inform strategic decision-making by exploring plausible futures. It first emerged after World War II, with an early focus on technology forecasting. Thereafter, the strategic foresight field was given a boost by the formation of Royal Dutch Shell's scenario planning team during the 1970s.[178] Since then, the scenario planning approach has emerged into a field of knowledge with numerous professional guides and books published its methods and practice.

More recently, strategic foresight has made its way onto the world stage. OECD Secretary General Angel Gurria, in his 2016 opening remarks to the Government Foresight Community in Paris, explicitly noted the importance of strategic foresight for exploring the unexpected.[179] As the creative destruction of the Fourth Industrial Revolution creates conditions of turbulence, unpredictable uncertainty, novelty and ambiguity (TUNA conditions), strategic foresight is coming even further to the fore.[180]

Two specific techniques under the umbrella of strategic foresight have been employed in this report— horizon scanning and scenario planning (see Figure 32).

Data61 used these techniques in combination to craft and communicate a narrative about the future of blockchain adoption in Australia, and to derive implications informing strategic decision-making.

The horizon scan involved a rigorous and systematic process of identifying trends relevant to Australian blockchain adoption, which could impact future decision-making. Trends can be understood as impactful changes that are likely to shape and influence the future and were classified as either social, geopolitical, economic, technological or environmental. Trends data were sourced from international and national statistics, the Data61 trends database, literature, internal workshops and stakeholder consultations, including interviews and the ACS Blockchain Industry Survey.

The scenario planning process followed from and built on the results of the horizon scan. It involved the evidence-based and logical imagining and explication of plausible future scenarios. In this report, eight plausible scenarios have been developed for Australian blockchain adoption in 2030. Each scenario was crafted with reference to plausible outcomes for labour, industries and exports.

The results from both the horizon scanning and scenario-planning exercises were thereafter rigorously informed and validated by a series of 15 interviews and a workshop, undertaken with key stakeholders and experts in the Australian blockchain space. The interviews were 30 minutes each, with five standardised questions asked of each participant.

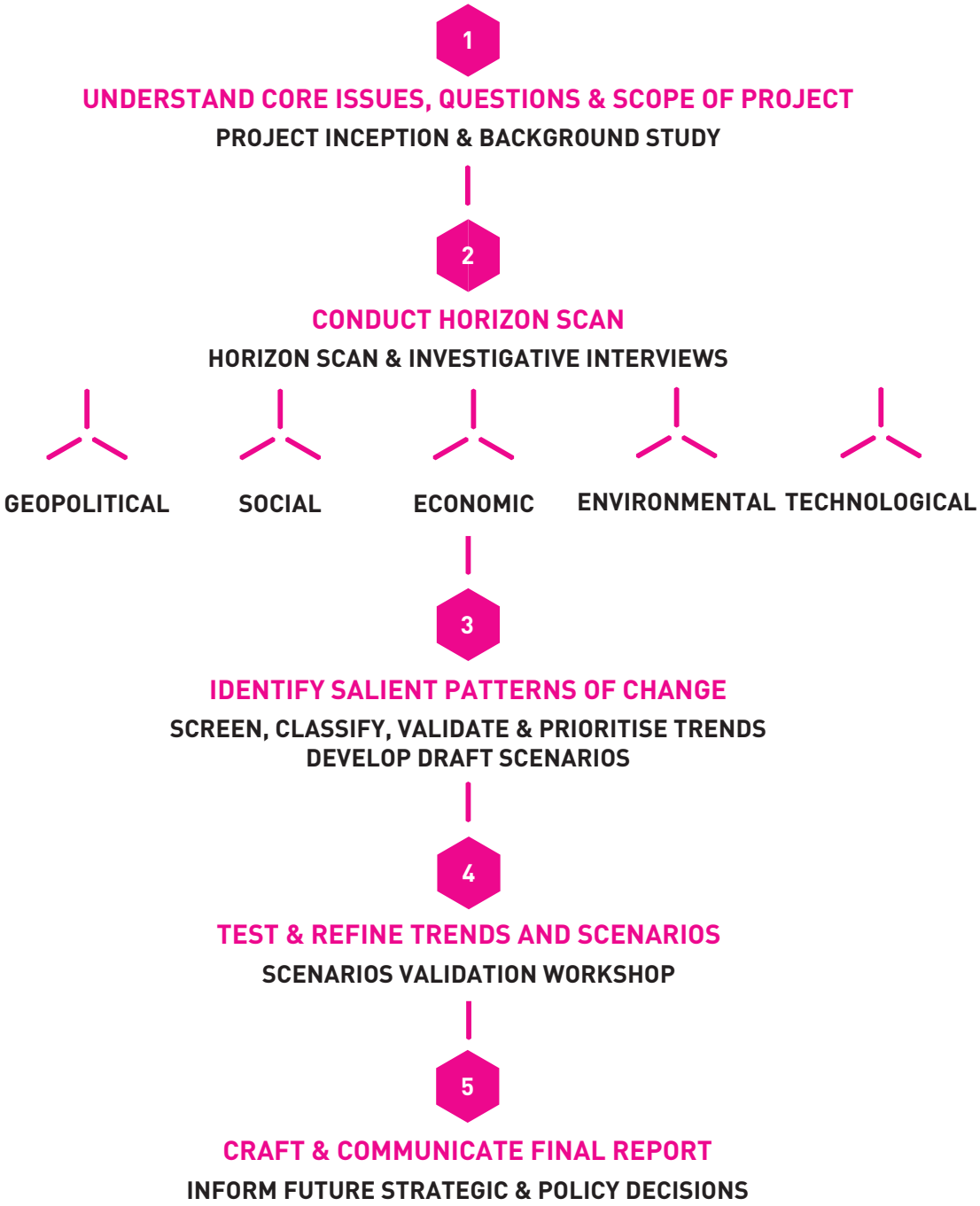


FIGURE 32. CSIRO'S STRATEGIC FORESIGHT APPROACH

Appendix B: Regulatory measures for blockchain

The table below provides some example regulatory measures introduced for blockchain and crypto-assets around the world[36-41]

COUNTRY	EXAMPLES OF REGULATORY MEASURES
Australia	**1999:** Smart contracts were permitted in Australia under the Electronic Transactions Act 1999, given that they satisfy all the traditional elements of legal contracts. **2017:** The Anti-Money Laundering and Counter-Terrorism Financing Amendment Act 2017 was passed, bringing cryptocurrencies into the scope of the country's regime for anti-money laundering. **2018:** The Australian Securities and Investments Commission released information providing guidance about how the Corporations Act may apply to Initial Coin Offerings (ICOs) and crypto-assets. In December 2018 new encryption law passed the Senate. It allows greater access to encrypted messages for security agencies.
China	**2013:** Bitcoin was defined as a virtual commodity that can be traded online by citizens. **2014:** The People's Bank of China ordered the account closures of banks and payment companies that were opened by operators of virtual-currency trading websites. **2017:** China banned ICOs, with a list of 60 ICO platforms to be inspected by local financial watchdogs. **2018:** Government agencies combined to form a taskforce, instructing local authorities to urge miners to stop their activities.
South Korea	**2017:** The country's financial regulator prohibited the issuance of new trading accounts by cryptocurrency exchanges. The Financial Services Commission considered closing down domestic exchanges for digital currency, and has placed stringent requirements on exchange activity.
Japan	**2017:** Japan introduced policy allowing merchants to legally accept Bitcoin as payment. **2018:** ICO regulation was proposed by a government-backed research group.
USA	**2017:** The Securities and Exchange Commission (SEC) issued a warning to investors about the lack of investor protection in cryptocurrency and ICO markets compared with traditional securities. **2018:** The SEC announced settled litigation and a consent decree targeting two companies that conducted ICOs.
UK	**2017:** The Financial Conduct Authority issued a statement illustrating the risks of investing in ICOs.

EU	**2018:** The European Supervisory Authorities for securities, banking, insurance and pensions issued a statement about the risks of virtual currencies. In May 2018, the European Union (EU) introduced General Data Protection Regulation, which outlines that citizens of the EU have the 'right to be forgotten' online.
Belarus	**2018:** A Presidential Decree on the development of the digital economy establishes the legal framework for buying, selling, exchanging, creating, and mining cryptocurrencies and tokens in Belarus and specifically for entities operating on the territory of the High Technologies Park.
France	**2016:** Two provisions allowed the use of blockchain technology for a type of zero-coupon bond. **2017:** An ordinance allowed the use of blockchain for a broader range of financial instruments.
Switzerland	**2014:** The Swiss Federal Council classifies virtual currencies as asset (property). **2018:** The Swiss State Secretariat for International Finance sets up a working group on blockchain and ICOs to study the legal framework with a goal to become a 'blockchain and fintech nation'.

Appendix C: Approach used in labour and industry analyses

Industry analysis approach

The dataset was compiled through a progressive online scan for Australian blockchain activities and companies between July and August 2018. Blockchain activity is defined as organisational actions aimed toward implementing or developing blockchain innovation, to yield blockchain products. Blockchain activity was classified as Australian if involved companies were founded and/or headquartered in the country. Data sources include Crunchbase, LinkedIn, media articles and company websites.

From this scan, activity details were extracted, organised and consolidated. The following data was collected on blockchain companies: state/territory, firm size, blockchain activity, industry and starting year. Blockchain activity types were divided into three categories: focused (single application products of the technology in a specific industry for a specific problem), farsighted (application products that could provide a solution to numerous problems in a single industry or across industries) or facilitative (providing finance, crypto-exchange, consulting or technical services for blockchain-related productisation).

Labour analysis approach

Analysis of the demand for blockchain labour in Australia was based on the data from Burning Glass Technologies (BGT).[181] BGT collects real-time online job postings from company websites and major job boards, removes duplicate advertisements and parses the advertisements into a systematic and searchable form. The data from BGT has been broadly applied in Australia and internationally for research into labour demand patterns and projections.[182]

In this report, data on blockchain jobs were obtained by filtering the BGT Labour Insight database. To identify technical skills for blockchain labour, our searching algorithm used 'blockchain' and 'cryptocurrency', as well as various skill categories, as search keywords. Enterprise skills are defined as transferrable skills that can be applied in a range of professions and industries, and are not unique to specific technical domains or jobs.

It needs to be acknowledged that BGT takes all efforts to remove duplicate job listings from their database, as well as to provide accurate coding for job classifications. However, the possibility that duplicate online job listings and/or miscoded data are present in the database cannot be completely excluded. BGT also provides no warranty as to the accuracy or completeness of the data; however, the dataset covers all available online sources (open for crawling).

Appendix D: High-profile use cases of blockchain in Australia

The below examples are high-profile use cases of blockchain that were identified as part of Data61's Australian Blockchain Activity dataset:

- In July 2018, the Australian Government awarded IBM a five-year partnership incorporating cross-brand solutions involving IBM software, cloud-capabilities and hardware, along with innovation programs aiming to push the government's agenda for digital transformation, including acceleration of blockchain application.[54]
- In the 2018–19 Federal Budget, $700,000 was reallocated for investigating the benefits of blockchain-augmented government services by the Digital Transformation Agency. The investigation was proposed to involve research into blockchain's current maturity, government readiness for adoption, and identifying problems the technology could solve, with an understanding of how government services could be supported by blockchain.[164]
- In January 2017 the Commonwealth Bank of Australia (CBA) supplied a crypto-bond for the Queensland Treasury Corporation (QTC)—a world first. This allowed QTC to generate a bond tender, see the investor bids in real time, finalise the allocation of investment, and instantly settle with investors. These capabilities reduce settlement risks and streamline the issuance process.[49]
- Since January 2016, the Australian Securities Exchange (ASX) has been collaborating with Digital Assets to examine and test the capacity of DLT to replace its CHESS (Clearing House Electronic Subregister System). In December 2017, the decision was made to continue with a DLT replacement. The ASX's DLT solution would establish a solid foundation for clearing provisions, enabling settlement and other post-trade services.[169]
- Announced in August 2018, the Australian National Blockchain is a new technology platform that will help to securely and transparently manage legal agreements. The blockchain built by the consortium of Herbert Smith Freehills, Data61, IBM and King & Wood Mallesons will enable companies to use the network for digital contracts, exchanging data, and authenticating/confirming legal contract status. It is proposed to be a publicly accessible blockchain solution at scale for Australian businesses, with the aim of enhancing legal compliance processes.[183]
- The World Bank selected CBA to arrange a blockchain-based 'bond-i' (Blockchain Offered New Debt Instrument). The bond-i has been developed through collaboration with the Treasury Corporation of Victoria, QBE and Northern Trust. The crypto-bond blockchain will be run simultaneously in Sydney and Washington so that bonds can be created, allocated, transferred and managed.[50]
- In March 2018, the Royal Melbourne Institute of Technology commenced Australia's first short university course on blockchain strategy. The program is industry-focused and was built in collaboration with the Blockchain Innovation Hub, Stone and Chalk, and Accenture.[62] The program will help students understand blockchain technology and its potential impact on society, applications across industries, value propositions, and strategic frameworks for blockchain application.[184]
- In October 2018, CBA and CSIRO's Data61 announced the development of a world-first application trial for smart money that would be programmable, personalised, and integrated with Australia's New Payments Platform.[13] The app prototype has been trialled through the National Disability Insurance Scheme.[14] Smart money has the potential to increase transparency, visibility and accountability for government payments, reduce administration costs for businesses, and enable companies to create innovative payment services and business models.[13, 185]

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