

Money in a digital age: 10 thoughts

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Where technology meets economics

Good afternoon, ladies and gentlemen. It is an honour to be here to deliver this lecture at the Lee Kuan Yew School of Public Policy. I would like to thank the organisers for offering me this opportunity.

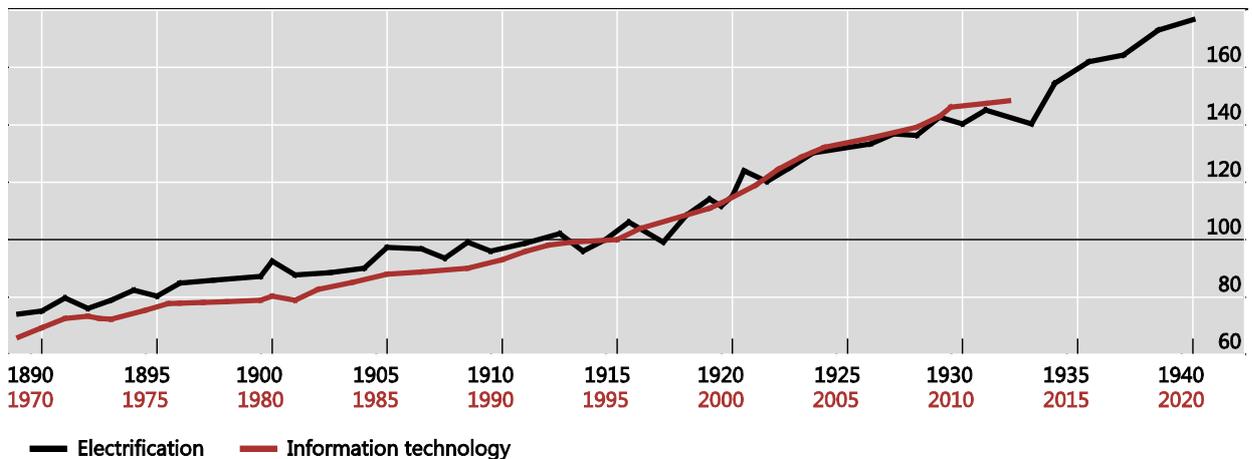
Under Lee Kuan Yew’s leadership, Singapore – as the saying goes – transitioned from “third world to first world in a single generation”. Singapore transformed itself through long-term social and economic planning by a meritocratic civil service. The School’s aim is to draw the lessons from this experience for Asia and the world at large. I cannot think of more laudable goals than those defined in its mission statement: developing thought leadership, improving standards of governance and transforming lives for a more sustainable world.

As we reflect about how public policy should best help countries and their citizens to develop, to improve and to transform, we must recognise the important role of technology. We see its transforming effects every day in the convenience, efficiency and ease that it brings to our daily lives. And, behind the scenes, technology has spurred economic growth to the benefit of all of us. Whereas during the period from 1890 to 1940 electrification drove labour productivity, since the 1970s information technology has assumed that role, as shown in Graph 1.

Labour productivity growth in the United States

1915 = 100 and 1995 = 100

Graph 1



Sources: J Kendrick, “Productivity trends in the United States”, 1961; D Byrne et al, “Is the information technology revolution over?”, 2013; and C Syverson, “Will History repeat itself? Comments on “Is the information technology revolution over?”, 2013.



Today, I shall focus on the intersection of technology and economics, paying particular attention to the way technological advances affect the role of money and payments. Since I am not only speaking at a premier public policy school, but also serving as an international public servant myself, the implications for public policy are foremost in my mind.

To me, the main issue is that good technology does not suffice for good economics. We have seen examples in the past of innovation inspiring rhetoric and enthusiasm that ultimately outpaced reality and effectiveness. While welcoming technological innovation, we should also test the claims of its proponents against the laws of economics, centuries of accumulated wisdom and plain old common sense. As US scientist and futurist Roy Amara said, "We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run."¹ Technological innovation can bring many benefits and advantages. But just because a new technology is useful, even transformational, in some respects does not mean that every application of that technology makes sense. In the 1930s, when electricity was the force transforming daily lives, there was a move to replace the gold-backed dollar with a dollar backed by electricity.² No one disputes the benefits of electricity. But running a freezer did not make that energy source the best choice for running finance.

We must ensure that technology is applied in a way that is fit for purpose and, ultimately, helps our societies to develop, to improve and to transform. This is especially so in the financial sector. Bedevilled as the sector is with asymmetric information, externalities, fallacies of composition and other market failures, some technological advances have led to misuses, including fly-by-night (or perhaps operate-by-internet) villains stealing people's money, and even undermining overall financial stability.

I shall view the economics of cryptocurrencies from this perspective and draw the lessons we have learned. It has been 10 years since Satoshi Nakamoto's white paper on Bitcoin.³ Bitcoin was a novelty, not well understood for some time, including by central banks. Since then, we have learned much more about how it operates. I have 10 thoughts about cryptocurrencies today and tomorrow.

The advent of cryptocurrencies and distributed ledger technology (DLT) and the emergence of fintech and big tech has made us all, but central banks especially, think hard about the value of technology for financial services. How can technology be best harnessed? For the Bank for International Settlements, and for the central banks and supervisory authorities which we serve, the digital age means new opportunities as well as new challenges in core areas. Technological advances affect not only the money and payments system, but the whole of finance from savers to borrowers. Moreover, they have implications for the broader macro economy, particularly price setting, touching central banks' responsibility for price stability. So it is an important thing to get right, and now is a good time to take stock.

I will start by summing up what we can say about cryptocurrencies today. Then I shall enter more speculative territory, where there are more questions than answers.

¹ See "Encyclopedia: Definition of Amara's law", *PC Magazine*, retrieved 11 November 2018.

² See R Shiller, "Cryptocurrencies have a mysterious allure – but are they just a fad?", *The Guardian*, 21 May 2018.

³ See S Nakamoto, "Bitcoin: a peer-to-peer electronic cash system", *White Paper at 1*, 2008, <https://bitcoin.org/bitcoin.pdf>.

1. Cryptocurrencies have serious economic design flaws⁴

Cryptocurrencies do not scale like sovereign money, they are prone to congestion, and the finality of payments is problematic. The first issue here is their cumbersome setup. To put it in the simplest terms: if I buy a coffee, you have to store the payment information (in fact you have to store the history of all purchases ever made,) and it may mean that your pending transaction cannot be processed easily in a short time.

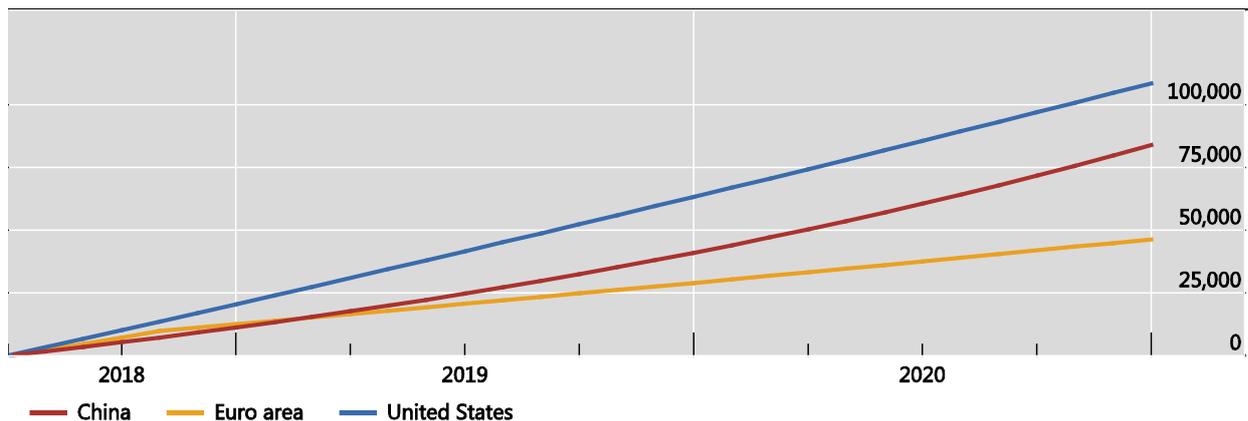
For starters, every transaction adds a few hundred bytes to the so-called blockchain, which accumulates over time to substantial file sizes. Even with only a comparatively low number of transactions that Bitcoin can process, file sizes of several hundred gigabytes result.

A simple thought experiment, displayed in Graph 2, shows just how inadequate cryptocurrencies are. If Bitcoin were to process the transaction numbers handled by actual national payment systems, file sizes would increase to tens of thousands of gigabytes within weeks. The associated communication needs would be huge.

A cryptocurrency handling actual transaction numbers would become unusable within days¹

In gigabytes

Graph 2



¹ The displayed hypothetical size of the blockchain/ledger is calculated assuming that, starting from 1 July 2018, all non-cash transactions in either China (red line), the US (blue line), or the euro area (yellow line) are processed via a cryptocurrency. Calculations are based on information on non-cash transaction numbers from CPMI (2017) and assuming that each transaction adds 250 bytes to the ledger. Euro area members include data for BE, FR, DE, IT and NL.

Sources: Bank for International Settlements, *Annual Economic Report 2018*, June; CPMI (2017): *Statistics on payment, clearing and settlement systems in the CPMI countries*, no 172, December.

⁴ See Bank for International Settlements, *Annual Economic Report 2018*, June 2018; and R Auer, "The technology and the economics of decentralised trust in Bitcoin and the blockchain", *BIS Working Papers*, forthcoming. See also R Menon, "Crypto tokens: the Good, the Bad, and the Ugly", remarks at the Money 20/20 Asia Conference, Singapore, 15 March 2018, <https://www.bis.org/review/r180321c.htm>.

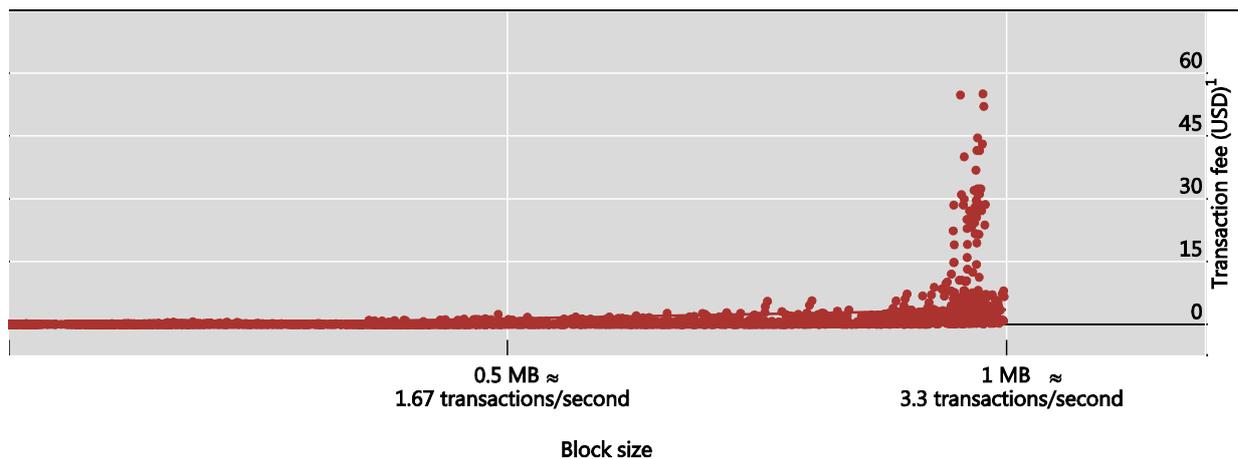
The underlying payment process congests...

In order to limit the growth in the size of the blockchain, each cryptocurrency limits how many transactions can be processed at any moment in time. Once transactions hit this limit, however, the system congests, fees spike and a long queue of pending transactions results.

Graph 3 shows this “congestion game”. As soon as the maximum block size is reached, sky-high fees follow, as experienced by most cryptocurrencies in late 2017, together with long queues of unprocessed transactions.

Whenever blocks are full, sky-high Bitcoin fees result

Graph 3



¹ Transaction fee paid to miners over the period 1 August 2010 to 22 October 2018; daily averages.

Source: Bank for International Settlements, *Annual Economic Report 2018*, June.

Congestion means that cryptocurrencies simply do not scale like sovereign money: they miss the positive network externalities that give rise to a virtuous circle. If all your friends use a particular messaging or payment app, you will download the same one: the weight of numbers makes it more useful. But the more users a cryptocurrency has, the more likely it is that its system will become congested, and the less useful it will be.

...and the finality of payments is problematic

Another problem is that even those transactions that have seemingly entered the ledger can be retroactively voided. In technical terms, cryptocurrencies such as bitcoin cannot guarantee the finality of individual payments. Although a user can verify that her transaction has been included in the ledger, unbeknownst to her an adversary trying to double-spend coins can create rival versions of that ledger. Since which one of the two ultimately survives is uncertain, the finality of payments is never assured. And because mining, contrary to the decentralised idea, has become an oligopolistic industry, this is a likely threat.

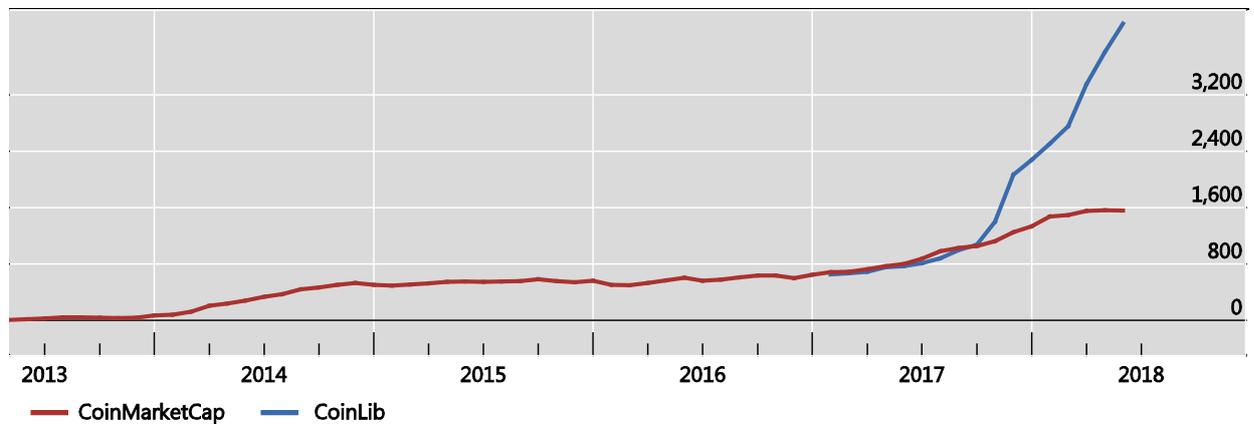
Transaction rollbacks can also occur due to so-called “forking”, when cryptocurrencies split into subnetworks of users, as has happened several thousand times in the course of the last 12 months (Graph 4). Again, this means that finality will forever remain uncertain.



Cryptocurrencies “fork” at an eye-popping rate¹

Number

Graph 4



¹ Based on monthly snapshots from two different providers.

Source: Bank for International Settlements, *Annual Economic Report 2018*, June.

2. Cryptocurrencies are unstable, including so-called “stable coins”

Remember that money is supposed to act as a unit of account, a means of payment and a store of value. I have just explained how cryptocurrencies fall short of the first two of those goals, and they are just as weak regarding the third.

Generating any confidence in a cryptocurrency’s value requires that its supply is predetermined by a protocol. Otherwise, it would be supplied elastically and debase quickly. Therefore, any fluctuation in demand translates into changes in valuation. The valuations of cryptocurrencies are subject to extreme volatility, as shown in Graph 5. This inherent instability is unlikely to be fully overcome by better protocols or financial engineering, as exemplified by many failed so-called “stable coins” – including, most recently, Tether, which saw a marked loss of confidence and substantial deviations from its targeted one-to-one peg to the US dollar.

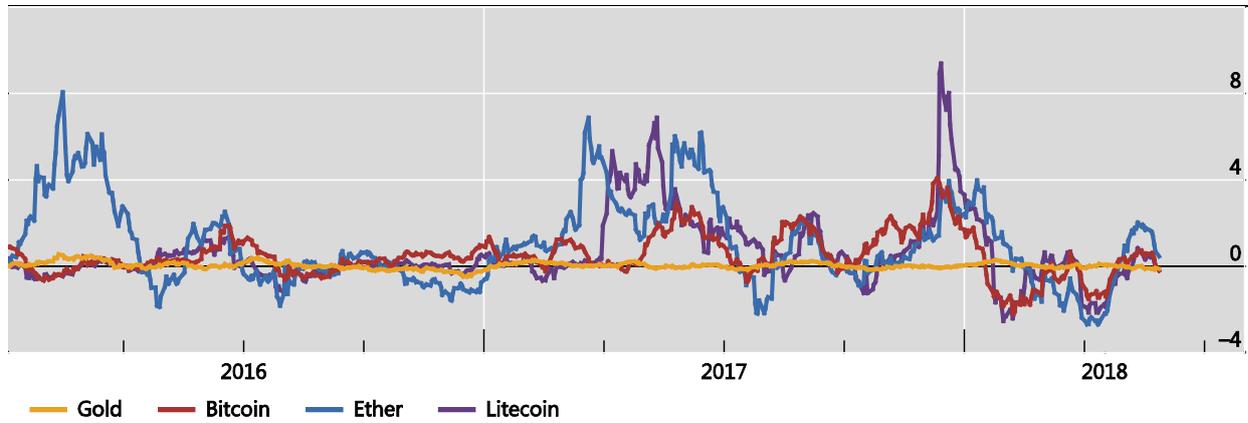
This outcome is not coincidental. Keeping the supply of the means of payment in line with transaction demand requires a central authority, typically the central bank, which can expand or contract its balance sheet. The authority needs to be willing at times to trade against the market, even if this means taking risk on its balance sheet and absorbing a loss. In a decentralised network of cryptocurrency users, there is no central agent with either the obligation or the incentive to stabilise the value: whenever demand for the cryptocurrency decreases, so does its price.



Valuation varies extremely¹

In per cent

Graph 5



¹ Thirty-day moving averages of daily returns.

Source: Bank for International Settlements, *Annual Economic Report 2018*, June.

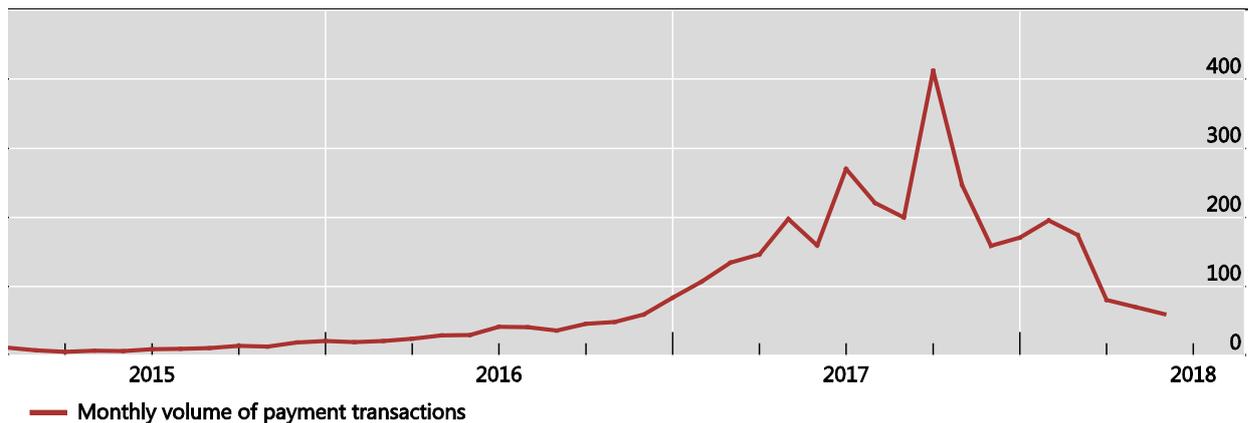
3. Hardly anyone uses cryptocurrencies for retail purchases

These economic limitations bring me to bitcoin's, and other cryptocurrencies', best-kept secret: nobody is actually using them any more for real payment transactions. Graph 6 shows the monthly global volume of transactions, expressed in US dollars, handled by the major bitcoin retail payment processing firms. As you can see, even at the height of the bitcoin frenzy in late 2017, the transaction volume was just USD 400 million – a tiny amount compared with the USD 500 billion processed each month by just one credit card company, VISA.

Bitcoin retail payment transactions handled by major bitcoin payment processing firms

In millions of USD

Graph 6



Source: chainanalysis.com.

Furthermore, even though many merchants initially touted bitcoin as a means of payment, most rapidly gave up on it because it turned out to be impractical, slow, expensive and unsafe. Many online sites such as Expedia.com have already stopped accepting bitcoin or any other cryptocurrency due to its manifold limitations.

4. Cryptocurrencies are highly conducive to illegal activities

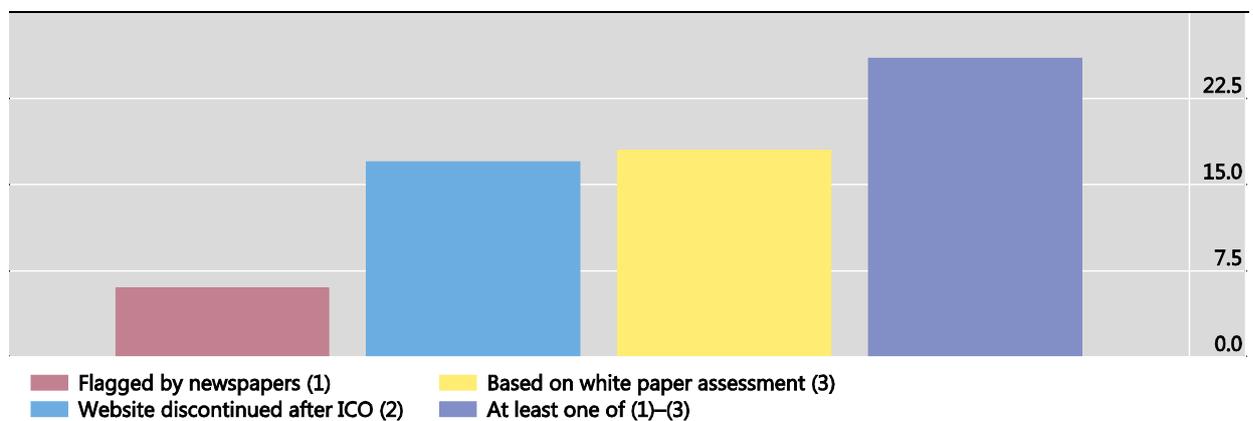
Digital currencies are vulnerable to digital theft. One industry report suggests that almost USD 1 billion in cryptocurrencies was stolen in the first six months of 2018.⁵ This is partly because users generally rely on third parties to store their holdings given, as I mentioned earlier, the massive size of the files involved. Since such crypto wallet providers or crypto exchanges are unregulated, users typically have no recourse if they turn out to be fraudulent or fall victim to hackers (as happened in the cases of Mt Gox and Bitfinex.)

Fraud also plagues initial coin offerings (ICOs), where cryptocurrency coins are auctioned in exchange for participation rights in a startup business venture. Many of these projects have turned out to be Ponzi schemes, as shown in Graph 7.

A large share of initial coin offerings is thought to be fraudulent

In per cent

Graph 7



Source: Bank for International Settlements, *Annual Economic Report 2018*, June.

Further, the anonymity of cryptocurrencies offers perfect cover for people who want to avoid capital controls or taxes, launder money or engage in other illegal transactions. One academic study suggests that about a quarter of bitcoin users and about 46% of bitcoin transactions are associated with illegal activity.⁶ Bitcoin reacted strongly to the shutdown of Silk Road, a major marketplace for illegal drugs, suggesting that some of the demand for cryptocurrencies derives from illicit activity. The ongoing investigation into the use of bitcoin to finance manipulation of the 2016 US presidential election provides another example.⁷

5. The latest advances are yet to solve these problems

All these critiques aside, one has to credit the developer community for a constant new stream of ideas touted to improve efficiency. One example is the Lightning Network. It is built on the concept of prefunded bilateral payment “channels”: each node has some preloaded value that it is willing to exchange with a nearby node for a claim on its value. By connecting many such two-way payment channels, it aims to be a working micropayment network, as illustrated in Graph 8.

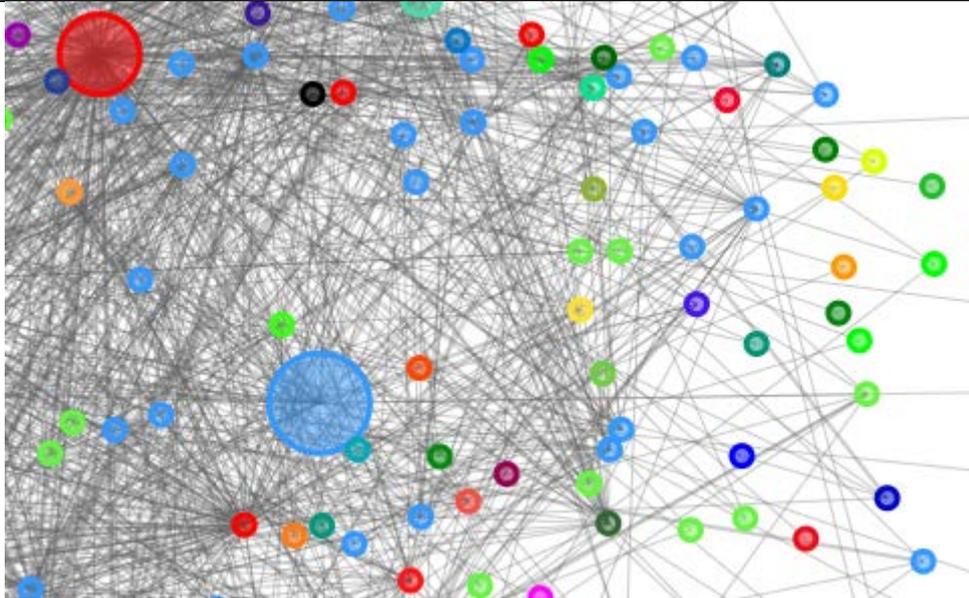
⁵ See CipherTrace, *Cryptocurrency anti-money laundering report*, Q3 2018.

⁶ See S Foley, J Karlsen and T Putniņš, “Sex, drugs, and bitcoin: how much illegal activity is financed through cryptocurrencies?”, 21 October 2018.

⁷ The US Department of Justice charged that to hack “into the computers of U.S. persons and entities involved in the 2016 U.S. presidential election and releasing the stolen documents—the Defendants conspired to launder the equivalent of more than \$95,000 through a web of transactions structured to capitalize on the perceived anonymity of cryptocurrencies such as bitcoin”.

Graphical representation of the Lightning Network

Graph 8



Source: R Auer, "The technology and the economics of decentralised trust in Bitcoin and the blockchain", *BIS Working Papers*, forthcoming.

However, there are reasons to be sceptical about whether this idea can ever work effectively. The key concern is one dear to economic network theory: the trade-off between efficiency and centralisation. If the Lightning Network remains truly decentralised, it will have a very large number of small two-way channels. For example, if routing a payment from A to Z involved four intermediate channels, it would in total require preloaded values five times as large as the payment amount. And indeed, given its present configuration, the test version of the network cannot reliably channel even a payment of USD 1, despite the network as whole having preloaded values worth in excess of USD 650,000.

This brings me again to a fundamental point: technology is not useful just because it can perform some tasks; it needs to be economically efficient at doing so compared with other ways of getting the job done. More on this next.

6. Cryptocurrencies appear to be a solution in search of a problem

It is not clear what problem cryptocurrencies are trying to fix. Part of the evolution of payments has been electronification and, more recently, digitisation. New digital payment services are emerging every day. In most markets, all but a few merchants now accept credit and debit cards. And cash itself is showing no signs of slowing down. Actually, cash in circulation has increased in tandem with card and electronic payments over the last decade.⁸ This is true for both advanced and emerging market economies, as shown in Graph 9. On average, use of cards and electronic payments has risen, from 13% of GDP in 2000 to 25% in 2016,⁹ and cash from 7% to 9% of GDP.¹⁰

⁸ See M Bech, U Faruqi, F Ougaard and C Picillo, "Payments are a-changin' but cash still rules", *BIS Quarterly Review*, March 2018, pp 67–80.

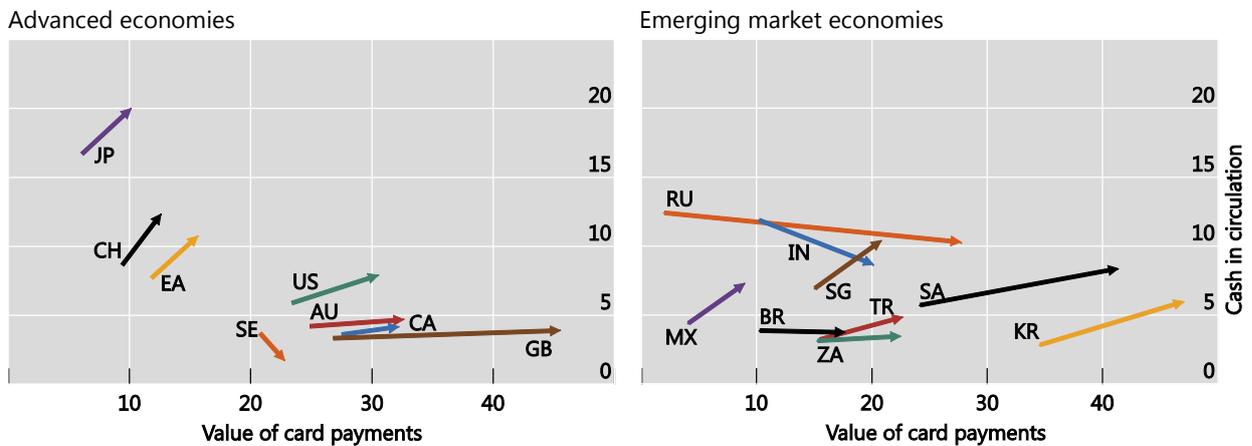
⁹ On average for CPI member countries

¹⁰ On average in a sample of CPI members and 22 additional countries.

Payments are a-changin' but cash still rules¹

As a percentage of GDP

Graph 9



¹ 2007–16 changes.

Source: M Bech, U Faruqi, F Ougaard and C Picillo, "Payments are a-changin' but cash still rules", *BIS Quarterly Review*, March 2018.

The notable exception to this trend is Sweden. Its cash in circulation has declined to below 2% of GDP. But Singapore typifies the trend quite well. Cash in circulation has risen to above 10% of GDP and card payments to around 20%; the average Singaporean citizen makes 147 card payments a year, or nearly three per week. Yet Singapore also has one of the highest-value banknotes in circulation: SGD 10,000, worth more than USD 7,000, even though it is not issued any more. So it seems cash is still king for many.

7. Cryptocurrencies compare unfavourably with other payment technologies

New technologies for the payments system are being adopted by central banks and the private sector on a continuous basis. As shown in Graph 10, real-time gross settlement (RTGS) for interbank payments is standard today. Given the technology cycle, many central banks are currently looking at next-generation RTGS systems to provide more robust operations and enhanced services.

Fast payment systems permitting real-time settlement of retail payments, launched in the 2000s, have allowed other innovations to flourish at the consumer level, including the introduction of mobile, internet and peer-to-peer payments. Based on a BIS analysis, fast payment systems are likely to become the dominant retail payment system by 2023.¹¹ As for cashless payments, these are becoming ever faster and more convenient. In Denmark, church collection boxes and street vendors now accept mobile payments. In China, fast food can be bought using "smile to pay" facial recognition technology. In the United States, college students share the costs of pizza and beers using apps that broadcast the purchases to their social media friends. I notice that scan-to-pay is quite common here, and that even at hawker stalls one can pay by QR code instead of cash.¹² While all sorts of payment innovations are thriving, note that these all work off existing payment systems, which central banks are working overtime to make even more robust, more resilient and more timely. This shows that, especially for payments where buyer and seller never meet in person, trust is vital. Here, a decentralised network of anonymous computers cannot replace tried and tested institutions like central banks.

¹¹ See M Bech, Y Shimizu and P Wong, "The quest for speed in payments", *BIS Quarterly Review*, March 2017, pp 57–68.

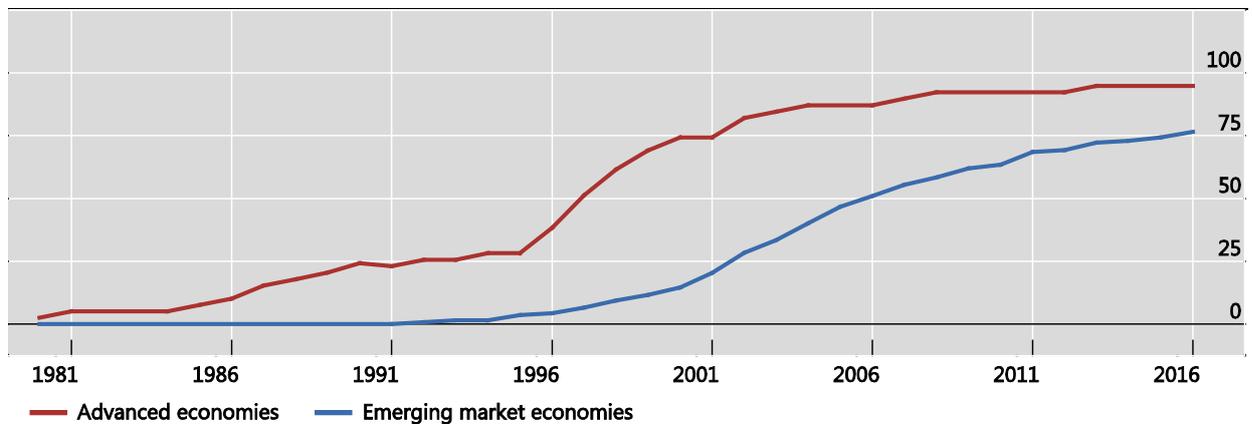
¹² See the Monetary Authority of Singapore's announcement on 17 September 2018 of a single QR code to be used by 27 payment schemes <http://www.mas.gov.sg/News-and-Publications/Media-Releases/2018/Singapore-Introduces-Worlds-First-Unified-Payment-QR-Code.aspx>



Share of adopters of real-time gross settlement systems by year

In per cent

Graph 10



Sources: M Bech, Y Shimizu and P Wong, "The quest for speed in payments", *BIS Quarterly Review*, March 2017; national central banks; World Bank Group; BIS calculations.

8. The case for DLT in public and private uses remains unproven

Are there, amid all the hype about cryptocurrencies, any instances of actual productive use of DLT? Much hope has been placed on applications where, combined with the use of wholesale central bank digital currencies (CBDCs)¹³, DLT may improve the efficiency of settling securities and derivatives transactions. A number of central banks, including the Monetary Authority of Singapore (MAS), the Bank of Canada and the Bank of Japan, have tested this concept.

As of today, these ways of employing DLT – designed to comply with existing central bank system requirements relating to capacity, efficiency and robustness – look broadly similar to existing infrastructures, and not clearly superior to them. The efficiency gains appear absent or very limited.

The fact that actual experiments currently show few benefits over existing systems is in line with recent analysis carried out by my colleague Hyun Shin together with Stephen Morris.¹⁴ As they show, a payments system based on DLT does not overcome the need for credit. Most importantly, when considering a DLT-based system, their analysis shows that, if the cost of credit exceeds even a modest amount, the coordination needed between participants for a payments system to function is not guaranteed. In all but a narrow range of cases, the decentralised equilibrium fails to deliver the credit needed to reproduce the high-volume payment flows that are normal in systems backed by the central bank balance sheet. While future proofs of concept may rely on different system designs, and more experimentation and experience would be required, the analysis in question casts doubt on whether central banks can usefully and safely implement these technologies.

9. If there are use cases for DLT-based cryptoassets, what is the regulatory agenda?

I have just shown how economic analysis can help explain why, at present, given its limitations, DLT has seen no widespread (legal) uses. Although one should be sceptical given the economics, real use cases

¹³ See also CPMI and Markets Committee (2018), Central bank digital currencies, <https://www.bis.org/cpmi/publ/d174.htm>.

¹⁴ See H S Shin and S Morris, "Distributed ledger technology and large value payments: a global game approach", presentation at the conference on *Cryptocurrencies and Blockchains*, University of Chicago Becker Friedman Institute, 9 November 2018, <https://www.bis.org/speeches/sp181109.htm>.



may arise as technology advances. What should then be the regulatory response? Ensuring a level playing field – same risk, same regulatory treatment – is the standard response and the right paradigm. This approach requires continuous adaptation, as the technological advances have triggered an enormous unbundling in financial services. Just consider the new providers of instant payments, eg the two well-known examples from Asia: Alipay and WeChat Pay in China. This in turn means that the focus of regulation has to shift from entities to specific financial functions.

How does it then work in practice? How to regulate, for example, in the case of cryptocurrencies? Here, as we determine what their functions are and for what economic ends, we should obviously be deeply concerned. I have already mentioned the vast extent of illicit activities financed by cryptocurrencies. One policy option could be that of “benign neglect” – that is, let the cryptocurrencies develop without any regulation at all and ultimately let market forces decide their fate. I think this is wrong. If there is no fundamental economic case for cryptocurrencies, we should not neglect them. Instead, we should direct our attention towards finding a decisive public policy response. Not doing so risks turning benign neglect quickly into malign neglect, which will just allow illicit behaviour to proliferate.

Unfortunately, public policy has arguably fallen dramatically behind the curve. Indeed, there is an immediate need to apply anti-money laundering and combating the financing of terrorism (AML/CFT) requirements for payments using cryptocurrencies. At the very least, we need to apply minimum regulations, particularly where such assets intersect with the conventional financial system (such as banks).¹⁵ I would emphasise that this is only a start: we may need regulations equivalent to those we impose on the use of sovereign cash. For example, when retail purchases are made using cash, limits apply. Retail cash payments are generally capped at EUR 1,000 in France and EUR 3,000 in Belgium, Italy and Portugal, while Australia is set to introduce a cap of AUD 10,000. Above that, only if the payment is properly recorded and verified to be legitimate can it proceed. If not, it constitutes a crime. Why not the same for cryptocurrencies?

Uncertainty over whether technological innovations are socially useful should in general give us pause in regulating now. After all, one does not want to regulate something that is useless or ends up being a “bad” (just like we do not adopt regulations requiring commodities traded illegally to be 100% pure). If there is no fundamental economic case, we should not try to regulate. Supervisory agencies, and securities and other regulators working with economists, thus have to determine the legitimate uses and purposes. Today, there abounds a cacophony of names – cryptoassets, crypto tokens, initial coin offerings, etc.

10. How to assess use cases of the new technology for central banks?

As I have just explained, recent technological developments are changing the role of money and the payments system. Developments offer many new opportunities, such as faster payments, but can also give rise to fresh regulatory challenges in that sphere. However, the impact of technological advances goes much further. Technological advances are affecting markets for all financial services, and changing the nature and forms of intermediation. They are also altering the broader economy and how economic activity can be monitored. These changes stand to offer many benefits and advantages to the users, the industry and the economy at large. Nevertheless, the changes also bring new risks, as I have noted in the case of cryptocurrencies. How best to respond and balance the benefits with the risks? How to adapt regulation? How to conduct policy in light of these changes?

¹⁵ Indeed, the Financial Action Task Force argued recently for an effective global, risk-based response to the AML/CFT risks associated with cryptocurrencies and other virtual assets (Financial Activity Task Force, “Regulation of virtual assets”, *FATF Recommendations*, 19 October 2018).

My first message here would be that central banks and other regulatory authorities need to be more proactive in the face of rapid technological changes. They need to scout out opportunities where technology can help them better meet their core mandates: assuring price and economic stability and fostering an efficient and resilient financial system. As technologies and related designs are evolving quickly, central banks will need to continually assess and reassess.

But how should central banks prioritise their actions and opportunities? The guiding principle should be that technological advances alone do not necessarily make good economic sense: one needs to investigate whether or not they make sense from a public policy perspective. We have learned this principle the hard way from earlier financial innovations, such as *subprime* and *CDO squared* before the Great Financial Crisis. We know this now in many respects for cryptocurrencies. It applies more generally to innovations. As central banks monitor and assess the latest technologies, they will need to challenge those that do not appear to meet the economic cost-benefit test or that put financial stability at risk.

It is very fitting to speak of these issues in Asia, which is the clearest example of how the financial sector is being transformed by technology. And there is no better place or time than Singapore today to speak about how technological innovations, and digitisation in particular, are affecting money and financial intermediation. MAS has been at the vanguard of central banks in responding to technological innovation.¹⁶

MAS has in many ways developed an integrated, public policy approach. One example is that authorities started with creating a “digital ID” to link individuals or legal entities to trusted data. The development of this public infrastructure facilitates productive fintech and big tech development and offers many potential efficiency gains (eg easing interbank payments, improving know-your-customer (KYC), enhancing financial inclusion). It also allows a levelling of the playing field, as only supervised institutions have access to the data. MAS has also pioneered the use of regulatory sandboxes, allowing firms and the supervisory agents to test financial innovations in a controlled environment. Moreover, it has been very proactive in adopting suptech and regtech. Other central banks are following its example. Let me take this opportunity to express my appreciation of the strong record of collaboration and the productive exchange of thoughts on these and other issues between our two institutions.

The role of the BIS

Lastly, I want to highlight the implications for the Bank for International Settlements. The BIS is very well placed to play the role of knowledge platform and forum for discussion of the unfamiliar and cross-cutting nature of these technological developments. In addition, the BIS can offer concrete policy insights and technological advances by being at the cutting edge itself.

As part of our new medium-term plan, we will step up our analytical efforts and increase work under the heading *Innovations and the Digital Economy*. Working in-house and through collaboration and knowledge-sharing with central banks and others, we will focus on the implications of technology trends for financial intermediation, monetary policy and the broader economy. We will undertake policy analysis on how key innovations (eg machine learning, artificial intelligence, DLT) and the increased availability of big data are informing policy and shaping the responses of central banks. Our output will be in the form of reports on emerging technology trends affecting central banking, in-depth insight studies and collaborative events.

In addition, we will combine our in-house technological expertise in a multidisciplinary *Innovation Hub*. The Hub will focus on the systematic identification of critical technology trends, and the development of use cases for application to harness technological advances for central banks. The Hub’s efforts will be

¹⁶ See R Menon, “Asia’s digital transformation”, remarks at the GIC Institutional Investors Roundtable, Singapore, 31 October 2018, <https://www.bis.org/review/r181102d.htm>.

leveraged to benefit from outside expertise, such as the large pool of talent in Asia, as a function of the ongoing initiatives. All this will benefit the broader community, delivering tangible public goods to improve the global financial system. In short, the BIS stands ready to help with reaping the opportunities while balancing the risks.

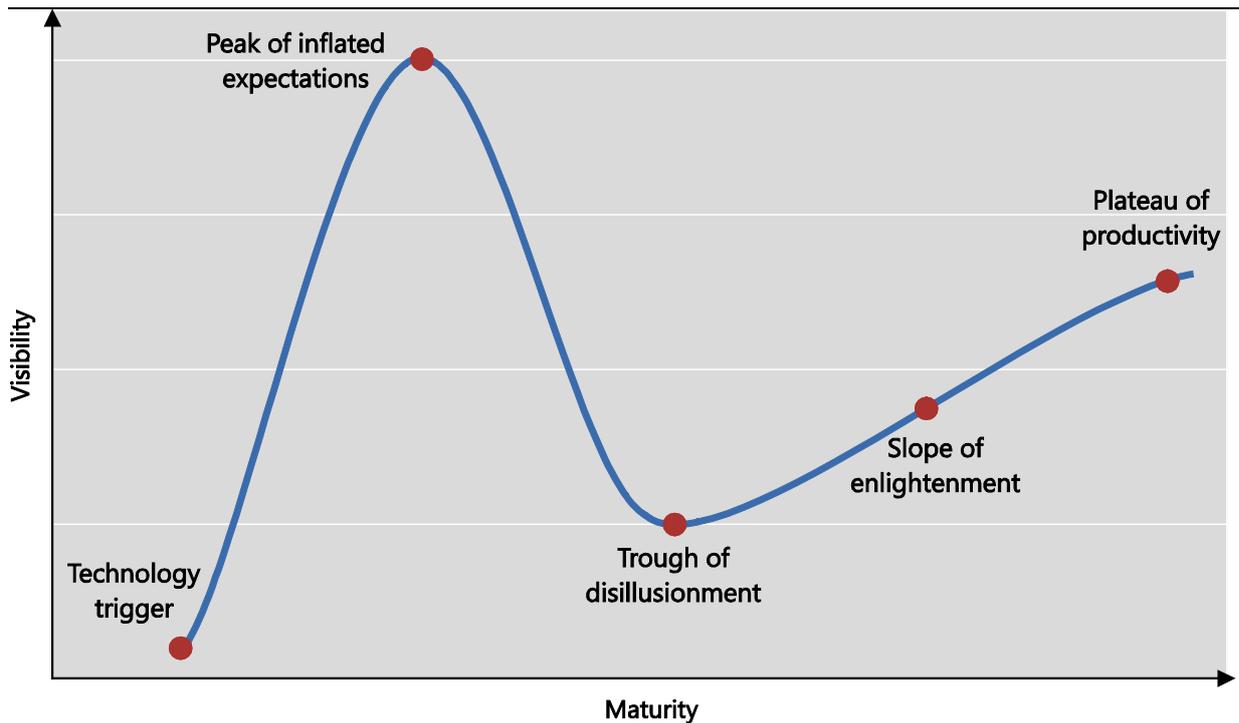
Choosing the right road

So, where does all this leave us? We are reaching an important intersection today, where economics and technology in finance meet. These are exciting times, with many directions available to travel. But good technology alone does not ensure good economics, just as good economics does not ensure good technology. I have shown this in the case of cryptocurrencies, but it also applies more generally.

Technology is only effective once it has found its economic purpose. Graph 1 showed how information technology, like electricity before it, can drive long-term growth. But innovations only drive growth once they enter general use. We can look at the life cycle of adopting technology, as shown in Graph 11. Many innovations take a long time to achieve mainstream adoption. And others never reach that point at all, but fall by the wayside. We could place today's cryptocurrencies at the peak of inflated expectations, and acknowledge that some are already obsolete or heading that way¹⁷. While new digital payment methods may appear at different points on the curve, it is too early to say which will become mainstream.

There is a life cycle in financial innovations

Graph 11



Source: Adapted from <http://declineofscarcity.com>.

¹⁷ Websites like <https://deadcoins.com/> and <https://www.coinopsy.com/dead-coins/> keep track of failed or abandoned digital coins and tokens



We take a public policy view of physical infrastructure: building new roads or bridges is not a decision which is taken overnight, nor are private interests given free rein to determine which route to take or how many lanes are needed. We must take the same amount of care with our digital infrastructure as we do with our physical infrastructure, keeping in mind the goals of developing, improving and (ultimately) transforming our economy and society. This is particularly important for the financial system, the most digitally connected part of the economy. The first step is to scout out the destinations we want to reach. Then we can consider the best routes, map out a course, and harness the best and most appropriate technology to help us get there. Let's decide on the destination before building the road.