



Money and payment systems in the digital age

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Introduction

Good morning. It is a pleasure to be here for the first Finance and Global Economics Forum of the Americas and the 70th anniversary of the Miami Business School. Of the gatherings that I have the honour of addressing, speaking at universities is among the most enjoyable. Here I engage with current and future thought leaders.

Many of you were born into a digital world. Some of you may have never known a world without the internet, without Google, without smartphones. Believe it or not, there was a time when libraries were the primary source of knowledge, information came from manual searches of books and microfiches, and computers took up the size of an entire classroom.

The situation is similar with money and payments: some of you may have never carried hundreds of dollars in cash to buy something, written a cheque at a grocery store, or searched for coins to make a call at a public telephone booth or feed a parking meter. A few of you who grew up outside the United States may have never even touched paper money until arriving here. Times are a-changin', and changing quickly.

Let me begin with a short informal survey – with a show of hands, how many of you typically carry cash? How many write cheques? How many broadcast payment activity on social media? How many own a cryptocurrency? This exercise highlights, in a small way, the different states of “money” with a limited sample size.

This morning, I would like to share my thoughts on money, payment systems and innovation. I would like to look at what money is, how it has evolved, what some of payments innovations taking place are and how cryptocurrencies fit into all of this.

“Money is what money does”

Money is a curious invention, yet maybe one of humankind’s most important. Certainly it is fundamental to the functioning of a modern economy. Throughout history, money has come in a huge variety of different forms. For millennia, it has served three roles: as a unit of account, a payment instrument and a store of value. It allows for efficient exchange of goods and services, specialisation of production, higher productivity, stronger economic growth and higher welfare. Adam Smith, in *The wealth of nations*, captures the definition of money nicely, describing it as “... the universal instrument of commerce, by the invention



of which goods of all kinds are bought and sold, or exchanged for one another".¹ The invention of money is so critical to society that its introduction happened independently across cultures, geographies and time.

A unit of account. Before the invention of money, societies subsisted on barter. People would trade one good or service for another. This system, however, was awfully inefficient as the marketability of certain assets was limited depending on the needs and wants of trading partners. A seller of livestock may not necessarily value a trading partner's crop of grains, for example. The introduction of money allowed for a common medium of exchange. The value of livestock did not need to be tied to (or measured against) the value of grains. Further, money allowed for divisibility. That is, the value of the livestock could be divided without necessarily dividing the livestock.

A payment instrument. The introduction of money also facilitated payment for goods and services. Money allowed buyers and sellers to settle obligations using a common medium of exchange. The Aztecs in what is now Mexico, for example, used cocoa beans as their principle currency. Prices of goods and services were measured by the number of beans, according to early explorers. According to one historical account, cocoa beans were kept in bags of 24,000. Talk about good accounting! Interestingly, the Aztecs were able to maintain the value of cocoa beans by limiting their production.²

A store of value. Further, certain mediums of exchange, such as precious stones and metals, allowed individuals to store wealth in commodity items that had value, were durable and were universally accepted for goods and services. The Native Americans in the eastern part of the present-day United States measured wealth based on how much wampum, a shell currency, was owned. In many parts of what is now Canada, animal furs served as a medium of exchange and store of value. The Hudson Bay Company, the trading company of the British Crown in Canada, noted the turnover of its branch offices in terms of beaver skins.³

Although money has come in different forms, banknotes and coins represent the most common form of physical money today. And thank goodness, because carrying bags of cocoa beans or lugging furs around would make for tough work.

Evolution of money

To understand the evolution of money from commodity items to current-day banknotes and coins, it is crucial to understand some of the key determinants of how money is used. Geography, technology, social factors and politics are important considerations.

To begin with, *geography* has played a part in the evolution of money. A medium of exchange is often something that is locally sourced. Maize, for example, was used in Guatemala as primitive money, and snail shells in Paraguay. The first coins in present-day Turkey were made from an alloy called electrum, which was naturally occurring in the area. Even in modern times, geography plays a role. The composition of coins continues to be influenced by the availability of local metals. The Royal Canadian Mint converted to a five-cent nickel piece in 1922 in part because Canada was the world's leading source of nickel ore at the time.⁴

¹ A Smith, *The wealth of nations*, 1776.

² See P Einzig, *Primitive money*, 1949, pp 175–6.

³ Ibid, pp 165–9.

⁴ See www.mint.ca/store/dyn/PDFs/RollTimeline_e.pdf.

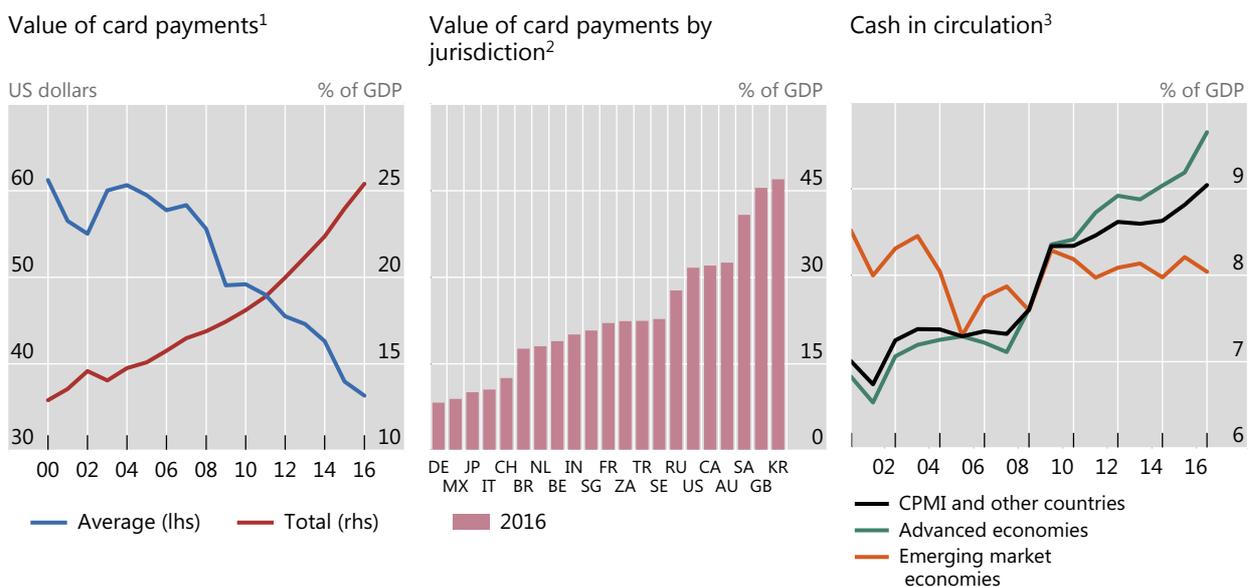
Technology is perhaps one of the most important factors in the evolution of money. The development of coinage and banknote printing, the electrification of payments and now the digitalisation of payments are possible because of technological advances. Manufacturing processes allowed mints to produce standardised coins. The invention of the telegraph allowed for electronic communications, leading to the establishment of the first electronic interbank payment system. And today, computers, the internet and mobile telecommunications have allowed for real-time, peer-to-peer and mobile payments.

Social factors influence how money is used. Germany and the Netherlands are neighbouring states, but the payment behaviours of their citizens could not differ more. A 2017 study by the ECB showed that Germans used cash in 80% of point-of-sale transactions, whereas the Dutch used cash in only 45%.⁵ The difference between these two populations is fascinating. There are a number of theories as to why Germans may prefer cash over other payment instruments – a dislike of borrowing and preference for anonymity, among others.

The decline in cash use in the Netherlands mirrors what is happening elsewhere in the world, including here in the United States. The value of card payments is increasing as a percentage of GDP. Graph 1 (left-hand panel) highlights how card payments represented 25% of GDP in 2016, compared with 13% in 2000. The value of card payments in some countries, such as Korea, the United Kingdom and Saudi Arabia, is more than 40% of GDP, compared with roughly 10% in Germany, Mexico and Japan. That said, cash in circulation is also increasing. It is up to 9% from 7% in 2000.⁶

Card payments and cash demand have generally increased

Graph 1



¹ Statistics for members of the Committee on Payments and Market Infrastructures (CPMI). ² Data for China are not comparable with other jurisdictions and thus are not shown. ³ Other countries: AE, BG, CL, CO, CZ, DK, HR, HU, ID, IL, IS, KW, MY, NG, NO, PH, PL, RO, RS, TH, UA and UY. Data start in 2002 for India, 2004 for Mexico, Turkey and South Africa, and 2005 for Russia.

Sources: CPMI, *Statistics on payment, clearing and settlement systems in the CPMI countries – figures for 2016*, December 2017; People’s Bank of China; IMF, *International Financial Statistics*; BIS calculations.

⁵ See H Esselink and L Hernández, “The use of cash by households in the euro area”, *European Central Bank Occasional Paper Series*, no 201, November 2017.

⁶ 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.



Memories can be societal, or personal. As a child, I lived through high inflation in Mexico. When I was eight, I remember my father giving me a wad of cash for the bus home from school. At the end of the school day when I tried to take the bus home, I was kicked off because my wad fell short of the bus fare. Fares had gone up in the course of the day, and I ended up walking home. Such an experience led me to value price stability and to understand the dangers of financial instability and its impact on people's lives. To this day, I probably carry a bit more cash than I really need.

Politics, of course, is something that we cannot get away from. The political class is responsible for establishing the legal framework in which money exists and commerce is conducted. The imposition of coinage in the Holy Roman Empire, for example, was a result of an imperial edict that the minting of coins was to be carried out by a select group of people operating a small number of mints and that these coins were to be used throughout the empire.⁷

Electronification and digitalisation of money

One of the most significant developments in the evolution of money has been its electronification and, more recently, digitalisation. Telephone networks and computers allowed for the first credit cards, automated teller machines and automated clearing houses (ACHs) starting in the 1960s and 1970s. Real-time gross settlement (RTGS) systems for interbank payments, a mouthful that I shall explain, emerged in the 1980s. Fast payment systems permitting real-time settlement of retail payments were launched in the 2000s. These developments allowed other innovations to flourish at the consumer level, including the introduction of mobile, internet and peer-to-peer payments.

RTGS systems allow banks and other financial institutions to send money to each other with immediate and final settlement. They are typically operated by central banks and process critical (read: high-value) payments to allow for the smooth functioning of the economy. Today, the top interbank payment systems in the G20 countries settle more than \$17.5 trillion a day, which is over 50 times a working day's global GDP.⁸ The Federal Reserve implemented one of the first RTGS systems in the 1980s and, as shown in Graph 2, RTGS is standard today. Given the technology cycle, many central banks are currently looking at next-generation RTGS systems to offer more robust operations and enhanced services.

⁷ See I Schnabel and H Shin, "Money and trust: lessons from the 1620s for money in the digital age", *BIS Working Papers*, no 698, February 2018.

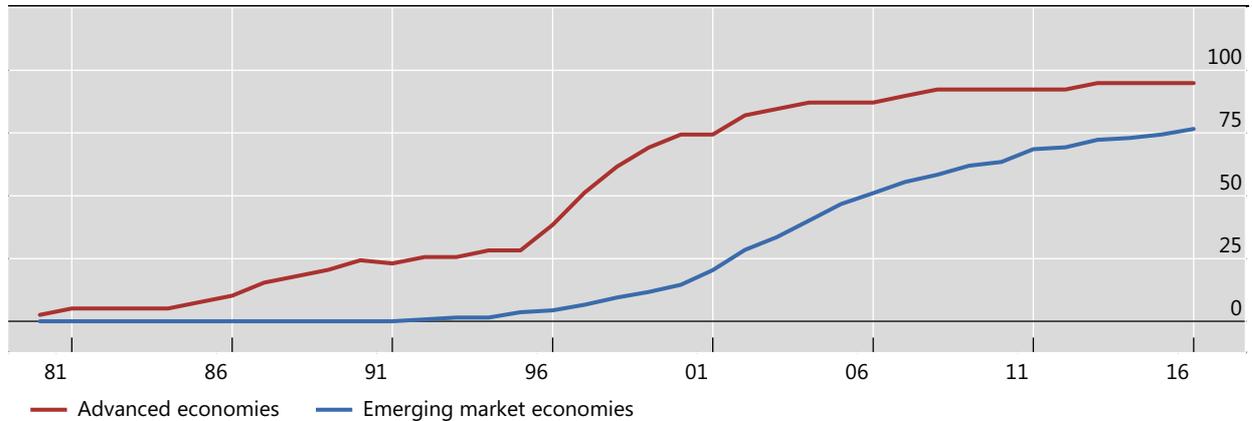
⁸ Source: BIS calculations.



Share of adopters of real-time gross settlement (RTGS) systems by year

In per cent

Graph 2



Sources: M Bech, Y Shimizu and P Wong, "The quest for speed in payments", *BIS Quarterly Review*, March 2017, pp 57–68; national central banks; World Bank Group; BIS calculations.

For retail payment systems, which you and I use to purchase goods and services, the pace of innovation has been truly impressive. Do you know that in Mexico consumer payments operate at the same speed as interbank payments? The beneficiary of a payment is credited money in near real time. That is, if I were to send you money from my Mexican bank account, you would see the funds in your Mexican bank account in 15 seconds or less.⁹ Mexico was one of the first countries to adopt a real-time retail payment system, and other countries are now following suit. Based on a BIS analysis, fast payment systems are likely to become the dominant retail payment system by 2023.¹⁰

The payment systems to which I just referred are back office systems that most people do not see or interact with directly. What you see and use are the front-end user interfaces. And the innovations on the front end have been staggering. It's not so long ago that payment options were limited to cash, cheques and plastic cards. During the last two decades, however, an array of options have appeared. You can now initiate transactions using mobile phones and other personal devices. One development that I find especially useful is in Argentina, where payments can be made using bank account aliases (eg "miami.florida.fantástico"). A banking customer can just say, "Please send pesos to 'miami.florida.fantástico'" and the money will arrive instantly in the right account.¹¹

These types of front-end interfaces, however, may soon be eclipsed by other innovations that could be used to make payments. Some companies are testing cashless systems – no cashiers, no lines, no cash, no physical payment devices. Amazon and others envision a future where you walk into a store, take what you want, and are automatically billed for the items using facial recognition and artificial intelligence. Though this approach may seem a bit scary, it is less so than having microchips implanted inside us, which some firms are also piloting! To be frank, though, neither of these options – facial recognition or microchip implants – are particularly appealing to me.

⁹ See CPMI, *Fast payments – Enhancing the speed and availability of retail payments*, November 2016.

¹⁰ See M Bech, Y Shimizu and P Wong, "The quest for speed in payments", *BIS Quarterly Review*, March 2017, pp 57–68.

¹¹ See www.bcra.gov.ar/Noticias/cuentas_bancarias_alias_cbu_i.asp.



Continuing innovations in payments

Although much attention has been focused on cryptocurrencies as the “it” innovation in payments, there’s much unheralded innovation going on. Central banks are working overtime to make the existing payment infrastructure more robust, more resilient and more timely. While this work is not as attention-grabbing as crypto-this and crypto-that, developing new hardware, software and processes to safeguard your money, strengthen financial stability and protect the economy is of immense importance.

More robust operations. Because payment systems are critical for a smoothly functioning economy, central banks are continuously working to ensure that the payment infrastructure is robust. Many central banks are exploring longer operating hours, including operating 24/7. This is particularly relevant for retail payment systems because commerce never stops. Central banks have been pushing the boundaries of what technology can achieve for operational robustness, including switching seamlessly between data centres at short notice and synchronising geographically dispersed data centres.

One interesting development in the central banking community is ongoing experimentation with distributed ledger technology (DLT) as a means to enhance operational robustness.¹² People often use DLT and Bitcoin interchangeably, but they are not the same! It is important to emphasise that DLT is the underlying technology for Bitcoin, which is just one use case. DLT is simply a set of processes and technologies that enable multiple computers to maintain collectively a common database. DLT does *not* mean mining of coins, public ledgers and open networks. And no central bank that I’m aware of is contemplating these properties in its DLT experimentation.

While central banks play around more with DLT, I think it would be useful to highlight two findings. The first is a Bank of Canada study noting that a DLT-based payment system meeting central bank requirements would be similar to what we have today (ie private ledgers, closed networks and a central operator).¹³ The difference is that a network of computers would be used to settle a transaction instead of one computer. The second is an ECB and Bank of Japan study concluding that processing times would be three times longer using DLT versus current systems.¹⁴ This may not seem like much when processing times are measured in seconds, but today’s standard is instant. My take is that current versions of DLT are not any better than what we already have today.

More resilient systems. Furthermore, central banks are working to improve their systems’ operational resilience. The international standards for systemically important payment systems require that they be able to resume operations within two hours of an operational outage.¹⁵ As you can imagine, resuming operations within two hours of something like a cyber-attack is not always easy to do. The problem needs to first be diagnosed, and then it needs to be determined whether the system can safely be turned back on again. Central banks have adopted, and others are exploring, different arrangements, including DLT-based arrangements and last resort contingency arrangements, to ensure the highest levels of operational resilience.

¹² See CPMI, *Distributed ledger technology in payment, clearing and settlement – an analytical framework*, February 2017.

¹³ See Bank of Canada, *Project Jasper: a Canadian experiment with distributed ledger technology for domestic interbank payments settlement*, 29 September 2017.

¹⁴ See European Central Bank and Bank of Japan, *Securities settlement systems: delivery-versus-payment in a distributed ledger environment*, March 2018.

¹⁵ See Committee on Payment and Settlement Systems and Technical Committee of the International Organization of Securities Commissions, *Principles for financial market infrastructures*, April 2012.



Faster settlement. For retail payments, there is intense focus on enhancing the speed of settlement. The days of multi-day cheque holds, whereby a bank can withhold funds until it receives the cheque from the debiting bank, are limited as real-time or near real-time settlement becomes the norm. Moreover, faster settlement on a 24/7 basis will allow new value added services, including cash flow and liquidity management and quicker and easier reconciliation processes. Last month, the Federal Reserve announced that it was seeking public comment on potential steps towards a fast payment system to allow business and individuals to receive money faster and reduce payment risk.¹⁶

Faster payments will hopefully lead to improved cross-border payment services, which is the next (and perhaps final) frontier for payment innovation. Sending money overseas remains cumbersome, slow and expensive.¹⁷ The introduction of fast payments across jurisdictions is akin to building domestic highways. The next step, of course, is to connect the various domestic highways into a global superhighway. Connecting fast payment systems with 24/7 operations and immediate settlement should one day allow for seamless settlement of cross-border payments. For the Americas, this would be a significant and important development.

Cryptocurrencies: fake money

No discussion of money and payments in the digital age would be complete without addressing cryptocurrencies. But are cryptocurrencies money? No. The use of “currencies” is misleading. Cryptocurrencies, such as Bitcoin, Ether and Tether, do not serve the core functions of money. No cryptocurrency is a true unit of account or a payment instrument, and we have seen this year that they are a poor store of value. This then raises the question: what are they? Let me expand.

I am not aware of any major business that uses a cryptocurrency as its primary unit of account. Even overstock.com, one of the early Bitcoin evangelists, lists prices in a sovereign currency. It merely accepts bitcoins using a USD/bitcoin conversion rate that is valid for up to 10 minutes. That is even worse than my boyhood bus fare! Graph 3 (left-hand panel) shows the volatility of bitcoin and other major cryptocurrencies. The bitcoin equivalent of one US dollar at the beginning of the year, for example, would be the equivalent of about 50 cents today. Having a stable unit of account is fundamental to having a smoothly functioning economy; otherwise, we would be subject to daily, if not 10-minute, price changes. Some companies are trying to solve the volatility of cryptocurrencies by tying them to an underlying asset, such as the US dollar. However, even these so-called “stable coins” also show volatility.

Also, if a retailer were to accept a cryptocurrency, there’s more than a few thousand cryptocurrencies to choose from. This number, as shown in Graph 3 (right-hand panel), has grown, and is growing, exponentially given the ease with which one can create a cryptocurrency. You and I can actually create one easily today in a few minutes. With a bit of coding work (or for a few hundred dollars to have someone else do the coding work), you too can have your own cryptocurrency!

¹⁶ See L Brainard, “Supporting fast payments for all”, remarks at the Fed Payments Improvement Community Forum, Federal Reserve Bank of Chicago, 3 October 2018.

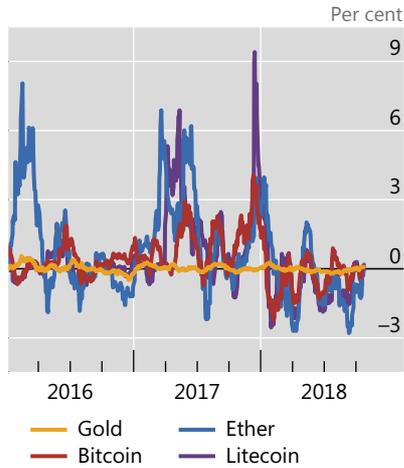
¹⁷ See CPMI, *Cross-border retail payments*, February 2018.



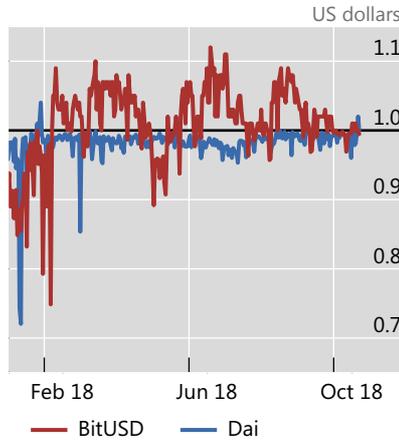
Volatility of select cryptocurrencies and number of cryptocurrencies

Graph 3

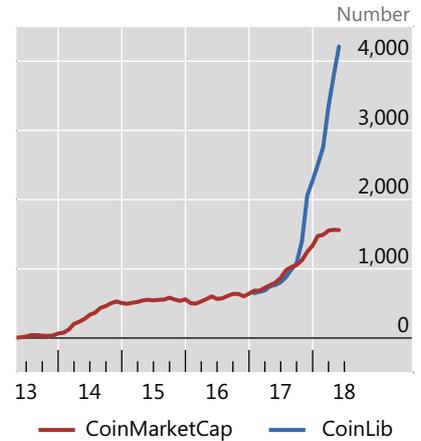
Major cryptocurrencies are comparatively volatile¹



“Stable coins” fluctuate in value²



Number of cryptocurrencies is growing rapidly³



¹ Thirty-day moving averages of daily returns. ² Daily price minimum. ³ Based on monthly snapshots from two different providers. CoinMarketCap includes only cryptocurrencies with a minimum 24-hour trading volume of \$100,000; CoinLib does not use a threshold.

Sources: BIS, *Annual Economic Report 2018*; www.bitinfocharts.com; www.coinlib.io; www.coinmarketcap.com; Datastream; BIS calculations.

As a means of payment, the acceptance of cryptocurrencies has not reached critical mass and is unlikely to do so for a number of reasons. First, the system is highly inefficient and expensive. As highlighted in the BIS’s Annual Economic Report, the energy and computing costs associated with cryptocurrencies amount to an environmental disaster.¹⁸ Graph 4 looks at some of the energy consumption and scaling issues that the crypto industry faces because of its reliance on a network of mining computers. All evidence to date points to the conclusion that cryptocurrencies face inherent limits in terms of efficiency and scalability. Because of these issues, it’s not surprising that the cost of a transaction can be high as highlighted in Graph 5.

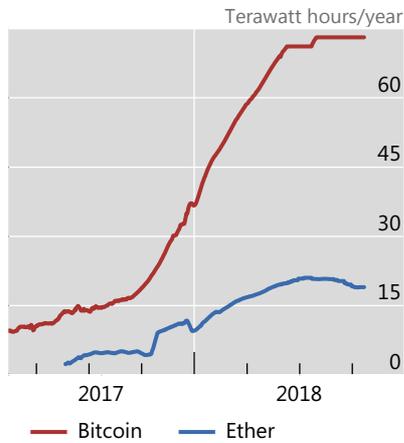
¹⁸ BIS, *Annual Economic Report 2018*, June 2018.



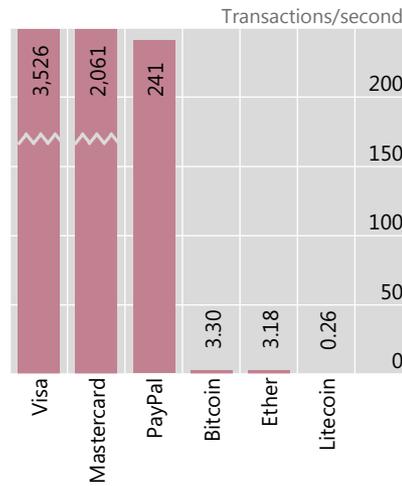
Energy consumption and scaling issues

Graph 4

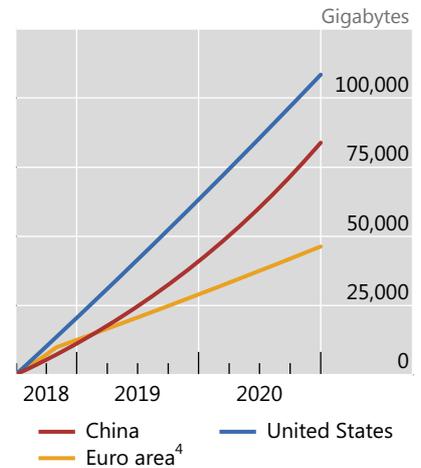
Energy usage of select cryptocurrencies¹



Number of transactions per second²



Hypothetical ledger size for nationwide retail cryptocurrency³



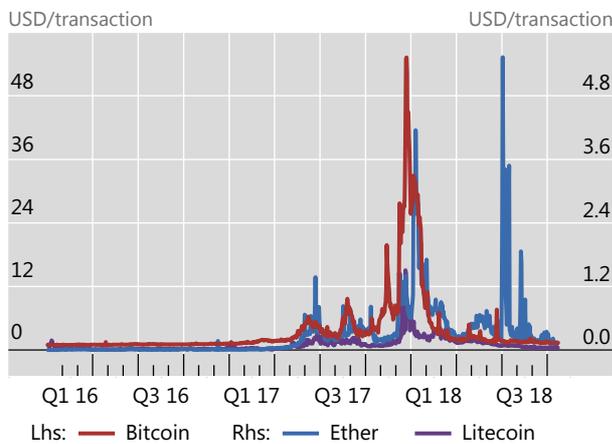
¹ Estimated. ² 2017 data. ³ The displayed hypothetical size of the blockchain/ledger is calculated assuming that, starting from 1 July 2018, all non-cash retail transactions of either China, the United States or the euro area are processed via a cryptocurrency. Calculations are based on information on non-cash transaction numbers from CPMI (2017) and assume that each transaction adds 250 bytes to the ledger. ⁴ Belgium, France, Germany, Italy and the Netherlands.

Sources: BIS, *Annual Economic Report 2018*; CPMI, *Statistics on payment, clearing and settlement systems in the CPMI countries*, December 2017; www.bitinfocharts.com; Digiconomist; Mastercard; PayPal; Visa; BIS calculations.

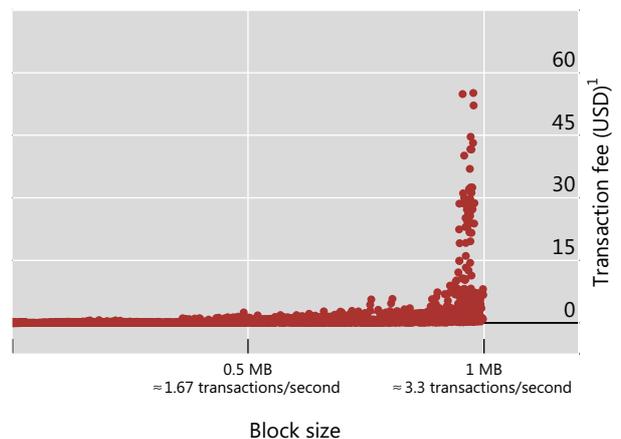
Transaction fees over time and in relation to transaction throughput

Graph 5

Transaction fees spike ...



... when blocks are full and the system congests



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

Sources: BIS, *Annual Economic Report 2018*; www.bitinfocharts.com; BIS calculations.

Second, take-up by consumers and retailers has been weak. There is a classic network problem. Consumers have not adopted cryptocurrencies because not enough retailers are accepting them, and retailers are not accepting them because not enough consumers use them. Interestingly, the few retailers that do accept cryptocurrencies are doing it more as a marketing gimmick than anything else. For those of you who remember the dotcom bubble, it's like adding ".com" to your corporate name. Most retailers accepting cryptocurrencies are converting them to cold hard cash upon receipt. This "accept and convert"



(versus “accept and keep”) gives an indication of how mainstream businesses think about cryptocurrencies and their value as a medium of exchange.

So if cryptocurrency isn’t money, what is it? From my perspective, cryptocurrencies are, at best, an asset of some sort. Perhaps an asset comparable to a piece of art for those who appreciate cryptography. Buyers of cryptocurrencies are buying into nothing more than a software algorithm. Some firms are trying to back cryptocurrencies with an underlying asset, such as cash or securities. That sounds nice, but it’s the equivalent of making art from banknotes or stock certificates. The buyer is still buying an idea or a concept or, if you will, an asset that is the equivalent of art hanging on your wall. If people want the underlying asset, they might be better served just buying that. Others have argued that cryptocurrencies resemble assets because they are like “digital gold”, with just the right amount of scarcity – like the Aztec cocoa beans. However, that scarcity is artificially created through an algorithm and, as I said before, there is no scarcity with several thousand cryptocurrencies!

Cryptocurrency enthusiasts often highlight the ability to avoid existing institutions. But is that a good thing? There’s not a day that goes by when there isn’t a story about stolen cryptocurrencies. One industry report suggests that almost \$1 billion in cryptocurrencies have been stolen so far this year.¹⁹ Most of those who have suffered cryptocurrency theft can’t do much in terms of recovery (the local police is unlikely to be of much help!). Further, numerous studies have noted that a significant amount of Bitcoin activity is shady. One academic study suggests that about a quarter of Bitcoin users and about 46% of Bitcoin transactions are associated with illegal activity²⁰ – whereas money and other assets held at regulated financial institutions are subject to rules on consumer protection, anti-money laundering and combating the financing of terrorism.

What’s next?

Money and payments continue to evolve, and I think the future is promising. I see more robust and resilient systems from central banks offering immediate settlement. I see foundations being laid for new, innovative front-end user interfaces that provide convenience, promote financial inclusion and permit increased economic activity. I see infrastructure being developed that will allow for more efficient and cheaper cross-border payments and remittances. I see central banks continuing to play a critical role in pushing the boundaries of how technology can enhance the payment landscape.

In doing so, central banks will need to monitor and manage new and different risks arising from the latest technologies. The use of DLT and other technologies, such as artificial intelligence and quantum computing, comes with new challenges. We still need to address questions related to the use of newer technologies, including reliability and security; interoperability between new and existing systems; the legal underpinnings of the processes associated with the technology; and data integrity and privacy. These issues are not easy, and addressing them will probably take some time given their complexity.

What I struggle to see, however, is cryptocurrencies taking off in any major way. Cryptocurrencies, as a unit of account and payment instrument, simply cannot compete with the value proposition offered by central banks and their systems. It is hard to compete with human intelligence and experience in managing processes and systems. It is hard to beat instantaneous settlement, which many central bank

¹⁹ See CipherTrace, *Cryptocurrency anti-money laundering report*, Q3 2018.

²⁰ S Foley, J Karlsen and T Putniņš, “Sex, drugs, and bitcoin: how much illegal activity is financed through cryptocurrencies?”, 21 October 2018.



payment systems provide. It is hard to replicate the enormous network that exists with today's payment infrastructure.

There have been many attempts in history to create private money; all have eventually failed. Tomorrow is Día de los Muertos in Mexico, when we remember the dead. In the land of money, this would include the likes of cocoa beans, beaver skins and snail shells. Many cryptocurrencies have shared the same fate, and more are to come.

But as I alluded in the beginning, money is a social construct. Therefore, the future of money and payment systems is in your hands. The form and use of money have historically been driven by social, technological and political factors, among other things. The future will be about your preferences: how stable you want your unit of account to be, how much anonymity and privacy protections you want, how much faith you have in existing institutions, how much faith you have in governanceless arrangements, and how much convenience you want in making and receiving payments. You are the ones for whom we are building next-generation systems.