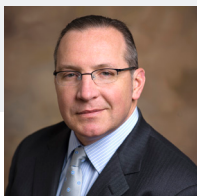




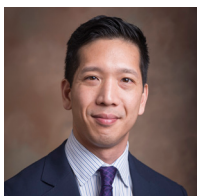
PRICE POINT®

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In-depth analysis and insights
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Global Technology **LOOKING BEYOND BITCOIN'S HYPE TO BLOCKCHAIN'S POTENTIAL**

KEY POINTS

- Bitcoin and other cryptocurrencies became the focus of the financial world in 2017 as their prices skyrocketed.
- We believe that blockchain, the technology behind the new cryptocurrencies, has economic potential that could far exceed the value of the currencies themselves.
- A plethora of companies are seeking to put this technology to work as it seems to offer a digital alternative to inefficient manual processes.
- The financials and health care sectors, in particular, are exploring blockchain applications, and they have the potential to disrupt many other industries.

Cryptocurrencies became the focus of the financial world in late 2017 as the price of bitcoin, the most prominent cryptocurrency, climbed from USD \$2,547 at the end of June to a peak of over USD \$19,000 in December, far outpacing the strong rally that was occurring in equity markets. Interest in the new currency had risen to the point that T. Rowe Price Portfolio Manager Henry Ellenbogen commented during a *Barron's* roundtable discussion in January that he had received 10 times as many inquiries about bitcoin than the stock market during the holiday season.

Although the value of bitcoin has dropped to around USD \$9,800 (as of February 15), down nearly 50% from its peak just a couple of months earlier, virtual currencies have continued to generate questions from our clients while attracting increasing attention from the media and regulators.

While T. Rowe Price portfolio managers do not hold any cryptocurrencies in

their investment strategies because of their speculative nature, we have been carefully following the topic because we believe blockchain, the technology that is powering them, has economic potential that could far exceed the value of the new currencies.

THE LONG, STRANGE TRIP FROM THE GOLD STANDARD TO VIRTUAL CURRENCIES

In one sense, the history of cryptocurrencies dates back to President Nixon's decision in 1971 to end the international convertibility of U.S. dollars to gold. Amid heightened inflation, and with concerns rising around the recognition that all global monetary systems were now based on fiat currencies, the U.S. came up with a creative fix: It was agreed that all oil would be sold in U.S. dollars. In effect, a gold standard had been replaced with an oil standard, which helped keep the U.S. dollar as the world's reserve currency.

However, emerging market crises of the 1980s and 1990s in Latin America as well as Asia revealed flaws in the U.S. dollar peg system. The devastating global financial crisis of 2008, having started in the U.S., raised further questions about the dollar's role as the world's primary reserve currency. The European debt crisis soon followed, which revealed underlying fissures within the construct of the euro. Ultimately, concerns grew about the ability of governments and developed world banks to maintain a stable global currency regime over the long term.

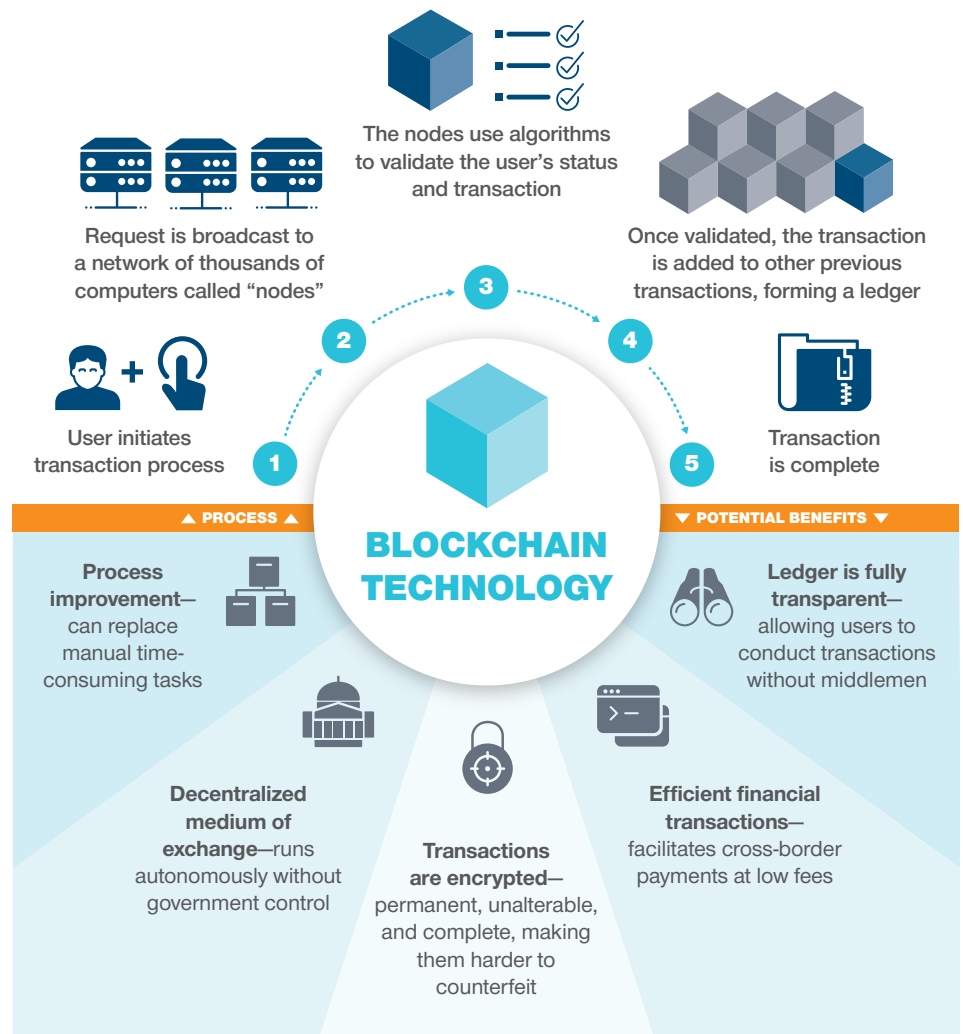
During this period of heightened uncertainty, the demand for decentralized digital currencies gathered momentum. Demand grew for a decentralized medium of exchange that could run autonomously without government control, and cryptocurrencies rose to fill the void.

Bitcoin, the original cryptocurrency, was created in 2009 by an individual—or perhaps a group of people—using the pseudonym Satoshi Nakamoto. Cryptocurrencies are produced through a process called digital mining, which requires electrical energy and powerful computers utilizing the latest processing chip technology. They have no physical form such as a bill or coin, are not backed by any government or legal entity, and only exist in a digital construct known as a token; their value is determined by the market.

The supply of cryptocurrency is not determined by a central bank but is often intentionally capped. For example, bitcoin was designed so that there would never be more than 21 million tokens in existence. Although some companies do accept bitcoin as a medium of exchange, most investors so far have treated it more as a speculative investment than an actual currency.

(For investors who would like a deep dive into the story of how the global economy moved from the gold standard to the supremacy of the U.S.

FIGURE 1: Blockchain—The Process and the Promise



Source: T. Rowe Price analysis.

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dollar in global trade, we recommend *Globalization in Historical Perspective* (University of Chicago Press, 2003), which is a good starting point for understanding the backdrop that produced cryptocurrencies.)

WHAT IS BLOCKCHAIN?

Bitcoin, and all the virtual currencies that have followed it, use a technology called blockchain. At its simplest level, blockchain can be thought of as a new—and potentially better—spreadsheet, something like a shared Microsoft or Google document that is populated with confirmed and encrypted entries.

It is commonly referred to as distributed ledger technology, with “distributed” meaning that there is no central authority required to approve transactions or to set rules and “ledger” referring to the transaction details that are recorded in a way that is visible to all authorized users.

When someone initiates a transaction using blockchain technology, the request is broadcast to a decentralized network of thousands of computers known as “nodes” (see Figure 1). The network of nodes validates the user’s status and transaction using algorithms. Once validated, the transaction is added to other previous transactions, becoming

another block added to the existing chain. The transaction is encrypted to be permanent, unalterable, and complete.

Blockchain was designed to be fully transparent and public, allowing users to conduct transactions without middlemen. The openness of the system allows for a single version of information to be shared among peers. Unlike conventional transaction systems that use middlemen, no one person or bad actor should be able to alter or duplicate information on a blockchain without group authorization.

UNLOCKING BLOCKCHAIN'S POTENTIAL

A plethora of companies—both large, established firms as well as small start-ups—are seeking to put this technology to work in a variety of industries as it seems to offer a digital alternative to manual, time-consuming processes. Not surprisingly, given the ability of virtual currencies to facilitate cross-border payments at relatively low fees, applications in banking, payment processing, and financial services are being vigorously pursued.

For example, Barclays is working on adopting blockchain technology to make its banking operations faster and more secure. In the payments field, Visa has launched a new product, B2B Connect, that facilitates international business-to-business payments. The service uses Chain Core, an enterprise blockchain infrastructure developed by Chain, a blockchain consultancy that works with large enterprise clients.

At T. Rowe Price, we are involved in a pilot program that uses Bankchain, a post-trade settlement platform powered by blockchain. The system has the potential to streamline the post-trade process and provide cost savings and operational efficiencies.

Outside the financial world, we believe that health care—a sector that relies on many legacy recordkeeping systems—could be disrupted by blockchain applications. One of the challenges hospitals face is the lack of a secure

To summarize, we believe it is important to look beyond the headlines about the gyrations in bitcoin's price and focus on the technology that is driving it.

platform to store and share data, and they are often victims of hacking because of outdated infrastructure. Blockchain technology could allow hospitals to safely store medical records and other data and share them with authorized professionals or patients, improving data security and even helping with the accuracy and speed of diagnoses.

The list of industries pursuing the possibilities of blockchain seems to get longer nearly every day, but we would like to highlight just a few more to show the potential reach of this technology:

- **Cloud computing:** Data storage on a centralized server is vulnerable to hacking, data loss, or human error. Using blockchain technology could provide more secure storage capabilities and provide better defenses against hacker attacks.
- **Cybersecurity:** Although the blockchain ledger is public, the underlying data are verified and encrypted using advanced cryptography and could potentially be less vulnerable to being hacked than other applications.
- **Supply chain management:** By using blockchain technology, supply chain transactions can be documented in a permanent and decentralized record that can be monitored securely and transparently. Such a process could reduce time delays as well as human error.

LIMITATIONS OF BLOCKCHAIN

While the potential is great, blockchain also has limitations. As with all software, the warning “garbage in, garbage out” holds true for blockchain. The information going into the database needs to be of high quality so that transactions are accurately recorded.

Speed can also be an issue. The process used to get consensus and verify transactions is purposely designed to take time. Currently, the bitcoin blockchain can only process seven transactions per second compared with the roughly 1,700 transactions Visa was processing in one second in 2016. This delay could be a significant obstacle for fast-paced transactions, such as securities trading.

Moreover, without a widely distributed grid of nodes, a blockchain network could be susceptible to hacking attempts, including what is known as the “51% attack.” Bitcoin and other cryptocurrencies are enabled by “miners” who use computers to solve complicated mathematical problems and are rewarded, in turn, with new currency. A banded group of attackers, controlling more than 50% of the network's mining computing power, could hypothetically prevent new transactions from gaining confirmations. Such an attack could halt payments between users and even possibly reverse transactions.

CONCLUSION

To summarize, we believe it is important to look beyond the headlines about the gyrations in bitcoin's price and focus on the technology that is driving it. Some might dismiss cryptocurrencies as another tulip bulb mania, but we see more similarities to the tech boom of the late 1990s, when a focus on speculative websites often distracted from the long-term transformative power of the Internet. Our analysts have been working diligently to understand how blockchain can disrupt industries, and they are looking for investment opportunities in companies that can find a way to efficiently use this potentially transformative technology.

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