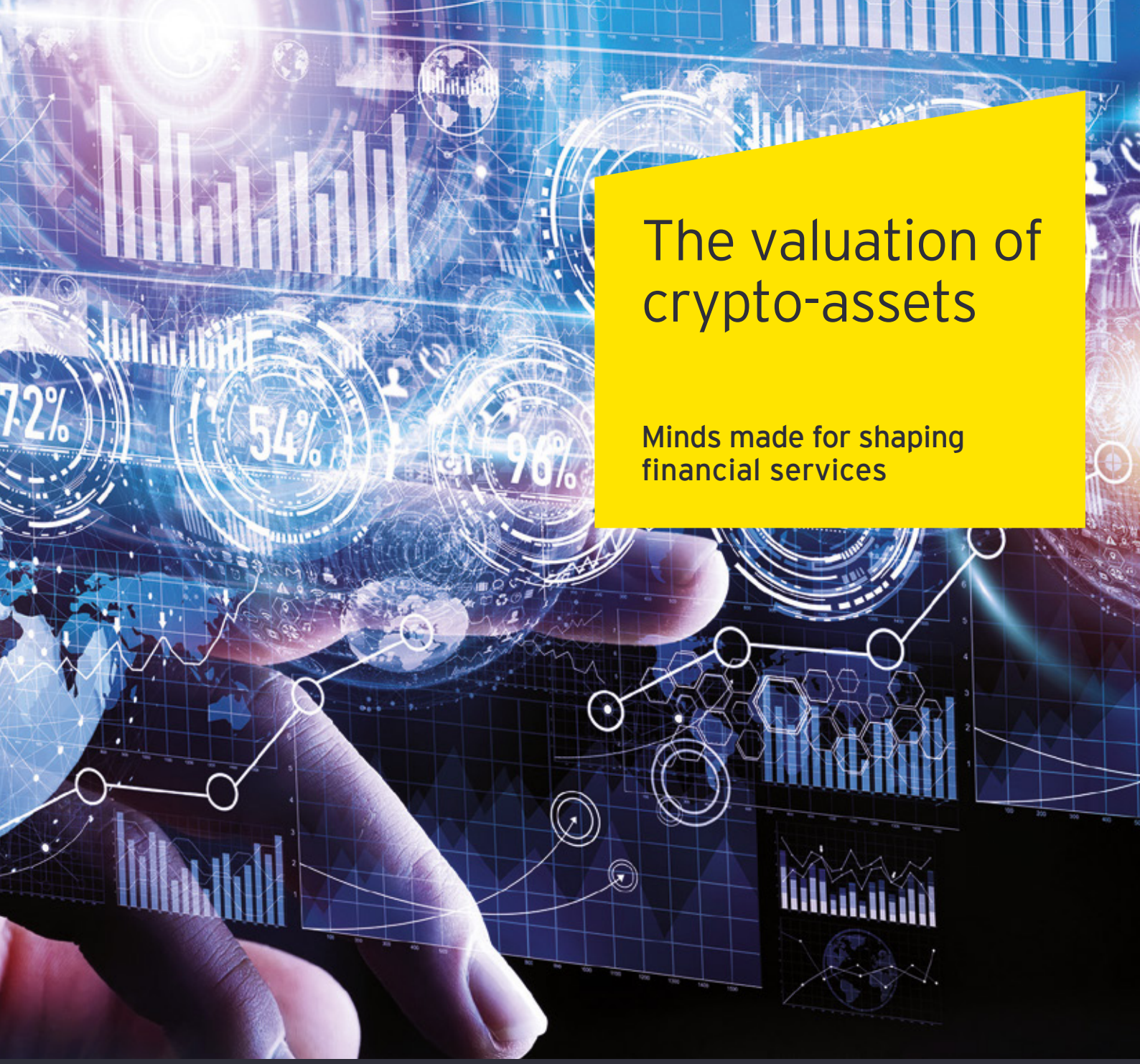


The valuation of crypto-assets

Minds made for shaping financial services

Building a better working world

When the financial services industry works well, it creates growth, prosperity and peace of mind for hundreds of millions of people. No other industry touches so many lives or shapes so many futures.

At EY Financial Services, we share a single focus — to build a better financial services industry, not just for now, but for the future.

We train and nurture our inclusive teams to develop minds that can transform, shape and innovate financial services. Our professionals come together from different backgrounds and walks of life to apply their skills and insights to ask better questions. It's these better questions that lead to better answers, benefiting our clients, their clients and the wider community. Our minds are made for shaping financial services. It's how we play our part in building a better working world.

ey.com/FSminds

Contents

Background

Crypto-assets experienced a breakout year in 2017. Initial coin offerings (ICOs) attracted circa US$7.5b of investment, surpassing the approximately US$2.5b of equity financing raised by distributed ledger technology companies[3.1] and reaching a significant level in the context of total global FinTech VC funding of US$16.6b.[3.2]

In 2018, price volatility increased and the pricing "bubble" in crypto-asset markets deflated, most notably in the case of bitcoin, which saw its price drop from approximately US$20,000 in December 2017 to under US$6,500 by June 2018.[3.3] ICO funding was strong in the first half of 2018, with approximately US$12.0b raised;[3.1] however, the market slowed sharply in the second half.[3.4]

Given their median size of about US$10m to US$12m, ICOs have attracted interest as a funding mechanism for small and medium-sized enterprises (SMEs), with the European Commission (EC) noting the potential for ICOs to be regulated under a future version of its proposed harmonized crowdfunding regime.[3.5] Regulators in other jurisdictions are similarly evaluating ways to incorporate ICO funding into their regulatory frameworks.

In our first publication addressing crypto-assets from an accounting and finance perspective, *IFRS (#) Accounting for crypto-assets*, we described a number of key fact patterns and set out a taxonomy of crypto-assets, including cryptocurrencies, utility or miniature autocratic government (MAG) tokens, and security tokens. We highlighted the potential for both the frequently misused term "cryptocurrencies," and the parallels drawn between ICOs and IPOs to mislabel the underlying economic relationships, and therefore value drivers, involved. In this publication, we discuss the key underlying principles and considerations for the valuation of crypto-assets.

There is a healthy degree of skepticism when it comes to the ability to apply traditional valuation techniques to crypto-assets. This has been heightened over the past year in light of the extreme volatility of bitcoin and other cryptocurrencies." In August 2018, The Economist magazine's Technology Quarterly stated that "there is no sensible way to reach any particular valuation" for cryptocurrencies.[3.6]

We beg to differ: in our view, a focus on determining fundamental value, based on traditional valuation techniques and principles, remains appropriate and applicable to these assets. Such techniques should consider the inherent volatility or riskiness of these assets, and are never more important than in times when market exuberance (and the base emotions of greed and fear) drive pricing.

There are also practical reasons for performing valuations. From our conversations with clients, regulatory authorities, ICO issuers and market participants, we note three key drivers of the need for a rigorous approach to crypto-asset valuation: financial reporting, taxation and investment considerations:

- **Financial reporting:** We observe that tokens are frequently allocated to employees and advisors as (deferred) consideration for services rendered, before they become exchangeable or before they achieve any meaningful level of liquidity. The fair presentation of such expenses in the issuer's income statement thus requires valuation.

- **Taxation:** There are tax implications to both the issuer and receiver arising from the issuance of such tokens. Furthermore, we understand that many issuers and holders of crypto-assets are either contemplating or are in the process of altering their legal entity structure in order to resolve historical inefficiencies, relocate, or respond to regulatory changes. This may require transfer pricing considerations or the valuation of illiquid tokens being transferred among entities.

- **Investment considerations:**
  - Investors in ICOs tend to emphasize qualitative considerations in their investment decision-making, paying little to no attention to quantitative analysis. As noted in our recent regulatory publication, *Life of a coin: shaping the future of crypto-asset capital markets,* ICO white papers tend to contain poor disclosures in relation to the assumptions used to price the tokens issued, often resulting in questionable valuations. This is a hindrance to market efficiency.
  - Similarly, individuals transacting for tokens — whether for services rendered to the issuer or as an ecosystem participant — are advised to undertake a logical calculation of the value of the token relative to goods or services exchanged, and to consider the supply and demand dynamics of the underlying token economy.

We draw attention to the fact that each of these valuation purposes may require a different basis of value, which will influence the judgment regarding the most appropriate valuation method to be adopted.

Valuation

We consider valuation principles for each of three main types of crypto-assets identified in *IFRS (#) Accounting for crypto-assets:* security tokens, utility (or MAG) tokens and cryptocurrencies.

In our experience, a large majority of crypto-assets in the market tends to fall into the latter two categories. Their function as a medium of exchange introduces the potential of adopting a valuation approach on the basis of the quantity theory of money (QTM). The novelty of such an approach relative to the more traditionally accepted market, income and cost approaches leads us to consider the QTM, and relevant supporting assumptions, in greater detail. Moreover, we address the frequently raised question relating to the split between the value of a crypto-asset and that of its underlying platform.

Security tokens

From a valuation perspective, perhaps the most straightforward form of ICO is one where the tokens issued represent economic interests in the issuing business, akin to ordinary equity securities. In this scenario, the ICO white paper will set out the token holder's right to receive distributions of profit from the activity carried out by the issuing organization. The ICO in this case is in substance an IPO of securities. This is highlighted by the July 2017 ruling by the U.S. Securities and Exchange Commission (SEC) in relation to The Distributed Autonomous Organization ("The DAO"), in which it was ruled that the tokens issued by The DAO as part of its ICO in 2016 technically constituted securities, and as such should have been subject to securities laws and regulations.[2.1]

Notwithstanding this, there may be meaningful differences between this form of ICO and a traditional equity or debt raise, which create unique valuation considerations.

The nature of the decision-making and distribution rights associated with the ownership of different security tokens varies, but one fundamental characteristic is common to all: the right to receive future distributions. This enables the use of traditional valuation methods under the market approach and income approach.

Market approach

The valuation method adopted for a given token under the market approach depends on its liquidity and stage of development. Relevant scenarios range from that of a token at the point of launch, i.e., one with no liquidity and no directly observable price, to that of a token with continuously updated prices in a direct trading pair against a fiat currency.

Quoted prices

Secondary trade pricing of tokens is an important reference point in assessing market value. Typically, there is no principal market, as tokens tend to be traded on a number of exchanges, but there may still be an active market.

Consideration of liquidity and depth of trades is important, but is also a matter of judgment – both in terms of the threshold to be applied and the means of assessment, i.e., whether a particular token is readily exchangeable only into another crypto-asset (even a highly liquid cryptocurrency, such as bitcoin or ether), or directly into a fiat currency.

Provided that a token exhibits sufficient liquidity in a direct trading pair against a fiat currency, we would consider it reasonable to adopt a quoted price as the market value for that token. Such a treatment should also be consistent with the accounting fair value hierarchy. The recent volatility in token and cryptocurrency prices does, however, illustrate that market value may differ from "fundamental value."

Where a token cannot reliably be exchanged directly for fiat currency (i.e., where such a realization requires one or more intermediate conversions, or "hops," into more readily convertible crypto-assets), or where liquidity is low, we would consider the adoption of a discount for lack of liquidity.

Comparable tokens

Where no secondary trade pricing is available or liquidity is too low to place reliance on the price, the market approach can be extended to compare the subject token to a recently launched token or one with liquid pricing.

Adopting a valuation multiple is challenging, as financial metrics such as revenues or earnings are typically not sufficiently comparable between assets. Liquid security tokens are, in our observation, relatively scarce, while comparisons to quoted or recently sold companies give rise to conceptual issues resulting from the different maturity and risk of the sources of the

income streams.

An alternative approach would be to consider the token market capitalizations achieved in recent, comparable ICOs as a proxy for the total value of the subject tokens issued, similar to the benchmarking approach taken in the valuation of early-stage companies raising VC funding rounds.

Comparability could be assessed on the basis of a scorecard approach, often undertaken by VCs investing into early-stage businesses, with potential scorecard items including the stage of the project's technological and commercial development, the quality and experience of the team behind the project, the size of the addressable market and the uniqueness of the project. This approach would likely yield a relatively broad and indicative value range.

Income approach

An income approach, based on cash flows to the security token's holder, is conceptually the best approach from the perspective of assessing fundamental value. It can prove particularly useful in informing investment decisions where market prices are heavily influenced by inefficiencies, sentiment and speculation. However, it may not be consistent with the bases of value required by financial reporting and tax valuation standards, which tend to emphasize more directly market-based measures.

Forecasts

Traditional start-ups tend to demonstrate excessive optimism in their forecasts and are associated with high failure rates. For example, research by the European Investment Fund indicates that approximately 57% of early-stage VC investments return a multiple of money (MoM) less than 0.25 times.[3.7] Research by AutonomousNEXT puts the failure rates of Kickstarter projects, pre-Series A start-ups and dot.com companies 10 years post-IPO at 65%, 70% and 85%, respectively. According to the latter source, ICOs have thus far exhibited a failure rate of approximately 50%.[3.1] An EY study, *Initial Coin Offerings (ICOs): The Class of 2017 – one year later*, found 86% of ICOs to be trading below their listing price.

Notwithstanding this, a high degree of optimism persists among many committed supporters of crypto-assets.
We would therefore encourage rigorous analysis of the size of the market targeted by each project and the share of that market that might be captured. A coherent view of the market's development should be appropriately factored into scenario analysis and the probabilities applied therein.

Discount rates

Discount rates are critical assumptions under the income approach; however, their estimation for investments in early-stage ventures is highly subjective. It is challenging to adopt the traditionally accepted Capital Asset Pricing Model (CAPM) in determining an appropriate discount rate. This is because market data such as betas are not observable, as comparable quoted companies do not exist, and large, judgmental, alpha risk premia assumptions are required.

One solution is to estimate a discount rate on the basis of VC investors' hurdle rates from survey data or published returns. There is a relatively large volume of return data published by certain large US pension funds. Such data may not be representative of the total market. Also, alternative investment performance indices often rely on self-reported data and may thus contain inherent biases such as survivorship bias. The use of internal rates of return (IRRs) and MoMs, in conjunction with return distributions, to estimate hurdle rates is a subjective process even where good data is available.

We would additionally consider another adaptation of the scorecard method, with scorecard items similar to those we cited under the market approach. Typically, this technique is applied as a direct determinant of the value placed on a stake in a company at a very early stage of development, but we believe the logic applies equally well to the estimation of a discount rate within the broad range observed in the market. The range of discount rates implied from VC investors' hurdle rates can be considered as a starting point. Then qualitative factors can be assessed, which may be considered to increase or decrease the risk profile of the project compared to that of a typical VC investment. Such factors may include funding risk (e.g., is the project fully funded over its expected life cycle, or will further financing rounds be required, and if so, what is the risk around

achieving the required funding?), intellectual property risk (e.g., is there clear ownership and protection around any intellectual capital developed?) and upfront participant commitments (e.g., the upfront involvement of participants may be considered to reduce the commercial risk of a project). In assessing these qualitative factors, a narrower discount rate range can be arrived at, which is more reflective of the specific risk of the project in question.

Discount rates under a scenario-based approach

Another approach is to adopt a scenario-based structure to the modeling of future cash flows. This allows the project's exposure to risks in the industry and broader environment to be separated from the probability of extreme situations, such as a failure or a unicorn birth (i.e., the achievement of a valuation in excess of US$1.0b). The CAPM can then be used to derive a relatively normal discount rate, reflective of the risk associated with investing in a quoted company exposed to the same geographies and end markets. In the case of the decentralized fog computed platform, SONM,[2.2] for example, this might mean making a comparison to cloud computing providers. Scenario probabilities can be estimated by reference to the return distributions observed in VC, as discussed above.

Project-specific considerations

It is important to consider the specific nature of each project when constructing a valuation under the Income Approach. To illustrate this, we draw attention to the difference between, e.g., The DAO[2.1] and SONM.[2.2] While the former approximated a normal corporation governed through the blockchain, the latter requires a somewhat separate analysis of the developer entity's ability to sustain its activities over the long term. This would affect our modeling of failure risk in each case.

Conclusion

Ultimately, the appropriate approach will depend on the specific facts and circumstances of each case, the time available for the analysis, the purpose, and the required level of reliance to be placed on the valuation. We believe that a rigorous analysis helps provide insight into value creation itself, and that quantitative analysis based on realistic assumptions can give investors a useful sense-check against more directly market-based inputs in their decision making. At the same time, we would caution against the false sense of precision that can emerge from valuation calculations. Token valuation will inevitably require careful sensitivity analysis and a sense of realism about one's confidence in the concluded value range. It is important to remember that the high inherent riskiness or volatility of these assets increases the likelihood that value may decrease, as well as increase, over time (sometimes dramatically).

Utility tokens

Many ICOs break the mold of financial markets entirely by offering what has come to be known as a "utility token." This ICO model involves the development of a distributed organization designed to share some resource in a peer-to-peer fashion. The developer designs a miniature economy of sorts, in which the token to be issued is to constitute the only possible medium of exchange, and sells the tokens upfront to fund the venture. In doing so, the developer acts much like, if anything, a miniature autocratic government setting up a currency for a newly created country. The maintenance of such a system hinges on the attraction and retention of user demand, which in turn depends on the fundamental viability of the value proposition and the ongoing maintenance of user satisfaction. The investment case for utility token ICOs thus builds upon an assessment of anticipated performance against these criteria, with the token price falling at the intersection of a variable demand for and finite supply of tokens (not the underlying resource transacted within the network).

The lack of a right to any future income stream as a result of utility token ownership presents unique challenges from a valuation perspective. Discounted cash flow modeling and traditional applications of the market approach may not be applicable. It does not, however, altogether preclude quantitative analysis.

Tokens vs. platforms

The utility token concept, in particular, highlights the question of how to consider value split between the crypto-asset itself and its underlying platform. While this question is also relevant to security tokens, where we consider the token to reflect a share of ownership in an enterprise and the platform to reflect an intangible asset of the enterprise, it is more complex for utility tokens.

The value of a utility token depends primarily on the demand for goods or services transacted on the platform and the quantity of tokens in circulation. Tokens are divisible and the prices of goods or services in terms of tokens can be adjusted, i.e., the price of a token in fiat currency terms can move independently of the price of a particular good or service transacted on the platform. The value of tokens is typically enjoyed by the users and not necessarily the operator of the platform.

The value of the platform to its operator is a function of how the operator extracts benefits (income less costs) from the platform on an ongoing basis and the sustainability of such benefits over time. We consider this value extraction, whether by the original platform developer or by any party to which it were to sell the right to operate the platform, as ultimately limited by the opportunity cost of available alternative means of delivering the service provided by the token platform.

Market approach

As in the case of a security token, the valuation method adopted for a given utility token under the market approach depends on its liquidity and stage of development. The range of scenarios and liquidity considerations for utility tokens mirror those already discussed in relation to security tokens.

Cost approach

Where no secondary trade pricing is available or liquidity is too low to place reliance on the price, opportunity costs can still provide an observable proxy for value.

The function of a utility token as a medium of exchange opens

up the first such proxy: the opportunity cost of utility. Participants in the utility token network will quote prices for goods or services they offer for sale, denominated in terms of the utility token. Therefore, one can observe these quoted prices and compare them to the fiat currency prices paid for alternative means of acquiring the same quantity of goods or services. From these two inputs, one can estimate a unit value for the token on the basis of the reasoning that rational users would not use the utility token network if the same goods or services were available elsewhere at a lower cost. For example, consider a utility token system designed for hard drive storage sharing, such as Storj.[2,3] Users offering hard drive space on the platform will accept payment in STORJ tokens, and a STORJ-denominated price per gigabyte-month (GB-Mo), will thus be observable. Concurrently, the large technology companies that provide cloud storage services to the general public will quote fiat currency-denominated prices per GB-Mo of storage space. Because the measure of utility, GB-Mo, constitutes a common denominator, dividing the latter price by the former yields the fiat currency price of a STORJ token.

For crypto-assets that can be mined, the cost of their generation through mining could also be considered a proxy for the lower bound of a range of value on the basis of the reasoning that rational miners would not mine at a loss. In our experience, however, utility tokens typically cannot be mined, making this consideration more relevant to the valuation of cryptocurrencies, such as bitcoin.

Quantity Theory of Money (QTM)

Utility tokens' function as the medium of exchange, or to put it another way, the only "legal tender" within their respective networks, creates meaningful parallels with fiat currencies. The miniature economy metaphor is instructive in that it enables one to view the utility token price level through the prism of the QTM.

Origins of the QTM

The QTM traces its origins back to the 16th-century writings of Nicolaus Copernicus and Jean Bodin. It was more formally developed by David Hume and Richard Cantillon[A] in the 18th century, before being restated in its recognizable, mathematical form by Alfred Marshall and Irving Fisher around the turn of the 20th century. Arguably, the central tenets of the theory have remained intact through all of its transformations, challenges and policy debates through to the present day.

$$M \times V = P^{**} \times Y^{*}$$

The formula states that the money supply (M) times money velocity (V) equals price level (P) times the volume of goods and services transacted in the economy (Y).

*In practice, real gross domestic product (GDP) is substituted into the equation as a measure of volume.

**Note: the price level (P) should not be equated with the price of a token, which we subsequently define as p.

In Appendix 1, we provide a detailed analysis juxtaposing the utility token phenomenon with each of the five pillars of the QTM. In performing this analysis, we have found no irremediable flaws in the QTM's application to utility tokens. In fact, we have discovered that the specific nature of this phenomenon allows us to avoid certain contentious economic debates. We therefore proceed to adopt the QTM as a quantitative framework for utility token valuation.

Practical application of the QTM to utility tokens: terms

In applying the QTM to utility tokens, we shall define and discuss each of the quantities within the QTM's "equation of exchange" as it relates to a utility token system.

Money supply

The money supply within a utility token system can be thought of as a combination of two quantities. The first is a long-run fixed M*, i.e., the total number of tokens determined by the developer upon issuance. The second is a float factor, f, equal to one minus the percentage of tokens retained in reserve by the issuer. The issuer's short-run reaction function, and thus the behavior of f, requires further study, but this quantity should converge to 100% over the long run.

[A]Richard Cantillon made a fortune speculating on the South Sea and Mississippi Bubbles, an interesting parallel to the cryptocurrency bubble witnessed in 2017.[3,8]

A simplifying assumption of treating M as constant could be made for valuation purposes.

Money velocity

The public nature of the distributed ledgers underpinning utility token systems makes money velocity an observable quantity- i.e., the inverse of the average period for which a token is held by one address. While any given token will have to be valued before its issuance, i.e., before its own velocity becomes observable, we would consider it reasonable to estimate velocity by reference to comparable tokens.

Comparability for this purpose could be established through analysis of the nature of the service accessible through the utility token system. The size and frequency of purchases to be made in the network constitute some of the more obvious points of comparison. One might also consider the extent to which the system caters to previously unmet needs as a proxy for its ability to attract user demand, as strong demand would likely lead to increased token liquidity and therefore easier convertibility into fiat currency.

One might be tempted to argue that transactions in utility tokens can and do occur outside of the ledger, e.g., when two customers of a centralized crypto-exchange transact. Such transactions are not observable and would therefore not be captured in the observed velocity. However, we would argue that the inclusion of such transactions in the velocity measure would not ultimately measure the fundamental role of the token as a transaction medium within its system, i.e., we would consider it appropriate to derive velocity solely from on-chain transactions.

Given our adoption, for valuation purposes, of a focus on long-run equilibrium, it should also be of limited consequence that velocity can fluctuate in the short run.

Volume of goods and services transacted

We consider the estimation of the volume of goods and services transacted, i.e., the "GDP term" of the QTM, to constitute the key area of estimation. In a utility token system, this term will equate to the overall value of the services rendered through the system during a specified period. To illustrate, we would cite the example of a utility token system designed for hard drive storage sharing. Such a system would effectively meet part of the global demand for remote file storage, and the value of the services rendered through it would thus be determined by the size of the overall market for remote file storage and the share of that demand met by the system.

That is, we consider it useful to decompose the GDP term, Y, into two further terms: market size, "D," and market share "s." Our valuation approach for a utility token would focus on deriving reasonable estimates of these quantities. Of course, such estimation involves considerable judgment and complexity.

Market size, for example, is likely to be further influenced by macroeconomic growth and the sensitivity of demand for the service to that growth. It is conceivable that some services will be normal and others inferior. Moreover, it would appear desirable to adopt a probabilistic approach to estimating D, i.e., to estimate either a distribution or a number of discrete scenarios.

Market share estimation, meanwhile, would almost certainly have to be probabilistic to be meaningful. Indeed, this could be the key avenue for modeling the relatively high risk of failure inherent in early-stage ventures, including utility token ICOs. This dynamic most likely introduces the additional complexity of modeling a non-normal distribution.

Ultimately, we would be highly skeptical of any point estimate arising from the above process as embodying a false sense of precision. However, we believe the valuation process should drive understanding of the fundamental value of the proposition and indicate the degree of confidence with which an investor might transact in a utility token at various price levels.

Price level

Given their nature, utility token systems benefit from the external reference point of fiat currency prices. The volume of goods and services transacted can thus be input as a fiat-denominated quantity, leaving the remaining, unknown

variable P also denominated in fiat currency terms.
For clarification, we note that an increase in the price level corresponds to inflation, which reduces the value of a currency. In the context of utility tokens, we therefore bring together our application of the QTM in a formulaic form that expresses the value of a token, p, in terms of the remaining quantities.

$$p = \frac{1}{P} = \frac{D \times s}{M^* \times f \times V}$$

p = token value
P = price level
D = market size
s = market share
M*= total token supply
f = float factor
V = token velocity

Practical application of the QTM to utility tokens: time

In our application of the QTM, we have thus far ignored the question of time, which is important from a valuation perspective. By focusing on long-run equilibrium, we have effectively visualized a future state of the utility token system, once operational and successful. Such development is likely to take a number of years.

The first option for reflecting the time value of money would be to discount the output of the QTM formula, calculated at a particular time horizon, to its present value, using an appropriate discount rate. Derivation of such a discount rate would itself involve considerable judgment. Two choices present themselves, and one would have to carefully consider the consistency of either with one's approach to modeling the probability of failure. If this were to be reflected in the probability distribution of the market share term of the QTM, the discount rate should only reflect a normal level of risk associated with the type of service rendered through the given utility token system, and no additional risk relating to the early-stage nature of the venture. Such a discount rate could most likely be determined using the CAPM. Alternatively, if the probability distribution did not incorporate the risk of failure, the discount rate applied would have to be much higher - i.e., most likely derived from the hurdle rates adopted by VCs to ensure appropriate returns on their funds.

The second option would involve the use of Monte Carlo simulation. This approach, based on arbitrage pricing theory as opposed to the income approach, would require the identification of all relationships among variables in the model and the specification of probability distributions for all input variables. It would also entail discounting at the risk-free rate. Ultimately, the two options should yield a similar result.

Conclusion

The nature of utility tokens may not enable discounted cash flow modeling or traditional applications of the market approach, but opportunity costs and the QTM can provide proxies for the fundamental value of a token. We have shown that the operation of miniature economies supported by utility tokens is consistent with the central tenets of the QTM, which enables the assessment of a token price based on the token economy's fiat currency-denominated GDP. Challenges remain in relation to the estimation of key inputs under this approach, such as demand and an appropriate reflection of the time value of money. This estimation will inevitably require careful sensitivity analysis and a sense of realism about one's confidence in the concluded value range.

Given the market practice of focusing on qualitative considerations, and even certain commentators' belief that no framework for the valuation of utility tokens exists, we consider it particularly important to draw attention to the available options. We believe all of these can help provide insight into value creation and give investors a useful sense-check against more directly market-based inputs in their decision making.

Cryptocurrencies: a cautionary note on Bitcoin

At first glance, the intended role of cryptocurrencies as general-purpose (as opposed to limited-purpose) media of exchange would appear to make them more suitable to analysis through the prism of the QTM. Moreover, the predetermined trajectory of M provides a level of certainty to market participants and thus largely removes the need to debate the various short-run dynamics discussed above.

Cryptocurrencies and Y

However, precisely because cryptocurrencies are not confined to a limited-purpose network providing a specific service for which demand can reasonably be modeled, the GDP term, Y, is almost impossible to estimate. For a cryptocurrency, D can perhaps best be thought of as equal to the aggregate demand in the global economy, with s being the "market share" of the cryptocurrency among various media of exchange, including fiat currencies. The price of a token, p, thus effectively becomes a function of market participants' expectations of the share of global GDP that will be transacted through the given cryptocurrency. Arguably, such expectations are highly subjective and very difficult to assess with any degree of accuracy. In light of this realization, the QTM's value as an analytical tool diminishes greatly.

Bitcoins as "digital gold"

There is an emerging consensus among market participants that, due to technological limitations, bitcoins (specifically) will not become a large-scale replacement for fiat currency in payments. Proponents of this view typically go on to argue that bitcoins will instead serve only as a store of value – the sort of safe-haven asset for the third millennium that gold has been for millennia past.

Unfortunately, that conceptualization would appear to violate the most fundamental assumption of the QTM, i.e., the assumption that the asset in question will be used as a medium of exchange. That is, if one did not expect bitcoins to be used to fulfill a transaction motive, the application of the QTM for valuation purposes would become invalid. Ultimately, that would leave us with no fundamental derivation for the price of a bitcoin, making bitcoin similar to collectibles such as fine wine or art, demanding a "trophy asset" premium that is not readily quantifiable.

Some quantitative analysis might still be possible based on the analogy to non-interest-bearing safe-haven assets that do not constitute media of exchange. However, even that may be impeded by the combination of:

- The sentiment-driven nature of safe-haven demand
- The novelty of cryptocurrencies

This leaves open the question of their capability of acting as the safe-haven assets their proponents view them as.

Having mentioned sentiment, we should also touch on technical analysis, i.e., the algorithmic analysis of historical price, trading volume and other statistical market data in order to identify trading opportunities, notably used by quantitative hedge funds. This type of analysis would certainly appear to be possible in respect of crypto-assets and, given the sentiment-driven nature of the market and high retail investor participation, perhaps even relatively profitable. We understand that quantitative hedge funds, similar to those operating in the traditional financial markets, do, in fact, operate in crypto-asset capital markets. It should be noted, however, that technical analysts and quantitative funds are likely to have relatively short investment horizons, as their methods are unlikely to be useful for a fundamentals-driven long-term investor.

Valuation discounts

Liquidity

Market participants should give consideration to the appropriateness of applying liquidity discounts to observable value benchmarks in concluding on a crypto-asset's value. In the context of our discussion of varying levels of liquidity in relation to the market approach, such discounts may be appropriate in certain circumstances.

For a crypto-asset traded in a liquid market in a direct pair against a fiat currency, a discount is unlikely to be warranted from the perspective of either commercial valuation considerations or financial reporting standards. However, where the subject crypto-asset cannot reliably be exchanged directly for fiat currency, or where the valuation of an illiquid subject crypto-asset is derived from the observable price of a liquid crypto-asset that is deemed comparable, we would consider the adoption of a discount for lack of liquidity to be applicable. The quantum of this discount could be determined similarly to when considering the liquidity discounts for traditional financial instruments such as private equity stakes.

Liquidity should also be taken into account in valuations performed under the income approach. In this case, we draw particular attention to the need for consistency of the assumptions adopted. Where a discount rate is determined by reference to VC investors' hurdle rates, one should note that such rates already reflect the required returns of fund investors, given the illiquid nature of the underlying VC investments. Therefore, no further discount for lack of liquidity should be applied. This contrasts with the alternative approach of deriving a discount rate on the basis of the market pricing of liquid financial instruments and modeling failure risk separately (as discussed earlier).

Blockage

Blockage discounts can be characterized as a specific type of liquidity discount relevant to large holders of a particular asset. Their adoption is typically prohibited by financial reporting standards, but may represent an important commercial consideration.

For example, where a utility token issuer retains a token reserve that is large relative to the trading volume in the market, it may be unrealistic to make business decisions on the assumption that a large volume of tokens could be sold without depressing the market price. A similar concern might arise on the part of a large holder of cryptocurrency, such as one of the approximately 1,600 "bitcoin whales" that collectively held about US$37.5b worth of bitcoins as of June 2018[3.9] when looking to quickly liquidate a significant holding.

In any event, estimating an appropriate blockage discount will require careful analysis of the historical supply and demand dynamics of the given market or, where the market remains nascent, of another market deemed comparable. There are formulas that may be adapted.

Summary

Valuation approach	Security tokens	Utility tokens and cryptocurrencies
Market approach	▸ Quoted prices ▸ Comparable tokens	▸ Quoted prices ▸ Comparable tokens

Income approach	▸ Possible
	▸ Key considerations:
	  ▸ Forecasts
	  ▸ Discount rates
		▸ Not applicable

Cost approach	▸ Not applicable	▸ Opportunity cost of utility ▸ Cost of generation (e.g., mining)

QTM	▸ Not applicable	▸ Possible
		▸ Practical aspects:
		  ▸ Estimation of equation terms
		  ▸ Time value of money

The valuation of a crypto-asset fundamentally depends on its nature, the key distinction being whether the subject asset grants its holder the right to a stream of future cash flows or not. We have demonstrated this on each of three token types: security tokens, utility tokens and cryptocurrencies.

For a security token, we consider the pure income approach to be conceptually the best approach from a fundamental perspective, particularly in an inefficient market driven by speculation. A market approach may also be considered, depending on the token's liquidity and stage of development.

For a token that acts only as a medium of exchange, the market approach may also be possible, subject to similar considerations. However, additional methods are available.

▸ For a utility token, we consider the opportunity cost of utility, i.e., effectively the token's purchasing power in terms of goods or services, as one potential proxy for value.

▸ For a crypto-asset that can be mined, i.e., typically a cryptocurrency, such as bitcoin, as opposed to a utility token, the cost of generating the token through mining could also be considered a proxy for the lower bound of a range of value, on the basis of the reasoning that rational miners would not mine at a loss.

▸ Another approach to valuation would be to adopt the QTM as an appropriate framework of analysis.

  ▸ On the basis of our research, the operation of the miniature economies supported by crypto-assets is consistent with the central tenets of the QTM. We caution, however, that this would not be the case for a crypto-asset for which its users did not expect it to act as a medium of exchange.
  ▸ The QTM's application involves significant judgment in relation to the estimation of appropriate inputs. Perhaps most notable among these inputs is the forecast demand for the goods and services transacted on a given platform. Its estimation becomes increasingly difficult as the breadth of these goods and services increases, the broadest use case being that of a general purpose replacement for fiat currency.

  ▸ In addition, the QTM yields a value for the crypto-asset as at a future date. The estimation of a present value thus requires the estimation of an appropriate discount rate.

Ultimately, the appropriate approach will depend on the specific facts and circumstances of each case, the time available for the analysis, the purpose and the required level of reliance to be placed on the valuation. We believe that a rigorous analysis helps provide insight into value creation itself, and that quantitative analysis based on realistic assumptions can give investors a useful sense-check against more directly market-based inputs in their decision making. Token valuation will inevitably require careful sensitivity analysis and a sense of realism about one's confidence in the concluded value range. However, we believe that should not be seen as encouragement to forgo a quantitative analysis altogether in favor of a purely qualitative one.

Appendix

Appendix 1 – QTM applicability to utility tokens

Thomas M. Humphrey, a long-serving economist at the US Federal Reserve Bank of Richmond and leading voice on the history of monetary economics, identifies five key pillars of the QTM, which we will use to assess its applicability to utility tokens:

- The proportionality of M and P
- The active or causal role of M in the monetary transfer mechanism
- The neutrality of money
- The monetary theory of the price level
- The exogeneity of the nominal stock of money[3.10]

Proportionality of M and P

The classical version of the QTM posited strict proportionality between M and P, on the basis of the assumption of the constancy of the public's demand for real cash balances held for transaction purposes. Neo-classical economists' restatements of the theory were more or less aligned, referring to non-interest-bearing transaction balances for day-to-day use and adding the notion of a buffer for contingencies.[3.10] Even under the strict proportionality assumption, attention was paid to the determinants of velocity.[3.8] Such factors were thought to change only gradually.[3.10]

Notable variables from a crypto-asset perspective include the frequency and size of payments, the stage of development of the banking system (or distributed ledger technology and crypto-asset capital markets), and even hoarding (or, as the case may be, HODL-ing [B]).

Petty and Cantillon's functions arguably foreshadowed Milton Friedman's restatement of the velocity of money not as a constant, but rather as a variable determined by a small number of independent factors. While that conceptualization removes the strict proportionality of M and P, it is not a major point of difference given monetarists' contention that velocity is a relatively stable magnitude.[3.10]

The parallel to utility tokens appears clear. Given that utility tokens do not bear interest, the long-run primary holding motive must be a transaction motive. The relative ease or difficulty of access to tokens (e.g., the number of hops required to enable conversion into fiat currency), which is determined by the development of crypto-asset capital markets and related systems, determines the size of the safety buffer a would-be user of a particular network must hold. In light of the limited-purpose nature of utility tokens, there is no difficulty stemming from broader definitions of "money" for QTM purposes.

The role of M: active or causal

Under the classical QTM, changes in M are said to cause (relatively) proportional changes in P, and not vice-versa.[3.10] One key insight from this formulation is that the QTM should be thought of in terms of flow as opposed to stock. In the words of Irving Fischer, "the history of the price level is a history of the race between increases in the money stock and increases in the volume of trade."[3.11]

In connection with the causal role of M, economists identified two transmission mechanisms: the direct expenditure and indirect interest rate mechanisms.[3.10] Even in the absence of a developed crypto-asset capital market with, e.g., utility token lending and derivatives markets, the direct expenditure transmission mechanism can be relied upon. This mechanism is also consistent with Friedman's concept of the wealth effect.

Ultimately, the active role of M points to a key assumption to be adopted in our analysis of utility tokens, i.e., the focus on long-run equilibrium. In its neo-classical formulation, the QTM allows for central bank control of the money supply. In the world of utility tokens, that parallel is only relevant in the short run. While the supply of utility tokens in a given network will be

[B] HODL has become the mantra of those market participants who hold a crypto-asset based on their belief in its long-term price appreciation, regardless of short-term losses. It originated as a misspelling of the word "hold" in a forum post, but has been reverse engineered into an acronym for "holding on for dear life."

fixed from the outset, it is common practice for the issuer to retain a large reserve, which it can sell down over time. This effectively enables the issuer to manage M and opens up the possibility of the issuer reacting to external variables in doing so. This could be seen as highlighting the need to further consider historical disagreements (e.g., between classical and Marxist economists[3.10]) over the direction of causality between M and P. Moreover, it would potentially complicate modeling if one were to attempt to take the short run into account.

However, in light of the long-term nature of early-stage VC investments, of which utility tokens are an extreme example, we consider it appropriate to focus on long-run equilibrium, disregarding short-run dynamics as a simplifying assumption.

Neutrality of money

In relation to money neutrality, i.e., the notion that manipulating M does not affect economic activity, the QTM has long distinguished between the short run and the long run. In the former, neutrality has been both argued and later demonstrated not to hold. In the latter, consensus on neutrality is widespread, uniting classical, Keynesian, monetarist and Marxist economists.[3.10] Long-run neutrality is also supported by quantitative analyses,[3.12] which in the world of fiat currency must contend with broader definitions of the money supply.

The implications of the short-run non-neutrality of money are the subject of some debate. Perhaps most notably, Keynesian criticisms of the QTM focus on economic policy matters such as sticky prices and the liquidity trap, i.e., they are criticisms of the notion that manipulating M can result in changes in economic activity.[3.10] Such debates are interesting in the context of managing a utility token reserve from the point of view of an issuer, e.g., making the decision to airdrop tokens in order to stimulate trial of the service in the hope of converting it into long-term demand. Indeed, central bankers, such as Bank of England Chief Economist Andrew Haldane, have suggested (on the example of online games[3.13]) that virtual currencies could serve as a tool of monetary policy study and experimentation. One question would then relate to the potential differences between the length and variability of "monetary policy" lags in a utility token system and those in the overall economy.

In any event, the M in a utility token system is fixed in the long run, at which point these challenges lose relevance. As noted above, utility tokens are long-term investments and we thus consider it appropriate to adopt strict neutrality as a simplifying assumption for valuation purposes, even though short-run dynamics may matter for investors with short time horizons.

Monetary theory of the price level

The monetary theory of the price level states that changes in P stem primarily from changes in M, and not from non-monetary factors. While proponents of the QTM readily admit that, e.g., technological change can influence prices, they argue that such factors primarily affect relative, not absolute prices.[3.10]

Prima facie, this pillar appears to pose some challenges to the QTM's application to utility tokens. Non-monetary factors could be said to affect the price level in a utility network, given that each such network serves only a limited purpose and the token price level thus bears more resemblance to a relative price than to the general price level of the overall economy. In the long run, when M is fixed, it can moreover be observed that the key determinant of the price level is, in fact, the exogenous variable Y.

In our practical application, however, we believe we appropriately incorporate the non-monetary factor through the separate evaluation of demand for the service provided by the network – i.e., through a direct estimate of Y. Once that factor is accounted for, we see no further theoretical shortcoming stemming from the monetary theory of the price level. Indeed, our method of analysis might even be seen as consistent with the Keynesian argument that the determinants of expenditure matter more than the quantity of money.[3.10]

Exogeneity of the nominal stock of money

Under the QTM, the nominal stock of money is determined by either natural factors, in the case of commodity money, such as gold, or by the decisions of a central bank, in the case of fiat money.[3.10] In the latter case, this exogenous determination of M is complicated by the potentially unstable linkages between

narrowly and broadly defined money, which the QTM assumes to be stable.
In a utility token system, the long-run M is fixed upon issuance, and hence arguments over the breadth of the definition of the money supply would appear to lose significance. This could potentially change with the development of crypto-asset capital markets, although such a development would appear much more likely for cryptocurrencies (i.e., general-purpose media of exchange) than for utility tokens.

One might then be tempted by the conceptualizations of different utility tokens as "money substitutes," i.e., as substitutes for one another, in the context of the QTM. However, that would not be strictly true in the sense that within each miniature economy, only one utility token, i.e., one acceptable form of "money," exists. Two utility token systems may offer a similar service and therefore compete for users, but that potentiality is one covered by the direct estimation of the Y term for the specific network being analyzed.

Conclusion

Having juxtaposed the utility token phenomenon with each of the five pillars of the QTM, we have found no irremediable flaws in the QTM's application to utility tokens. In fact, we have discovered that the specific nature of this phenomenon allows us to avoid certain contentious economic debates. We therefore proceed to adopt the QTM as a quantitative framework for utility token valuation.

Appendix 2 – supporting detail

The DAO

The DAO was one example of the more general concept of a distributed autonomous organization, in this case designed as a decentralized VC fund of sorts. Its 2016 ICO became, at that time, the largest crowdfunding in history, attracting over US$150m from over 11,000 investors. DAO tokens entitled their holders to a vote on the projects to be financed by The DAO's funds and to distributions of returns derived from those projects.

The DAO collapsed soon after its launch, due not to its business model, but rather to a vulnerability in its smart contract code. This case has been useful in furthering the broader public debate on ICOs, as it prompted an investigation by the SEC into whether ICO tokens (such as those held by investors in The DAO) constitute securities. The SEC released its report of investigation in July 2017, stating that DAO tokens were securities and should thus have been subject to securities laws and regulations.

For further information on The DAO, please refer to:

Christoph Jentzsch, "Decentralized Autonomous Organization to Automate Governance," Slock.it website, download.slock.it/public/DAO/WhitePaper.pdf, accessed 11 September 2018.

"Understanding The DAO Attack," Coindesk, www.coindesk.com/understanding-dao-hack-journalists/, accessed 15 January 2018.

U.S. Securities and Exchange Commission Release No. 81207, Report of Investigation Pursuant to Section 21(a) of the Securities Exchange Act of 1934: The DAO, United States Securities and Exchange Commission, 2017.

A2.2 SONM

SONM is a decentralized fog computing platform designed to enable individuals to provide spare processing power to those who need it, which facilitates computing, network and storage services between end devices and the cloud.

The low opportunity cost enables low prices, and the processing power can be substantial – comparable with the world's fastest supercomputers. This translates into a low-cost resource for small businesses, especially those developing artificial intelligence (AI) and data analytics capabilities, as well as for scientists developing cures for diseases such as cancer and Alzheimer's. This was demonstrated by an older, non-blockchain project called Folding@home, which was designed as a volunteer initiative allowing distributed atomic-level simulations of protein folding, achieving speeds of up to 135 (quadrillion floating point operations per second (PFLOPS) and directly contributing to 139 scientific research papers.

In contrast, SONM's SNM token allows computing power providers to receive a share of the network's income on the basis of their efforts – akin to an ordinary share. Unlike many early-stage companies, SONM and, in our observations, other security token projects typically do not use a tiered capital structure that would differentiate between debt and equity, instead giving the holder a direct share of revenue as long as the network remains operational. The expenses of running the SONM network are covered by the income from a share of tokens retained in a reserve fund. This fund can be likened to retained earnings. One could take a view that the token carries a right to some proportion of the income attributable to an overall, purely equity-financed firm.

For further information on SONM, please refer to sonm.io and the following:

SONM, "SONM," Github, github.com/Cryptorating/whitepapers/blob/master/SONM/Sonm1.pdf, accessed 11 September 2018.

SONM, "SONM Business Overview," Github, github.com/armdev/bitcoin-blockchain-ethereum-/blob/master/Sonm-BusinessOverview.pdf, accessed 11 September 2018.

A2.3 Storj

Storj is a decentralized cloud storage network designed to enable individuals to provide spare hard drive space to those who need it. The platform is under development by Storj Labs, but the exchange of hard drive space is to occur among users in a peer-to-peer fashion. The STORJ token, issued in a September 2017 ICO, is to constitute the medium of exchange on the platform, i.e., the means of payment for the hard drive storage space.

For further information on Storj, please refer to storj.io and the following:

Shawn Wilkinson et al., "Storj: A peer-to-peer cloud storage network," Storj.io website, storj.io/storj.pdf, accessed 29 October 2018.

Appendix 3 – references

A3.1.
Lex Sokolin, Matt Low and Latham & Watkins LLP, # Crypto Utopia: The $20 billion Cambrian explosion of tokenized digital assets, and the emerging infrastructure being built to support them, 19 July 2018, © 2018 Autonomous Research LLP and Latham Watkins LLP.

A3.2.
CB Insights, Fintech Trends to Watch in 2018, 31 January 2018, © 2018 CB Information Services, Inc.

A3.3.
"Bitcoin price, charts, market cap and other metrics," CoinMarketCap,coinmarketcap.com/currencies/bitcoin/#charts , accessed 7 November 2018.

A3.4.
"CRYPTO: Did ICOs raise $300 million or $2 billion in September? Depends who you ask," AutonomousNEXT, next.autonomous.com/thoughts/crypto-did-icos-raise-300-million-or-2-billion-in-september-depends-who-you-ask, accessed 11 November 2018.

A3.5.
European Commission Staff Working Document SWD(2018) 56 final, Impact Assessment Accompanying the Document "Proposal for a Regulation of the European Parliament and of the Council on European Crowdfunding Service Providers (ECSP) for Business" and "Proposal for a Directive of the European Parliament and of the Council amending Directive 2014/65/EU on markets in financial instruments", European Commission, 2018.

A3.6.
"Bitcoin and other cryptocurrencies are useless," The Economist website, www.economist.com/leaders/2018/08/30/bitcoin-and-other-cryptocurrencies-are-useless, accessed 2 November 2018.

A3.7.
Dario Prencipe, Simone Signore, Helmut Kraemer-Eis, EIF Research & Market Analysis Working Paper 2017/41 – The European venture capital landscape: an EIF perspective. Volume III – Liquidity events and returns of EIF-backed VC investments, 10 April 2017, © European Investment Fund 2017.

A3.8.
Thomas M. Humphrey, "The Origins of Velocity Functions," Economic Quarterly Volume 79/4, October 1993, © 1993 Federal Reserve Bank of Richmond.

A3.9.
Hannah Murphy, "Bitcoin whales control third of market with $37.5bn holdings," FT.com, www.ft.com/content/c2.568aec-6b26-11e8-8cf3-0c230fa67aec, accessed 11 November 2018.

A3.10.
Thomas M. Humphrey, "The Quantity Theory of Money: Its Historical Evolution and Role in Policy Debates," Economic Review, May/June 1974, © 1974 Federal Reserve Bank of Richmond.

A3.11.
Thomas M. Humphrey, "Fischer and Wicksell on the Quantity Theory," Economic Quarterly Volume 83/4, October 1997, © 1997 Federal Reserve Bank of Richmond.

A3.12.
a Yi Wen, "The Quantity Theory of Money," Economic Synopses, 2006, © 2006 Federal Reserve Bank of St. Louis.
b. James B. Bullard, "Measures of Money and the Quantity Theory," Review, January/February 1994, © 1994 Federal Reserve Bank of St. Louis.
c. Yash P. Mehra, Working Paper 89-2: Cointegration and a Test of the Quantity Theory of Money, April 1989, © 1989 Federal Reserve Bank of Richmond.

A3.13.
Andrew G. Haldane, "A Little More Conversation, A Little Less Action," Federal Reserve Bank of San Francisco Macroeconomics and Monetary Policy Conference, 31 March 2017.

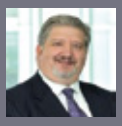
Paper authors:

Rommel Johnson
Director, EY EMEIA FS Transaction Advisory Services
Ernst & Young LLP (UK)
T: +44 20 7951 9145 I E: rjohnson1@uk.ey.com

Jennifer Bufton
Senior Executive, EY EMEIA FS Transaction Advisory Services
Ernst & Young LLP (UK)
T: +44 20 7951 6520 I E: jbufton@uk.ey.com

Jiří (George) Daniel
Executive, EY EMEIA FS Transaction Advisory Services
Ernst & Young LLP (UK)
T: +44 20 7197 7149 I E: gdaniel2@uk.ey.com

Valuation, modeling and economics leadership:



Kevin Sands
Associate Partner, EY EMEIA FS Transaction Advisory Services
Ernst & Young LLP (UK)
T: +44 20 7951 5512 I E: ksands@uk.ey.com

Sara Elinson
Partner, EY Americas FS Transaction Advisory Services
Ernst & Young LLP (USA)
T: +1 212 773 8139 I E: sara.elinson@ey.com

Louise Keely
Partner, EY Americas FS Transaction Advisory Services
Ernst & Young LLP (USA)
T: +1 312 879 2994 I E: louise.c.keely@ey.com

Andre Toh
Partner, EY APAC Transaction Advisory Services
Ernst & Young LLP (Singapore)
T: +65 8333 3196 I E: andre.toh@sg.ey.com

Transaction advisory services leadership:

David Barker
Managing Partner, EY EMEIA FS Transaction Advisory Services
Ernst & Young LLP (UK)
T: +44 20 7951 2005 I E: dbarker@uk.ey.com

Gavin Jordan
Partner, EY UK FS Transaction Advisory Services
Leader, Global Head of Mergers & Acquisitions
Ernst & Young LLP (UK)
T: +44 20 7951 2689 I E: gjordan@uk.ey.com

EY | Assurance | Tax | Transactions | Advisory

About EY
EY is a global leader in assurance, tax, transaction and advisory services. The insights and quality services we deliver help build trust and confidence in the capital markets and in economies the world over. We develop outstanding leaders who team to deliver on our promises to all of our stakeholders. In so doing, we play a critical role in building a better working world for our people, for our clients and for our communities.

EY refers to the global organization, and may refer to one or more, of the member firms of Ernst & Young Global Limited, each of which is a separate legal entity. Ernst & Young Global Limited, a UK company limited by guarantee, does not provide services to clients. For more information about our organization, please visit ey.com.

EY is a leader in shaping the financial services industry
Over 30,000 of our people are dedicated to financial services, serving the banking and capital markets, insurance, and wealth and asset management sectors. At EY Financial Services, we share a single focus – to build a better financial services industry now and for the future.

© 2019 EYGM Limited.
All Rights Reserved.

EYG No. 012682-18Gbl
EY-000084300.indd (UK) 01/19.
Artwork by Creative Services Group London.
ED None

In line with EY's commitment to minimize its impact on the environment, this document has been printed on paper with a high recycled content.

This material has been prepared for general informational purposes only and is not intended to be relied upon as accounting, tax or other professional advice. Please refer to your advisors for specific advice.

ey.com/FSinsights