

Leading Digital Socio-Economy to Efficiency

– A Primer on Tokenomics –

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Abstract—Through the usage of cryptographically secure and digitally scarce tokens, a next evolutionary step of the Internet has come. Cryptographic token represent a new phenomena of the crypto movement with the ability to program rules and incentives to steer participant behaviors that transforms them from purely technical to socio-economic innovations. Tokens allow the coordination, optimization and governing large networks of resources in a decentralized manner and at scale. Tokens bring powerful network effects that reward participants relative to their stage of adoption, the value they contribute and the risk they bear in an auditable, decentralized and therefore trustful way. We illustrate which important role tokenomics plays in the creation of, and sustainable and efficient operation of cooperations.

Keywords: Economy of Things, Socio-Economy, DLT, Blockchain, Cryptoeconomics, Tokenomics, Token, Protocols, Incentives, Game-theory, Cryptography

I. INTRODUCTION

Continous innovation and change is a constant companion of man kind and general human interaction. Just as social forms have changed, so have communication tools, money or other economic principles. Out of many technological advancements, the issuance of cryptographic token on a digital distributed ledger has the potential to redefine social and economic interaction over the Internet from scratch.

Distributed Ledger Technology (DLT) provides an organizationally decentralized alternative for maintaining certain states and has the potential to transform the *Internet of Information* to the *Internet of Value*. The difference between information and value is *scarcity*. Organizationally decentralized but logically centralized, temper-proof and accessible states will allow for the creation of software protocols that can undermine the power of centralized intermediaries.

Before Bitcoin, it was thought to be impossible to achieve attack resistant consensus among unknown nodes in a distributed peer-2-peer (P2P) network¹. Bitcoin introduced, for the first time, a mathematical solution with the introduction of a resilient consensus mechanism. Bitcoin’s “Proof-of-Work” was the first consensus protocol that made economic cost of attacking the system disproportionate to the benefit of doing so. Bitcoin has proven over ten years that censorship and counterfeiting is economically unprofitable.

¹Byzantine General’s Problem

Cryptographic and game-theoretically secured this distributed consensus that sparked a new field of science around economic coordination, also referred to as “*Cryptoeconomics*”. It can be described as the study of efficient economic interaction, beneficial to the participants in untrusted environments. Although, in principle every participant could be corrupt, sensible economic interaction is possible[1].

The Bitcoin blockchain is the first practical instance of cryptoeconomics. It produces “trust by math” rather than *trust due to reasonable context* or “*justified trust* by default of a legal contract.” We refer to “trust by math” as *trustless* environment[2].

In this primer we would like to shed light into these novel concepts and to provide a comprehensive overview. Stepping back from the hype, we want to provide a clear understanding of the concept and power of *Tokenomics* without having to know the details of DLT. Some readers will be surprised at the opportunities it opens up for a more efficient, incentive aligned and democratic economy.

A. Terminology

We start off by introducing some terminology and go more in detail in subsequent chapters. The blockchain movement has brought up fancy words like *Cryptoeconomics* or *Tokenomics*, but beneath it all there are economic agents - human and artificial - trying to connect. They must connect in order to produce, create, exchange and communicate within a market.

1) *Token*: Generally speaking, a token is a thing which serves as a visible, tangible or intangible representation of a fact or a right. For example, a driving license card is a token which represents the fact that you are trained and allowed to drive a car.

A cryptographic token is a cryptographically secure, provable representation of a fact or right, which can, additionally be processed in digital systems like decentralized networks. Tokens are digitized multi-purpose instruments, ranging from simple-single to multi-complex designs. It could be value, stake, voting right, or anything. A token is not limited to one specific role or utility, it can fulfill a lot of roles in its ecosystem, in-depth VIII-B.

The digital representation of a tangible or intangible asset via a token on a DLT, is called *Tokenization*, which should

rather be seen as a business construct or a tool than a technical phenomena[3].

2) *Cryptoeconomics and Tokenomics*: *Cryptoeconomics* and *Tokenomics* can be used almost interchangeably, as in the early days of the internet, the terminology is lagging behind.

Cryptoeconomics can be understood as the combination of cryptography, game-theory and economics to create robust decentralized peer-to-peer networks. Cryptography is used to prove things in the past, game-theory is used to design the interaction protocols that are interlinked with economic incentives to encourage desired properties to hold into the future. Code and economics are intrinsically interlinked. The underlying challenge is that in decentralized P2P systems, that do not give control to any centralized party, one must assume that there will be bad actors lurking to disrupt the system.

Tokenomics encompasses the concept of economic system and optimization design to incentivize specific behaviors in a community, using tokens to create a self-sustaining ad hoc economy. It includes game theory, mechanism design, and monetary economics. Tokenomics is a broader subject and includes a variety of components which are introduced in section IV.

One may separate the fact, that cryptoeconomics mainly focuses on the monetary-aspects of the system, whereas tokenomics has broader aspects than remunerative incentives, like voting rights or network externalities. Nevertheless, we use from now on the term *tokenomics* and consider the aspects of cryptoeconomics within this term.

II. SOCIO-ECONOMIC EVOLUTION IN THE DIGITAL AGE

DLT networks can be regarded as a socio-economic evolution of the Internet. Blockchain protocols can be seen as novel collaboration frameworks that provide higher levels of transparency while reducing bureaucracy with self-enforcing code. Blockchain protocols enable networks in a distributed and decentralized manner, thereby minimizing principal-agent dilemmas² of organizations and subsequent moral hazards³ by introducing tokenized incentives. This networks can be compared with digital representations of society and economy. Cryptographic token, within those distributed networks, provide incentives to automatically align and enforce interests in the absence of third parties (intermediaries). Due to this, we believe that this protocols provide the substrate for the next evolution of the Internet, Web 3.0, as it enables a new form of decentralized human collaboration and offers the building blocks of scalable and resilient collaboration frameworks.

A. *IoT, EoT and dEoE*

The term Economy of Things (EoT) evolved from Internet of Things (IoT). Internet of things refers to the fact that nowadays, due to ubiquitous connectivity, not only humans connect via the web. It is also possible to build networks

²Wikipedia (2020): Principal-agent problem. Available online at https://en.wikipedia.org/wiki/Principal%E2%80%93agent_problem

³Wikipedia (2020): Moral Hazard. Available online at https://en.wikipedia.org/wiki/Moral_hazard

of things like sensors, fridges, cars - so called IoT devices. However, connecting everything with everything by itself is not sufficient. The connected entities need to be able to interact in ways comparable to established economic mechanisms such as search and find, negotiation, payment, settlement, building trust etc. in order to make use of the connectivity.

As discussed earlier in our paper (Poddey et. al 2019), the IoT therefore needs to be converted into an EoT. However, although broadly used, the trailing part 'of things' is misleading. In fact, what is meant by EoT is a digital economy of everything (dEoE) - a heterogeneous mix of e.g. small IoT devices, more powerful digital entities like machine learning based services running in the cloud and humans, interacting seamlessly.

In Web2.0, functionality was basically centralized. The functions of a service could in fact be split into several modules, but there typically is a central point of service providing access. In Web3.0 even smaller modules can be incorporated as individual entities, connecting and interacting with others on their own behalf. These entities are usually called agents. Web3.0 therefore can be understood as a multi-agent system in which functionality - or in a more general form the capability to achieve a goal - emerges from interaction of fragmentary contributions. The capability therefore is no longer embodied in a monolithic entity, but distributed across a network of agents, each embedding only a part of the necessary modules. Agents providing new fragmentary contributions might appear, others disappear.

The dEoE therefore is a prime example of a complex open context system and distributed ledger protocols will provide the soil to the next evolutionary step of the Internet enabling higher socio-economic output[4], in-depth VIII-A.

B. *Protocols as efficient exchange coordinators*

Protocols can be described as a set of rules or procedures that govern the transfer of data between two or more electronic devices. The protocol defines how data is structured, or how the data is send from one to another party. Usually, those data is used to described certain states between its participants. States reflect the common knowledge of involved parties[5].

Protocols can be seen as routers of economic activity, as systems of logic that coordinate exchange between suppliers and consumers. Protocols encode the rules of engagement that coordinate the exchange of a service between supplier and consumer. All participants must strictly abide by the rules of engagement, otherwise there will be no exchange. Therefore, a protocol disables or at least, reduces human corruption. The flatness with which a protocol treats everyone that is connected to it, is part of what drives its efficiency as a coordinator of exchange.

As exchange coordinator, a protocol should be minimally extractive for its "user", whereas businesses are incentivized to be maximally extractive. Protocols are in between supplier and consumer, but are no classical centralized middle-man, that's why they are less extractive. In the absence of a central party,

as with blockchain protocols, protocols provide structures for businesses, but are no businesses per se.

Protocols enable and create networks of exchange, as the TCP/IP created the Internet. Instead of being freely open limitlessness, like the Internet, those crypto based protocols now have limits. Limits are introduced through scarce token that store the value of the whole protocol. Those limited protocols now create, enable and entail economics[6].

C. The Delta to traditional economies

Traditionally, large parts of our society have been organized and secured by a legal system enforcing contractual agreements which regulates the interactions within societies. The governance rules hereby regulate the process of decision making among all stakeholders involved and allows people to interact within a community, network or an organization on a sound basis. Rules enable exchange — economic exchange but also social exchange. Those rules are enforced by the government and its agencies, which provide a central authority.

Within a permissionless blockchain network, no central authority exists to enforce those rules. The protocol underlying the network automatically enforces the governance rules set by the community. As such, the blockchain protocol is comparable to the constitution and laws of nation states. Those protocols minimize the principal-agent dilemma or reduce moral hazard in a resistant manner. Different researchers in Economic science, e.g. Joseph E. Stiglitz, have engaged to the proposition, that markets do not work in a simple and idealized way and therefore nation states mainly steer the actions of their citizens by disincentivize. If you break the law, you either pay or go to jail[7]. Similar mechanisms, e.g. burning the staked funds⁴, are hard-coded into a blockchain protocol as with "Proof-of-Stake"⁵.

Incentivisation uniquely enabled through cryptographic token and self-enforcing rules within the network therefore emphasize a radical change, in-depth IV-B. Those networks have the potential to align stakeholders by the consensus rules. Token would incentive individual behavior in a global distributed network to collectively contribute to a common goal, we refer to this as *tokenized network*.

One important difference between economics and tokenomics is that economics most often starts with predictive goals, and tokenomics mainly starts with design goals. This provides the possibility to design an ecosystem according to the desired properties and core values in order to avoid e.g. power concentration or plutarchy[8].

To summarize, token-based networks can be compared to some kind of digital nation state, where each digital state has their own interest area, rules and desired system goals. The biggest advantages thereby, ensuring trust by trustless technologies and automatization through self-enforcing rules and incentives.

⁴Staking simply stands for holding a cryptocurrency in a wallet for a fixed period, then earning interest on it.

⁵Ethereum Wiki (2020): Proof of Stake. Available online at <https://eth.wiki/en/concepts/proof-of-stake-faqs>

III. NOVEL COOPERATION FRAMEWORKS

Cooperation is a complex system with an open context, which must be designed and tested primarily on an inter-human level. Conventional cooperation frameworks for cooperative orchestrated (software) ecosystems are mostly hierarchical structured and perform manually processed processes that can hardly meet the requirements of international collaborations with a multitude of stakeholders. They usually lack the necessary degree of consistently fair co-determination rules, since hierarchical structures are very susceptible to individuals making decisions that are not in the public interest. If, on the other hand, everyone is involved in the decision-making process, efficiency and scalability suffer and the collaboration is literally paralysed as the number of participants increases. Therefore it exists a tension between scalability, i.e. the number of decisions that a collective can make in a given period of time, and resilience, i.e. the incorruptibility of these decisions. In addition, the success of open innovation initiatives often fails due to the lack of incentive mechanisms for investors to make financial and non-monetary contributions to stimulate further development in a sustainable way[9].

A. Why conventional approaches fail

Conventional approach to build a commons-based digital infrastructure failed without strong incentives.

Quaero⁶ was a European research and development program initiated in 2008 aiming to realize a European search engine surpassing American-based ones. Critics immediately realised that “Going head-to-head with Google with a project involving well-funded, energetic entrepreneurs would be foolish. Attempting the same with a multi-government collaboration is beyond description.”. In 2015 Quaero was aborted after spending more than 200M€ of public funds[10].

The problem of building commons based digital infrastructures can be thought of as a “Knowledge Contribution Game”, where two parties called “Leader” and “Follower” iteratively decide whether to contribute to the digital infrastructure of defect/free-ride⁷. Such a game is very similar to the mechanics of Open Source Software (OSS) projects and provides two fundamental insights[11]:

- 1) If leaving uncontrolled, the conventional approach will result in both parties defecting. Such an outcome can be seen in some OSS-projects.
- 2) If it turns out to be economically beneficial, then mutual contribution will definitely happen. Such an outcome can be achieved by implementing the right incentives.

In this respect, it is key to realize that a common and shared strategic goal is necessary but not sufficient to avoid the free-rider problem. The free-rider problem can temporarily alleviated by public funding but as this funding is based on the work done and not the results achieved the incentive

⁶Wikipedia (2019): Quaero. Available online at <https://en.wikipedia.org/wiki/Quaero>

⁷The free-rider problem is a type of market failure that occurs when those who benefit from public resources do not pay for them

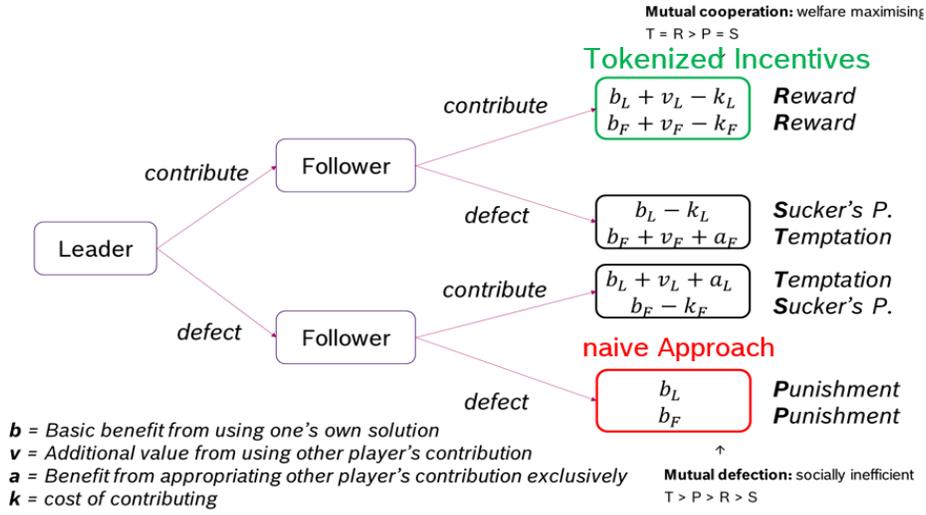


Fig. 1. Knowledge Contribution Game to model building process of commons-based infrastructure

to provide a long-term operating infrastructure is limited. This is especially true, if no long-term subsidizing by public authorities is planned. Long-term incentive alignment play a crucial role to ensure long-term goal orientated cooperation and contribution within a stakeholder group.

B. Digitalization of Governance

The coordination of the participants therefore requires a well-considered design approach and a collection of sophisticated rules and processes, which are summarized under the term "Governance". Governance is an applied social problem and generally refers to the process of reaching social consensus. Guidelines, decision-making and conflict-resolution processes for cooperation can take different forms in its degree of formalization and ways of implementation. Today's cooperations are build on paper-based contracts or informal agreements which includes a set of exchange conditions. Those are manually interpreted and enforced by legal action at a higher instance like e.g. a nation state court. Machine-readable and verifiable contracts and digital tokens as a representation of rights and tool for incentives provides the foundation to digitize governance processes across multi un-trusted parties.

An example demonstrate *Decentralized Autonomous Organizations* (DAO)⁸. An implementation of cooperation that lives autonomously in virtual space. It uses social networks combined with Distributed Ledger Technology (DLT) as a collaboration tool. The organizational structure and processes for decision-making are digitally mapped without the need of a central intermediary. Trust is created in software and processes through open source code and targeted contributions are encouraged through token-based incentive mechanisms. DAOs currently still raise legal and technical questions, but they provide an outlook on how contracts and cooperation processes will be gradually transferred to the digital age.

⁸Wikipedia (2020): Decentralized Autonomous Organizations. Online available at https://de.wikipedia.org/wiki/Dezentralisierte_Autonome_Organisation

IV. TOKENOMICS

Tokenomics is an emerging field of economic coordination games in cryptographically secured P2P networks. The term emerged in the developer community and gained traction by academia but it still remains under-design, possibly because it is often used in different contexts leads to different meanings when trying to come up with a general definition.

Tokenomics applies game theoretic mechanism design in combination with cryptography to create robust decentralized P2P protocols. The main characteristics are the following:

- Building systems (networks) that have certain desired properties
- Using game-theory and economic incentives to encourage the system to hold desired properties in the future
- Using cryptography to prove properties about the past, makes it tamper-proof

Tokenomics is interdisciplinary and requires a deep understanding of cryptography as well as game-theory. The cryptography underlying these systems is what makes the P2P communication within the networks secure, and the game-theory is what incentivizes all actors to contribute to the network so that it continues to develop over time. The incentive mechanism is designed to make the network fault-tolerant and attack-resistant. Beyond, mechanism design leads the system evolve to the desired properties over time. This allows entities who do not know one another to reliably reach consensus about the right state[12].

By introducing scarce tokens, thus limits as mentioned in II-B, protocols allows for (social) coordination in evolving, complex open system formed by a large number of participants. This coordination, based on game-theoretical and economic principles embedded in the protocol, evolves the system as a whole towards the desired properties.

George A. Akerlof⁹ wrote in his famous 'lemon markets' paper about markets with information asymmetry: "It should also be perceived that in these markets social and private returns differ, and therefore, in some cases, governmental intervention may increase the welfare of all parties. In other words, free markets (without any intervention) will, in general not lead to efficiency; it is even only under exceptional circumstances that free markets are efficient."

Tokenomics can now be used to properly design efficient markets. This means, protocol and incentive mechanism design aligns stakeholder interests in order to create more efficient markets.

Each participant acts "selfish", that means, from his or her local point of view profit maximisation. Game theoretical mechanism design ensures that the system properties result and that the individual players do not benefit disproportionately[4].

The more complex and larger the networks are, consisting of different stakeholders, the more important and significant is the design of game theoretical mechanisms. Cryptography can be seen as a linear component, whereas game theory rather an exponential and complex one.

A. Cryptography to secure the present and past

A consensus mechanism is a set of self-enforcing rules and process that define how different nodes can reach an agreement on the true state of the network. Proof-of-Work is the first implementation of a distributed consensus protocol. The protocol is primarily based on expensive computer computation involving hashing (SHA-256), Merkle Tree and P2P networking for creating, broadcasting and verifying blocks on the network[13].

In such a setup, if you abide to the rules, you earn money. It is uneconomical to misbehave, since you get no reward for playing against the rules. The mining computers (miners) in this network validate each block and compete with each other. The competition is about a cryptographic puzzle, where all miners compete to be the first to solve the mathematical problem behind the puzzle. Only the right unique hash value will solve the puzzle. The first miner that solves the mathematical puzzle is allowed to write the transactions to the blockchain thereby creating the next block. In return, the winner earns a "block reward" for the costs incurred in form of net network tokens.

This means that all network participants that work towards adding blocks of transactions to the ledger can potentially earn network tokens. By participating in this competition, miners collectively make sure that all transactions included in a block are valid[1].

B. Economics to incentivize evolution towards desired properties

"Show me the incentives and I will show you the outcome." - Charlie Munger

⁹Wikipedia (2020): George A. Akerlof. Available online at https://de.wikipedia.org/wiki/George_A._Akerlof

The Psychology of Human Misjudgment¹⁰, a speech given in 1995 by Charlie Munger¹¹, illustrated how behavioral psychology can be applied to business, economics and problem-solving. Charlie Munger illustrated how psychology can be used to obtain more structured and thorough understanding of how incentives shape human actions. Sometimes the solution to a behavior problem is simply to review and adapt incentives to make sure they align with the desired goal.

Money is one of the greatest forces of social good, besides social norms. Remunerative incentives align interest. It keeps people honest. Monetary incentives should be integrated into many areas of socio-economic interaction as possible to achieve the desired behaviour. Punishment, e.g. through taxes, works good to prevent actions whereas incentives work best to encourage them.

V. FROM INCENTIVES TO TOKENIZED INCENTIVES

Incentives drive human behavior. Understanding incentives is key to understanding people and socio-economy. Vice versa, failing to recognize the importance of incentives can lead to misconstructions and errors. Incentive mechanisms can be described as rules of the game for groups of individuals which are designed in such a way, that certain goals are achieved if the group members act rationally on their own benefit within the framework of these rules. The desired social state is then compatible with the individual incentives. The group can be a society, an organisation or a community of contractual partners.

Incentive mechanisms serve to implement the given social goal by a non-cooperative balance of the resulting game. Incentives can be either:

- 1) Negative incentives and control: Increases willingness to show the desired behavior by sanctioning its undesired counterpart.
- 2) Positive incentives and enabler: Enables and increases willingness to show the desired behavior by rewarding it.

Incentive mechanisms are a conceptual tool of economic and game-theory. They are used for economic analysis in various fields of economics, e.g. incentive mechanisms in the taxation of industrial economics, the allocation of goods, resources and risks or the economics of the public sector. Incentives can be any kind of reward or punishment that range from remunerative to solely moral or reputational aspects[14].

Tokens are a central component of the solution to the coordination problem¹². By means of tokens, one can create efficient alignment of different stakeholders within a network. For outsiders, tokens act as speculative objects, which again does not correspond to the reality of the token economy. Tokens, properly designed, represent the ownership of scarce

¹⁰YouTube (2020): The Psychology of Human Misjudgment, Available online at <https://www.youtube.com/watch?v=pqzcCfUglws>

¹¹Wikipedia (2020): Charlie Munger. Available online at https://en.wikipedia.org/wiki/Charlie_Munger

¹²Wikipedia (2020): Coordination game. Available online at https://en.wikipedia.org/wiki/Coordination_game

digital resources and coordinate the actors in a given network, e.g. through block rewards in the Bitcoin network[15]. It has become increasingly important to design the right set of incentives that can achieve the desired system-level behavior.

The different types of incentives within a token-based economy need to be aligned in order to properly design the token. The token can then be used to orchestrate the creation and governing the evolution of those protocols. Blockchain protocols provide a new way of issuing, redeeming and automatically enforcing the rights associated to these tokens, in a digital and distributed manner. It is therefore economically irrational for a participant to disregard the established rules, as the economic benefit to behave against the rules leads to a lower surplus for the individual.

A. Remunerative Incentive

For simplicity, we focus in this primer solely on remunerative incentives. Moral and coercive incentives are important, but less likely to demonstrate.

Remunerative incentives, analogue to monetary-incentives, lay the foundation to DLT-based networks. Those incentives provide the operators of the network with financial rewards in order to sustain the network, e.g. in Bitcoin blockchain the block rewards.

In addition to the upper block rewards, there are other financial incentives conceivable. The most common used financial incentive form of tokens are *Initial Coin Offerings (ICO)*. ICO's are used to fund and kickstart the development of a digital collaboration.

One of the most fundamental steps for entrepreneurs is to find capital to fund their idea. Leveraging the blockchain technology, organizations have only recently started to fund their operations with ICOs.

Those ICO can be compared to traditional Initial Public Offerings (IPO), but offers additional advantages e.g. direct democratic participation. During ICOs, organizations distribute their cryptographic tokens to investors in exchange for capital. Investors become token holders and provide different functions and utilities within the issuer's network as soon as the project is launched[16].

The funding amounts in ICOs exceed most investment rounds by traditional funding vehicles. Recent data shows an average of 1600 investors per ICO, with average funds raised of \$9 million. Conventional crowdfunding is dramatically smaller and much less internationalised[17].

Considering tokens, in particular utility tokens¹³, can be the incentive mechanism necessary to boost the development of the respective infrastructure via an ICO.

Due to insufficient regulation and business practice, token issuers can take advantage of a SAFT, in-depth VIII-D. To speed up alignment process, a bridging vehicle is required. Such a bridging vehicle is a "Simple Agreement for Future Tokens" (SAFT). SAFT is a financing contract for an option

¹³Utility Token can be regarded as a kind of exchange or resource that guarantees certain functionalities, voting rights or access within a network.

on a token offering. The aim of this SAFT would be, that a founding entity can sell such an agreement to their early investors and partners instead of tokens in a fast and regulated manner. Hence, through their capital, investors acquire the right to future tokens at a preferential price, in-depth VIII-D.

VI. TOKENIZE TO MAKE IT A SUCCESS

Incentive-efficient funding increase the so-called leverage effect of funding instruments, e.g. the effect of subsidies on private expenditure as an input for R&D activity.

The reason for this is the simultaneous divergence of interests and information between potential recipients and funding agencies. In principle, funding policy can therefore be approached at two levels, namely through:

- 1) Reducing the information asymmetry, i.e. the alignment of the divergent information situations of the funding recipient and the funding agency *or*
- 2) Incentive mechanisms that align the interests of funding recipients with those of the (welfare-maximizing) funding provider

By interlinking the two interest groups, principal and agent, the behaviour of the agent can be controlled. This agent is to be encouraged to efficiently perform the contractually agreed and owed service and not to deceive the principal either before or after contract conclusion[18]. Interlinking principal and agent on basis of incentive alignment through the use of cryptographic tokens, allows a target-oriented and efficient funding project progress.

A well-balanced token design would incentivize network participants to take a risk in adopting a new platform before it is clear that it is worth it, and reward them with ownership that will have future value thanks to their contribution. Comparable to investment in startups. Token design is a complex and time-consuming endeavor that includes social choice, financial and legal aspects.

VII. CONCLUSION

Tokens are far more than the publicly perceived financial speculation instruments. Token can represent a multitude of aspects like e.g. ownership or rights of participation and are an integral part of incentive mechanisms, which leads fair digital ecosystems to high efficiency.

Tokenomics can contribute to speeding up the evolution of incentive-based decentralized ecosystem. Tokenized incentives align multiple interests alongside a desired outcome, from the funding towards the desired long-term oriented system properties. Tokenomics therefore assures a long-term perspective to *cooperative*¹⁴ collaboration in the digital age.

Adherence to the principles and values that are designed and set through the evolutionary process of a digital collaboration can lead to a functioning market economy characterized by socio-economic efficiency. Efficiency by means of resource allocation provides better socio-economic output in the sense for each individual and for the digital cooperative as a whole.

¹⁴The term "cooperation" is composed of "cooperation" and "competition".

VIII. APPENDIX

A. A: Coalition games, cooperation and efficiency

The combination of competition and cooperation at the same time is referred to as cooperation.

Cooperation in supermodular¹⁵ systems generates a surplus. The larger the set of agents taking part, the larger the total surplus. Therefore, the goal is to achieve what is called the 'grand coalition'. The dEoE tend to be supermodular. Therefore, it is important to establish a cooperation based dEoE based on adequate surplus sharing, both, from a viewpoint of most efficient capability increase, as well as socioeconomic sense.

For example taking a certain action in a certain system state, or, in the cooperation model, contributing a certain element, typically takes effect in a time-, state- and network participant distributed fashion. There may even arise local positive effects to the actor, while related costs are (mainly not directly identifiable) distributed to others.

This effect is referred to a externalities and related to imperfect information.

Joseph Stiglitz, George A. Akerlof and A. Michael Spence jointly received the Nobel Memorial Prize in Economic Sciences (2001) for their research in the context of the theory of markets with asymmetric information. Stiglitz is a distinct critic of the idea of the invisible hand applied to economics in the sense that free markets should lead to efficiency as if guided by unseen forces.

In other words, free markets (without any intervention) will, in general not lead to efficiency; it is even only under exceptional circumstances that free markets are efficient.

Based on these insights, we argue that the formation of the dEoE should not be left over to unregulated markets. It requires dedicated and continuous methodological support establishing such a dynamically adapting balance as mentioned by Stiglitz. Not least to prevent a comparable outcome to Web2.0, where the utility and power aggregated in the hands of a few quasi platform monopolists, taking advantage of it to the detriment of smaller competitors and society. One of the goals of the algorithmic and social mechanisms based self-governance, in combination with societal governance of dEOE endeavors is to establish functioning market economy.

dEOE is not about naive cooperation, but cooperation. It is important for a functioning market economy to have a healthy competition, e.g. about providing key expertise.

Diminishing competition and arising monopolies have a detrimental effect to the total system. Over and above, for complex systems operating in open contexts, diversity i.a. in the form of competence is important for antifragility and hence persistence of the system. Therefore, a competition based diversity on the one hand, balanced by an adequate protection of minorities form the breeding ground for futures contributors of key expertise and hence prevailing efficiency.

¹⁵Supermodularity is related to convex coalition games, and the solution concept introduced by Lloyd S. Shapley (1953)

Maximizing the benefit from a local perspective (associated to selfishness of agents) is not evil per se, but the reflection of a necessary contribution to efficiency of the total system. It needs to be counterbalanced such, that entity-local maximization leads to maximization of globally desirable outcomes (i.e. socio-economic optimal results). This compensation also addresses the free-rider issue[4].

B. B: Token Taxonomy

Establishing a consistent and reliable taxonomy for cryptographic assets, known as token, is important to laying a foundation from which developers, policymakers, and investors can make more sense of how to design, apply, or regulate tokens.

Cryptographic assets do pose a challenge on regulators because they integrate properties of currencies, commodities and payment systems, and the resulting classification will have implications for their legal and regulatory treatment. Some tokens might represent completely new asset classes, like native protocol tokens that have hybrid functions, which are not easy to classify, from tokens that might very simply represent assets of the existing economy that are easily classified, understood from a business logic perspective, and therefore also regulated. An example of assets that are easy to classify or regulate are tokenized securities, comparable to conventional securities. In practice, many of the utility tokens also serve as means of payment within their network and are thus also kind of 'payment/currency token', this makes a clear-cut classification difficult. The taxonomy presented here intends to give a broad overview of the different properties and types of tokens.

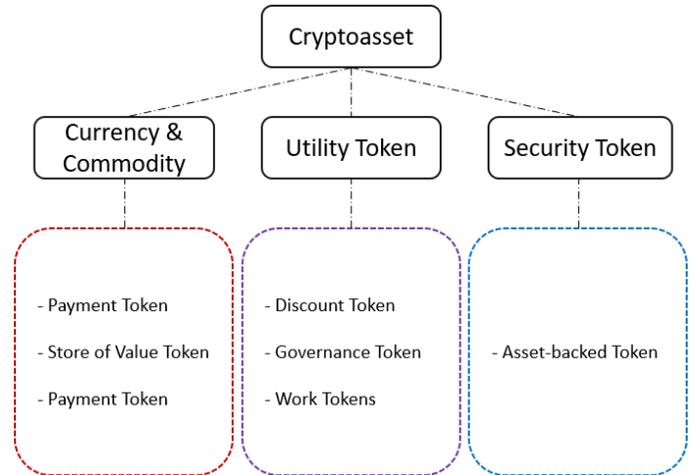


Fig. 2. Classification of Cryptoassets based on Fabric Venture Analysis[15]

The main utility for each token type are illustrated below:

- **Currency & Commodity:** Focus on payments and store of value, e.g. Bitcoin
- **Utility Token:** Integral part of the platform itself with additional functionality, e.g. Ethereum
- **Security Token:** Represent the value of an underlying off-chain asset, thereby enhancing liquidity, divisibility and access.

C. C: Cryptoeconomic Primitives

Economic primitives exist in the analog world. Primitives are generous and well established building blocks of markets that developed over time and form the tools used in international markets and business in general. However, blockchain technology has opened up a whole new way of doing business and enables economic applications previously not possible. These new applications require new building blocks.

Cryptoeconomic primitives can be understood as protocol based incentive systems linked to an underlying, unique cryptographic token. The token enables the coordination and allocation of resources to achieve a shared goal through the use of economic and cryptographic mechanisms. A token is therefore inevitable to build a decentralized self-sustaining system. Without the token, the system will fail or work less efficient than with a token[19].

A cryptoeconomic primitive should result in the predictable coordination of a set of actors (whether it be humans or machines) towards some specific shared goal or outcome. This can include predictably failing in certain situations and knowing limitations.

One example can be found in the category of *Curation markets*. Curation markets are a certain primitive, that is specifically designed to curate information and reduce information asymmetry. The most known primitives are Token Curated Registries (TCRs) and Curved Bonding. Both share the same goal to incentivize token holders to curate information, but differ in behavior and output: Token Curated Registries give you a binary outcome, e.g. "yes" or "no" entrance, whereas Curved Bonding systems give you a gradient score of the relevance of something[20].

Outside of curation markets, other cryptoeconomic primitives include:

- Prediction market: incentivize coordination and allocation of capital to correctly forecast future events
- Stablecoin: incentivize coordination and allocation of capital to maintain the stable value of the stablecoin relative to some measure (e.g. \$1 USD)
- Bonding curves: a mathematical curve that defines a relationship between price and token supply to avoid pump-and-dump¹⁶.

The above examples are existing cryptoeconomic primitives, but still very experimental. However, a lot of further research is required to provide the tools that will unleash the full economic potential of DLT could provide for the future.

Each mentioned primitive is interesting on its own, but bundled together they are truly powerful. The combination of different mechanisms will enable the creation of protocols and systems that weren't possible prior to their existence. These emergent systems will be greater than any of the individual primitives on their own[20].

¹⁶Wikipedia (2018): Pump and Dump. Available online at https://de.wikipedia.org/wiki/Pump_and_Dump

D. D: Simple Agreement on Future Tokens (SAFT)

This new agreement between investors and issuers is designed to ensure that token offerings are handled correctly under supervisory and criminal law worldwide, thereby providing investors and entrepreneurs with greater security for their actions. SAFT intends to ensure that the offered tokens do not violate international financial market regulations, enabling the issuing entity to meet KYC requirements and comply with anti-money laundering (AML) and terrorist financing regulations.

Due to the SAFT being a non-debt financial instrument, investors who purchase it face the possibility of losing their money. The document only permits investors to take a financial stake in the endeavor. This means that investors are susceptible to the exact same enterprise risk as if they had gotten a SAFE¹⁷ instead, and at the same time incentivizing early partners to contribute to the success of the project.

SAFT covers the most common issues of unregulated token sales and would enable projects to obtain funding faster and stay regulatory fully compliant. The precise conditions of a SAFT vary and need to be aligned to the specific project fund raising strategy and desired cryptoeconomic principles.

The following part gives an overview about the course of a SAFT (generalized):

- 1) The issuing entity of a token-based decentralized network enters into a written agreement, called a SAFT, with accredited investors. They determine investment size and the respective conversion/discount rate/pre-emption right. The developers don't issue any pre-functional tokens at this stage, but they do file the required forms with the regulators.
- 2) Accredited investors provide capital stock to founding entity (developers).
- 3) Founding entity initiates project and develops network. This could take months/years. Still no pre-functional tokens are issued.
- 4) (Optional) Additional SAFT Series possible if more capital is needed.
- 5) Once the network's basic functionality exists, the founding entity creates the token and provides the possibility for conversion/delivery. Investors can now ideally trade their tokens through the automated market maker or on an open market to realize their profit, as it is now a consumptive token for the public[21].

¹⁷A SAFE (simple agreement for future equity) is an agreement between an investor and a company that provides rights to the investor for future equity in the company similar to a warrant, except without determining a specific price per share at the time of the initial investment.

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