Decentralized Public Ledger as Enabler for the Gift Economy at Scale

(Literature Study)

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***Abstract*—This paper conducts a literature study to answer the question if a decentralized ledger (blockchain), as used in Bitcoin and other alternative money like informational commodities, allows scaling of the Economy of Giving from small communities to a global scale. It starts by introducing the concept of Economy of Giving and the technology behind decentralized ledgers. It answers then the non obvious question how both concepts can be combined and explains the resulting implications. Finally, it concludes with an analysis why such a combination is favourable and gives an outlook to future work that is needed to make this new model a success.**

I. Introduction

The following paper conducts a literature study with the purpose to develop an alternative or extension to the current market or barter economy. It investigates if current technological developments have the power to scale up the Economy of Giving. For this purpose the problem was analysed in an interdisciplinary way, including, but not limited to the fields of computer science, social studies, media theory, economics and finances.

The market economy is since a few decades the dominant economical model of our society. Part of the problem of this system is the centralized structure of the underlying financial system and the resulting need of trust in these institutions. Starting from the *Subprime mortgage crisis* around 2007 and 2008 in the US, the strong interconnection of our economy has led to a global financial crisis and then to the *Great Recession*. As described in the book *Healing Capitalism - Five Years in the Life of Business, Finance and Corporate Responsibility* [Ben14] these problems are noticed and acknowledged by traditional, conservative economists. This paper investigates how the Economy of Giving, or Gift Economy, as used in small communities, e.g. between families and friends, can be transformed in such a way that it is suitable for global markets, and how such a model can complement the market economy. In difference to the top down approach, fixing the current system, the proposed solution is to build in a bottom up way an alternative or parallel system.

This section has given a short motivation why an alternative economical system is favourable. In the next section, section II, the used mathematical model is described and as well as the reasons why such a model is needed. In order to understand the explained solution, the technological concept of decentralized ledger is explained in section III. In section IV the two concepts are combined in such a way that the Economy of Giving is applicable at global scale. The paper concludes in section V with an outlook to further work.

II. Economy of Giving

Economy of Giving, or Gift Economy, is the earliest form of economical system and has not vanished since the early days of humanity. In our modern society it is mainly hidden beneath the market or tender economy. Additional to the use in small communities and families, the Economy of Giving could be seen as theoretical model behind charities [Ahl00], [And88], but also behind open source and file sharing communities [Bar98].

One example how the principles of giving are used in a technical way is BitTorrent. BitTorrent limits the download speed for users that do not provide enough upload speed. This enforces everybody to share parts of the content in order to get more. Not directly based on human interactions and only applicable in a limited context, it is a simplified version that is able to keep track of a net present value of a future settlement or yield. Another, maybe more suitable, example are open source communities. The involved developers work most time for free and share the results with the community or the public. According to the paper *The power of gifts: organizing social relationships in open source communities* [BL01] gifts are not always given to a specific person, but to the public. Sharing goods, in this case the source code, with more than one person is only possible because digital content does not lose value during replication and the costs do not increase. That makes the digital Gift Economy slightly different than the classical one.

Also with the rise of countless open source and file sharing communities the Gift Economy was not able to challenge the existing economical system. Based on the optimistic view of the early internet days in 1998, the article *The hi-tech gift economy* [Bar98] describes free markets and the rise of the Gift Economy. Nearly eight years later, in 1996, an update was posted. It mentions the shift of the Gift Economy to main stream. Additional to open source communities, the author mentions blogging to underline his thesis. The internet, as it is currently, is a mixture between classical and alternative economical systems. This type of Gift Economy is mainly limited to sharing of digital content with no direct yield from single entities. In difference to giving away material goods the costs for sharing digital content stays nearly the same for big quantities in comparison to sharing only one.

The point that the Gift Economy has reached main stream in the digital world makes it necessary to develop a mathematical model that could be applied at internet scale. The paper *Mathematical Foundations for the Economy of Giving* [Wei14] describes such a model in detail. This model is used in the scope of this paper to show that new technological developments make it possible to scale this model and hence the Gift Economy. The transaction based approach makes it especially suitable for a combination with decentralized public ledger technologies. Dependent on the direction of the transaction the account balance value is decreased or increased. After multiple transactions between two or more entities an equilibrium is reached. In an informal way an equilibrium could be defined as state where each entity has received the same amount of goods as given away (subjectively). The concept of an equilibrium, that is reached automatically after some time, makes the Gift Economy sustainable and unfair entities are eliminated over time.

In order to understand the combination of this model with decentralized public ledger technology, the most important concepts are outlined here. For a detailed description about the full model see [Wei14].

Supply Entity P offers the good a (supply). Modelled as: $P \xrightarrow{a}$.

Demand Analogous to the supply the demand is modelled as $Q \xleftarrow{b}$.

Transaction A transaction is the combination of supply and demand, modelled as $P \xrightarrow{a} Q$. That means P offers the good a to Q and Q accepts this good.

Yield A net present value of a future settlement. The yield value is specified by the yield coefficient. Based on the law of diminishing return this value gets smaller after each transaction.

Social account or mental bank account Accounts related to one entity, for each other entity (1-to-n relationship), that keeps track of social credits (yield values).

It could be seen from the construction of the model that the biggest hurdle towards scalability is the tracking of transactions and not the computation of the yield values. Another problem towards digitalizing of our social relationships is to derive yield curves that include the social bias towards counterparties. Such a bias has to be computed for each entity and must be updated if the social relationship changes.

III. Distributed Ledger

The first time a working decentralized ledger for public transactions was developed by the person or group Satoshi Nakamoto. In the paper *Bitcoin: A Peer-to-Peer Electronic Cash System* [Nak08], published in November 2008, the concept was introduced the first time to the public. Bitcoin was not the first digital payment method that was developed, but it was the first one that solved the double spending in a decentralized way. Some examples of earlier approaches were NetCash (1993) [MN93], NetCents (1998) [PHS98] and a patent with the name *Method of electronic payments that prevents double-spending* (1998) [DKM98].

The approach as presented in the Bitcoin paper creates a decentralized public ledger, called blockchain. It keeps indirectly track of bitcoin values by linking transactions. One effect of this design decision is that the value encapsulated in one transaction and related to one bitcoin address has to be paid out completely. Similar to cash no partial payouts are possible and the unspent money has to be transferred back to the same address or to a new one, resulting always in a new transaction. In Figure 1 this concept is visualized with one input and multiple outputs and vice versa with multiple inputs and one output. Input and output are transactions that specify ownership change of bitcoin values.

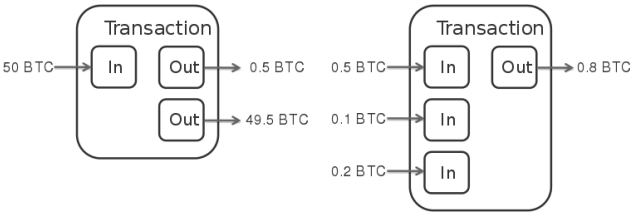

Fig. 1. High level visualization of transactions.

The following list outlines a few points why the Bitcoin blockchain is suitable as a starting point for developing a digital version of social accounts.

- **First implementation** The fact that Bitcoin was the first decentralized public ledger makes it currently the de facto standard.
- **Customizable** The definition of a transaction could be redefined and a completely new and independent blockchain could be started.
- **Open Source** The reference implementation and a lot of additional software and tools are released as open source.
- **Growing Community** Through the gain in popularity, the community around Bitcoin grows steadily.

Especially the customizability and the availability of the reference implementation as open source makes it attractive for adaptation. The transaction based approach and the solved double spending problem in a decentralized manner are further properties that simplify the combination with the presented mathematical model.

IV. Economy of Giving at Scale

The current use of decentralized public ledgers or blockchains is to keep track of financial transactions, mainly in the form of money-like information commodities [BW14]. In this section we will see that the same technology could be used to create a new blockchain. This blockchain is not used to track financial values, but the mentioned *account balances*.

The idea to overcome human limitations with technology is not a new approach and was discussed throughout history [Bre00]. As described by Marshall McLuhan in his famous quote, *The Medium is the Message* (1964) [McL64], not only

the content changes our society, but also the fact that such a technology exists. In this case, technology allows us to outsource our social relationships, or at least the related yield values, to such a medium. The intermediate effect is that we are able to overcome our limitation with how many people we can actively interact [Dun11]. This limitation is the biggest bottleneck for the scalability of the Economy of Giving.

Another empowering factor is the availability of detailed information about a single person from different sources, like social media and the transition of financial data to the digital world. This information about a single person and more importantly the connection between people allows the reconstruction of social structures without starting from scratch. One of the difficulties in the application of the mathematical model, described in section II, is the computation of yield coefficients. In order to guarantee a realistic balance, this value has to take into account a social bias, e.g. favour towards family members or close friends. The constant analysis of social graphs could support the computation and even update yield coefficients in real time, if something changes in the relationship between two entities.

All resulting weighted transactions between specific parties sum up to the balance from person A to person B. In general these transactions are unidirectional. That means that the balance from person A to person B is different from the balance back from B to A. The concept of an equilibrium has not to be explicitly modelled and could be defined as stability of all outgoing and ingoing transaction to one party.

This unidirectional transactional model, with two (or more) entities, is modelled by [Wei14] and a first decentralized public ledger is described as Bitcoin in [Nak08]. The combination of the mathematical model with the technology allows to implement the model in a scalable way. This combination has the potential to overcome the upper bound limit of active social connections that every human being faces, resulting in a global scale Economy of Giving without human limitations.

How could the mathematical model be implemented based on the Bitcoin blockchain?

The Bitcoin blockchain is used as a starting point and modified in such a way that it assemblies a decentralized ledger which is capable of keeping track of yield values. The resulting social accounts are not explained and could be derived directly from the ledger.

1) **Supply and demand transaction** The current blockchain contains one-way values in each transaction. Bitcoins are transferred from one entity to one or multiple others. In order to model the supply and demand yield values, a separated value for each involved entity has to be specified.
2) **All transaction are public** In order to make the sensitive yield values private, asymmetric encryption could be used. The same way as Bitcoin amounts are protected of unauthorized spending.
3) **Pseudonymity** Also if the yield values are not or could not be protected the pseudo anonymity of the blockchain makes it possible to hide the identity of the involved entities. Without knowing the related tokens of an entity it is not possible to reconstruct the account balance.
4) **Decentralization** The decentralization allows scalability, but makes it also possible that the blockchain is not controlled by one or a group of entities.

By creating a new blockchain and specifying a new transaction schema, which is suitable for the underlying mathematical model, a separated decentralized public ledger can be created. This blockchain keeps track of the yield values and can be used to construct social accounts.

In the rest of this section the paper investigates what modifications have to be made in order to satisfy the requirements of the given model. It is a first analysis for future implementations and practical case studies. By no means it is complete, nor it discusses all the practical issues. Although it should make clear, with a little bit of effort, that it is possible to scale the Gift Economy. Maybe more importantly it shows that our mental account for yield values, an essential part of our social relationships, could be outsourced to a digital medium.

Given the transaction $P \xrightarrow{a} Q$, the yield values of P and Q are denoted as t^P and t^Q respectively. For the supplier P the value $t^P \geq 0$ and for Q, $t^Q \leq 0$. If the sum of these values result in zero ($t^P + t^Q = 0$), both share the same view on the transaction value and are called *compatible*. For further discussions we differ between a decentralized public ledger with only compatible values and one with mixed values (compatible and non compatible values).

A. Blockchain with only compatible values

From the earlier discussed structure of the blockchain implementation it can be seen that it is suitable for the model. Both use one value for each transaction between two entities and are dependent on the previous transactions.

The bitcoin value is substituted with the yield value, that is per definition the same for both parties. Dependent if the entity is on the receiver or sender side the sign is changed during computation of the current social account value from plus to minus or vice versa.

Instead of referencing the (yield) values of previous transactions, the number of transactions is counted and used for the yield coefficient adaptation, following the same way as described in the mathematical model.

With these changes the next transaction from P to Q references exactly one previous transaction. For greater performance and convenience, the last transaction could always keep track of meta data, such as the number of previous transactions or a dedicated bias value for the involved entities.

B. Blockchain with compatible and non compatible values

Through the bidirectional relationship of a transaction and the differentiation between yield values for both entities this approach is more complex, but also more realistic. In comparison with the above mentioned approach, this approach allows to separate supply and demand. A *supply transaction*[1] can be published with a limitation of how many copies or versions are available. Without knowing the demand, the

[1]Here the term transaction refers to a blockchain transaction and not to a transaction in the mathematical model

access to the goods can be limited to specific entities or made publicly available. Each demand transaction references the supply transaction and if necessary changes the meta data values, e.g. decrements the copy or version counter. Additional to the fact that both, supply and demand, transactions can have different yield values, this design decision allows the issuing of goods without intermediate demand. Such a property is not only useful, but necessary for the Gift Economy in the digital world. For example, open source software is issued to the public without knowing all involved entities.

V. Conclusion

After giving a motivation why a sustainable economical model is needed, the Economy of Giving was explained on the example of the digital Gift Economy. Starting from the scalability limitation of human beings, it was shown that outsourcing the account balance, used for keeping track of yield values, could solve this problem. The use of decentralized public ledgers satisfy, with only small changes, the requirements for a technology that can empower the Economy of Giving at scale.

The focus of this paper was how to scale the mathematical model behind the Economy of Giving. Further work will be to determine how yield coefficients can be derived and how social connections can be modelled in a digital way. To develop a system that is widely accepted and trusted, the yield values should be computed in such a way that they feel natural to the involved entities. That means also that computed yield values should resemble, as good as possible, the real and subjective yield values that we store mentally.

The move of our lives into the digital world, the progress of computation and storage technologies[2] makes it even more likely that we are able to extend our social relationships to the digital world.

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[2] For example HP's "The Machine" see http://www.youtube.com/watch?v=JzbMSR9vA-c