Sustainable Money System

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Authors
Stef Kuypers (stef@happonomy.org)
Thomas Goorden (tg@eenwereldmetlef.be)
Bruno Delepierre (bruno@happonomy.org)

Executive summary

The contents of this document are provided to contribute to the discussion of a **Central Bank Digital Currency** (CBDC) and was originally written as a response to the discussion paper published by the Central Bank of England[1] in March 2020 and has been adapted for wider applicability. References to the discussion paper have been retained. This document's objective is to provide an **alternative perspective** on the design of monetary systems to be taken into consideration.

This document describes an **alternative monetary system**, called the **Sustainable Money System** or **SuMSy**. Like the international monetary systems currently in use (Eurozone, dollar, etc) it has the objective of creating a **stable financial system**. Unlike those systems, SuMSy explicitly adds the objective of **increasing human well-being**.

SuMSy has a special relevance today within both the ongoing **climate crisis** and the added **COVID-19 pandemic**, due to its unique impact on **sustainable behavior** and its response to **financial strain**.

At its core, SuMSy consists of a mechanism that creates money through **guaranteed income** (a type of **universal basic income**) and stabilizes the total money stock through **demurrage**, a type of negative interest.

SuMSy has a mathematically provable **positive impact** on financial **equality**. Through past **game-testing** experiments, it also appears to have a **significantly positive impact on economic behavior**. Participants make more sustainable, long-term choices and experience significantly less economically induced stress.

SuMSy promises to **stabilize money supply** (liquidity), create a **healthy entrepreneurial market environment**, be **impervious to growth/degrowth** pressures and **actively resists both inflation and deflation**.

A **technological design** is available for both a **centralized SuMSy**, which could exist as a 'classical' Central Bank Digital Currency, and a decentralized SuMSy, for which an **early prototype** exists.

Various **design considerations** leave room for further research and subsequent policy choices.

The **positioning** of SuMSy within and towards the current monetary system could consist of a **voluntary incremental introduction**.

SuMSy is the **result of research and experimentation** during the past five years.

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[1] https://www.bankofengland.co.uk/-/media/boe/files/paper/2020/central-bank-digital-currency-opportunities-challenges-and-design.pdf

Sustainable Money System

This document is structured as follows:

- First, an overview of the **objectives** of SuMSy, the Sustainable Money System proposal.
- This is followed by some **definitions** of frequently used expressions.
- Next comes a (brief) discussion on how various concepts have **historically** been discussed and tried out before.
- The following part is perhaps most important, it describes the most **basic design** elements of SuMSy.
- A report is included on the (qualitative) **results of (social) experiments** on the impact of monetary systems within economic games.
- Next up is a discussion on the key advantages and challenges of SuMSy.
- A wide range of **design considerations** is listed. These address a number of common questions regarding SuMSy.
- An overview is given on various **computer simulations** (including an agent based system) that were/are being developed in this context.
- A brief description is given on the **technical implementation**, including designs for a centralized and a decentralized version.
- The **positioning** of SuMSy in regard to the current monetary system is discussed, including possible transition paths.

Objectives

Objective 1: A stable financial system

The goal of virtually all monetary policies is to create a **stable financial system**. This is reflected in the objectives of virtually every central bank:

- The primary objective of the **Bank of England** is to **maintain monetary and financial stability**.
- Similarly, the primary objective of the **Eurosystem** is to **maintain price stability**, while the "natural role" of monetary policy in the European Central Bank is to meet this objective.
- The **Federal Reserve** has two primary objectives: (1) **maximum employment**, which means all Americans that want to work are gainfully employed, and (2) **stable prices** for the goods and services for purchase.
- The purposes of the Bank of Japan are to aim at **achieving price stability** and to contribute to **financial system stability.**

Despite their hard work, one could argue that central banks are struggling to meet their objectives through their current monetary policy.

Not only is there a structural problem with "boom & bust" cycles where commercial banks have a tendency to liberally extend credit in times when the economy is at peak performance while being very reluctant to do the same when there's an economic downturn. This pro-cyclical lending behaviour of commercial banks reinforces both the "booms" and the "busts"[2]. Central bank monetary policies have so far not been able to counter these effects sufficiently enough to avoid these boom and bust cycles.

The banking system itself is also struggling to maintain its stability. A working group at the IMF has defined no less than 390 systemic banking crises among the IMF member states between 1970 and 2017[3].

The standard definition of price stability, as it is understood by the wider population, requires prices to remain at roughly the same levels, thus neither going up or down too much over a longer period of time. This is an unachievable goal with monetary policies that strive for an inflation which is near but just below 2% and therefore in direct conflict with the stated goals. The ECB, and most central banks, created a workaround for this by changing the definition of price stability[4] to mean that prices do not rise more

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[2] https://www.researchgate.net/publication/228321363_Leveraged_Borrowing_and_Boom-Bust_Cycles

[3] https://www.imf.org/en/Publications/WP/Issues/2018/09/14/Systemic-Banking-Crises-Revisited-46232

[4] https://www.ecb.europa.eu/mopo/strategy/pricestab/html/index.en.html

than 2% per year, which happens to be the inflation target aimed for by most central banks worldwide. Changing a definition in this way can be regarded as intellectually unfair and could be a source of confusion when communicating with the population at large.

Lastly, there is a reinforcing feedback loop between the financial system and the performance of the economy. Due to the nature of money creation policies[5] of the current system, loans are instrumental to keep the money supply going. If the nominal amount of new loans falls below the nominal amount of bank debt settlement, the money stock shrinks unless central banks resort to either quantitative easing (QE) or helicopter money to make up for the difference. Lending has a tendency to drop in times of crises due to a postponement of investments. The consequence of this is that a slowing economy has a negative impact on the money stock, which in turn has a negative impact on the performance of the economy.

These issues are not indications of malpractice, lack of expertise or effort but point in the direction of systemic problems with the current monetary and banking system.

Therefore, the following question is crucial:
Is it possible to design a monetary policy/system which is inherently stable?

More specifically, is it possible to create a monetary policy that - by design rather than by continuous intervention - secures the stability of the money supply/stock, regardless of the performance of the economy?

If this can be done by design it would at least eliminate the reinforcing feedback loop between the monetary system and the performance of the economy which is currently present and most likely prevent the very volatile boom & bust cycles our economy finds itself in today. Such a monetary policy should also foster stable prices and facilitate sufficient economical performance to support modern life, without continuously risking financial instability.

Objective 2: Human well-being

Although the link might not seem obvious at first sight, adding **environmental and social sustainability and positive impact on human well-being** as an objective is worthwhile to be considered. This stems from a long-standing criticism that the design of the current capitalistic system promotes inequality[6] [7] when left unchecked, thereby requiring regulatory measures which are dependent on political decisions. This politicalization has led to de-regularisation of markets, particularly in the United States

[5] https://www.imf.org/en/Publications/WP/Issues/2019/12/20/Money-Creation-in-Fiat-and-Digital-Currency-Systems-48843
[6] Capital in the 21st Century - Thomas Piketty
[7] https://www.scientificamerican.com/article/is-inequality-inevitable/

and the UK, with largely negative consequences on equality. High inequality, in its turn, results in devastating effects on society at large[8].

Therefore, a well designed monetary system should:

- reduce **financial strain and improve mental health**[9].
- include a **natural tendency to reduce inequality**. This **increases prosocial behavior and cohesion in communities**[10] [11] [12].
- **increase the individual agency of participants** in an economic system[13], which also helps with the "buy-in" or **acceptance of the economic system**.
- **encourage sustainable choices** by disconnecting them from security needs.
- **strengthen the (psychological) meaning of economic activity** and decrease the financialization of everyday life[14] [15].
- **help prepare for and prevent catastrophic risks** like climate change[16].
- be constantly **evaluated and adjusted for maximum (positive) impact on overall human well-being**[17].

These goals are often perceived to be at odds with economic growth, which is stated as a goal in most economic policies. It can be found in the Articles of Agreement of the IMF [18], in the Stability and Growth Pact (SGP) of the European Commission[19] and in the Sustainable Development Goals[20].

In most economies economic growth is currently measured by growth in GDP, a single number. New proposals for measuring economic growth are currently on the table[21] [22]. These proposals could lead to a redefinition of what is considered to be economic growth and resolve the conflict with the goals stated above.

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[8] https://www.equalitytrust.org.uk/about-inequality/latest-research
[9] https://journals.sagepub.com/doi/abs/10.1177/002214650604700102
[10] https://www.nature.com/articles/nature01963
[11] https://journals.sagepub.com/doi/abs/10.1177/1745691610393524
[12] https://greatergood.berkeley.edu/images/uploads/ClassCompetition-PDF.pdf
[13] https://onlinelibrary.wiley.com/doi/abs/10.1002/job.322
[14] https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780198755609.001.0001/oxfordhb-9780198755609-e-29
[15] http://fessud.eu/wp-content/uploads/2012/09/Financialisation-Economy-Society-and-Sustainable-Development-An-Overview-Working-Paper-Series-No.206-April-2017.pdf
[16] https://www.researchgate.net/publication/340269785_Emerging_issues_in_energy_climate_change_and_sustainability_management
[17] For a comprehensive overview of quality of life determinants see https://www.happonomy.org/en/the-science-behind-happonomy/
[18] https://www.imf.org/external/pubs/ft/aa/index.htm
[19] http://data.consilium.europa.eu/doc/document/ST-9344-2017-INIT/en/pdf
[20] https://sustainabledevelopment.un.org/?menu=1300
[21] https://www.oecd.org/naec/averting-systemic-collapse/SG-NAEC(2019)3_Beyond%20Growth.pdf
[22] https://www.beehive.govt.nz/sites/default/files/2019-09/Economic%20Plan.pdf

Here the question becomes: is it possible to design a monetary policy/system which supports these new notions of economic growth, helps to resolve the current day conflict and achieve the above mentioned goals?

mani (pona)

To reflect the fundamental difference between the current monetary system and SuMSy, a differentiated nomenclature is introduced:

1. "**Standard money**", or the currencies used within the current monetary policies of central banks worldwide. "**Money**" is used as the short abbreviation. Examples are of course the euro, dollar, yen, etc.
2. "**mani pona**" (which could be translated as "**good money**"), which is the label used in this paper for the hypothetical currency used in the Sustainable Money System or SuMSy for short. "**mani**" is used as the short abbreviation for such a currency (always to be written in lowercase).

In short, wherever "money" is used in this paper, one could substitute it with "euro" or "dollar", wherever "mani" is used, it designates a hypothetical currency that implements SuMSy.

mani could be considered to be a special kind of "stablecoin". These are generally speaking currencies with some form of asset-backing (such as gold or even another currency). The backing of mani would be humans themselves. Of course, this does not mean that you can trade in mani for human beings. The money stock in the system is simply determined by the number of account holders in combination with the numerical parameters which are described below. As long as the account holder stays alive, there is a guaranteed income which they have access to, for which the holder is a type of "fiat backing", similar to wage considerations when determining mortgages.

mani is, in its current design, a digital currency without a physical representation (such as a paper form like cash). It - of course - includes ledgers and uses cryptographic functions for verification and encryption purposes, which would be required in any modern digital monetary system. At first glance it might seem to meet all of Jan Lansky's requirements[23] for being a cryptocurrency. However, SuMSy is not based on a cryptographic "blockchain" ledger and does not ensure pseudo-anonymity, so it does not fully match Jan Lansky's description of cryptocurrencies. To avoid confusion, SuMSy/mani is simply not to be designated as a cryptocurrency.

[23] http://si-journal.org/index.php/JSI/article/viewFile/335/325

Definitions

Guaranteed Income (GI)

A **guaranteed income** is a concept related to a Universal Basic Income (UBI). The most commonly used scholarly definition today defines UBI as a periodic cash payment (1), unconditionally delivered (2) to all (3) on an individual basis (4), without means-test (5) or work requirement (6) (BIEN, 2018).

A guaranteed income differs from a UBI as the height of the amount must be sufficiently high to lead a minimally qualitative life, something which is not necessarily the case with a UBI. This means that the recipient must be able to cover **all basic needs** (decent housing, food, clothing, energy, drinkable water, ...) and be able to **live a humane life** (e.g. to buy basic hygiëne products, go to school, etc).

Ideally - but optionally - this guaranteed income is increased with an extra amount which people can spend freely. Note that, if required because of excess demand for specific products or if deemed appropriate because of policy priorities, qualitative spending limitations can still be installed.

Demurrage

Demurrage is expressed in percentages and is a (negative) interest charged on a financial account. It can be viewed as the cost of storing value. The term “demurrage” is commonly used in e.g. the shipping industry, where shipping companies can charge damages when a delay occurs in the loading or discharging of cargo.

The demurrage is calculated and subtracted from the account balance right before the guaranteed income is added to it. More precisely, demurrage is calculated on a weighted average of the account balance over time.

Note that demurrage effectively reduces the default income (= GI - demurrage) for accounts which hold large balances. This eliminates the “Matthew effect[24]” common in financial stimulation measures, where the “rich get richer and poor get poorer”.

Fiat money

Fiat money is national money that is not pegged to the price of a commodity such as gold or silver. The value of fiat money is largely based on the public’s faith in the currency’s issuer, which is normally that country’s government or central bank.

[24] Rigney, Daniel (2010). "MATTHEW EFFECTS IN THE ECONOMY.” The Matthew Effect: How Advantage Begets Further Advantage. Columbia University Press. pp. pp. 35–52.

Legal money is a medium that is prescribed to be money by laws and regulations, that is, imposed by a government. The most tangible criterion of legal money is whether a medium can be used to pay taxes. It may not bear any own intrinsic value, say, when existing in paper or electronic form. The term “legal money” may be used synonymously with “fiat money” and “legal tender.”[25]

Velocity

Velocity, in this context, is the rate at which money is used for transactions, expressed as the turn-over fraction of the total money stock over time. In a speculative financial system, the velocity can be very volatile, depending on the volatility of the (perceived) underlying value of the currency. In a deflationary context, where the value of a currency increases over time, people tend to hold on to their monetary assets, thereby decreasing the velocity of money. In (hyper)inflation, where the value of money rapidly decreases, the velocity goes up significantly. There is a reflective causal link between velocity of money and inflation/deflation where one can strengthen the other (higher velocity causes inflation, lower velocity causes deflation). Large variations in the velocity of money are a clear sign of financial instability.

Gini coëfficiënt[26]

The Gini coëfficiënt is one of the possible measurements of inequality in an economic system. Simply put, it can be thought of as the deviation from absolute income equality. If a single person were to accumulate all possible income streams in a system, the Gini coëfficiënt would be 1 (or 100%). In a fully equal system, the Gini coëfficiënt would be 0 or 0%.

Brief historical discussion

The origin of the modern monetary system can be considered to lie in the founding of the Bank of England and the first issuance of “bank notes”, initially backed by private shareholders[27]. In many ways, this shows that the functioning of a monetary system is a deliberate design, not an emergent property.

The idea of a guaranteed income has a long history, especially under the more popular term “basic income”. From 1516 when Thomas Moore hinted at a universal basic

[25] Definition from IMF working paper “Money Creation in Fiat and Digital Currency Systems“ https://www.imf.org/en/Publications/WP/Issues/2019/12/20/Money-Creation-in-Fiat-and-Digital-Currency-Systems-48843

[26] The Palma ratio is generally preferred over the Gini coefficient as it is considered to be less sensitive to income changes in the middle of the distribution (Gastwirth, 2016). The Gini coëfficiënt is simply better known and is sufficient here. https://www.tandfonline.com/doi/full/10.1080/2330443X.2017.1360813

[27] https://www.bankofengland.co.uk/-/media/boe/files/archive/publications/history-and-functions.pdf

income (UBI) in his work 'Utopia' to Bertrand Russell in 1918 (Klein, 2016), the idea of a UBI has been around for many centuries.

Today, two closely intertwined issues have again provoked people's interest in a UBI: rising income inequality and the potential of increased unemployment. As for the former, the Organization for Economic Cooperation and Development (OECD) states "the average income of the richest 10% of the population is about nine times that of the poorest 10%, up from seven times 25 years ago". One of the most important roots for this income inequality can be found in globalization (Lindert & Williamson, 2003).

A second catalyst is computerization which is considered by many as a potential threat to employment: in a 2013 study[28], Frey and Osborne researched the task and skill demands of 700 occupational categories along with progress being made in computerizing routine tasks and decisions. Their results showed that up to 47% of existing jobs in the US will most likely become redundant.
A variety of UBI experiments have been conducted across the globe with mixed positive results. For a brief overview and a more detailed account on UBI see Delepierre, 2017[29] [30].

Fiat money also has a long history. Currently, it is being proposed in the form of "perpetual bonds" to fight the COVID-19 pandemic crisis in Europe[31]. According to this proposal by George Soros, the principal of the bond would simply never need to be paid and the interest rate is extremely low. The term "perpetual bond" suggests a loan, but since repayment is at the absolute discretion of governments through their central banks (and doesn't have to actually happen) it doesn't act in the same way economically. In many ways it would function almost exactly like fiat money (or helikopter money), if the interest is 0 or extremely low.

Negative interest rates also already exist in the current financial markets and are e.g. used by Central Banks to stimulate lending even further than with regular low rates[32]. It is interesting to note that the main reason for these negative rates is to increase the volumetric growth rate of the (monetary) economy by actively encouraging the creation of loans and bonds.

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[28] https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf
[29] Overview of basic income experiments: https://docs.google.com/document/d/1TL_C7clhxuu7rHMZpQFFIaasRWFK7nqp-QeLUYp4hkg/edit?usp=sharing
[30] Does a universal basic income contribute to income fairness? https://docs.google.com/document/d/1RNVoT2jGNQgBpfWsuA42zvWtP18yqAjpwRNV-PBAMo0/edit?usp=sharing
[31] https://www.marketwatch.com/story/soros-the-eu-should-issue-perpetual-bonds-to-fund-the-economic-recovery-from-coronavirus-2020-04-22
[32] https://www.forbes.com/sites/vineerbhansali/2020/03/26/why-the-fed-is-going-to-go-to-negative-rates/#7c32d955e3bc

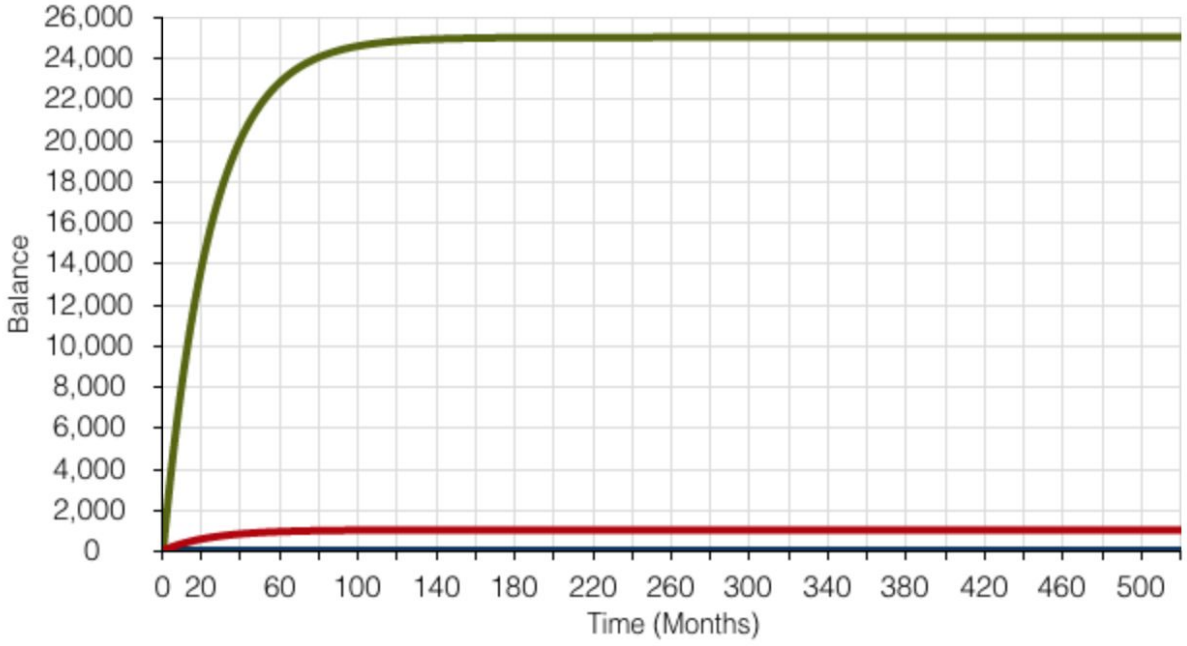
Basic design proposal of SuMSy

The following is a design proposal for the Sustainable Money System, or SuMSy, which aims to meet all the objectives listed above. A number of possible variations on this design are discussed below. However, the basic structure in all variations consists of the following elements:

1. All SuMSy accounts always have a balance equal to or greater than zero. A negative balance is, in this basic design, impossible.
2. mani is created through a **Guaranteed Income (GI)**. A fixed amount of mani is created at regular intervals on all SuMSy accounts, as a special form of **fiat money**.
3. **Demurrage (D)** is applied to all SuMSy accounts, before new GI is deposited on the accounts. This amounts to a negative interest applied to the account balance. In the basic design all mani removed by demurrage is effectively destroyed.

Note that the addition of demurrage makes SuMSy fundamentally different from most UBI proposals. SuMSy accounts cannot accrue mani indiscriminately. For an inactive account where no transactions take place, the balance ceases to (naturally) grow once the amount of guaranteed income matches the amount removed by demurrage. This number is called the "**Stabilized Account Balance**" **(SAB)** and it is (in this basic design) equal to the guaranteed income divided by the demurrage.

The "natural growth" of an inactive SuMSY account looks like this, with for instance a (monthly) GI of 1000 mani and a (monthly) demurrage of 4%. The green (top) line is the evolution of the account balance, the red (middle) line is the evolution of demurrage:



As can be observed, the account balance “flattens out” after a specific amount of time. Demurrage stabilizes at the same time. This “Stabilized Account Balance” (SAB) depends entirely on the chosen parameters.

The SAB for this example is equal to 1000 / 4% = 25000 mani.

From this feature alone, a number of crucial aspects of SuMSy can be determined:

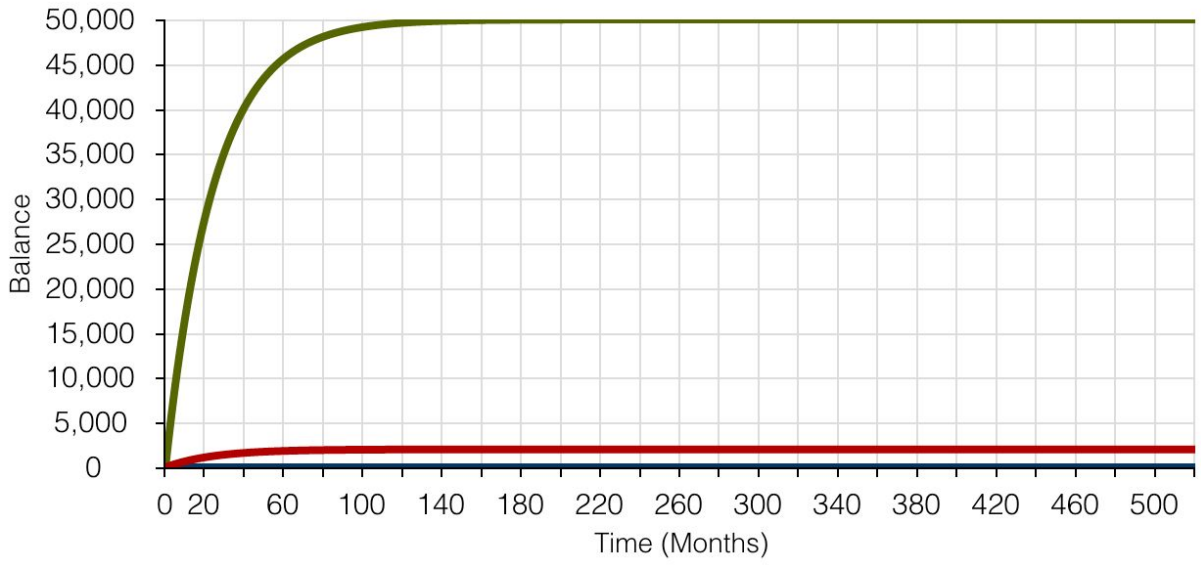
1. The maximum total amount of mani in circulation is limited by the number of SuMSy accounts (N) and equal to N x SAB.
2. In the absence of economic activity, the Gini coëfficient of SuMSy automatically returns to 0. This means that absolute equality is the “natural state” of SuMSy.
3. SuMSy automatically scales with population size (if government mandated) or the number of participants (if it is opt-in).
4. A SuMSy account and its associated mani comes into existence when a human joins the system and is destroyed, abandoned or inherited when this person leaves the system or dies. This is what it means for SuMSY to be backed by or “pegged to” human existence itself.

Perhaps less obvious is the fact that a single ledger per person is sufficient to implement SuMSy. There is - in principle - no need for dual accounting. It is not necessary to create a “ledger of debt” (assets) in a regular bank to create mani. The creation of mani resembles that of cash: the only real consideration is to make sure it is not possible to (fraudulently) change the amount of GI that a SuMSy account registers, which would be similar to counterfeiting cash.

Of course accounts would not be inactive in a working economy. An inactive account simply provides a good view on the ‘default state’ of the system and the natural evolution of the mani stock.

Accounts which have economic activity on them will stabilize at account balances which are dependent on the spread between in the total income stream (GI + income from labour + income from investments) minus the total expenditure stream.

For example, when adding an income stream of 3000 mani (from labour + investments) to the example above as well as an expenditure of 2000 mani, the account balance stabilizes at 50 000 mani as long as the income and expenditure streams are maintained.



Results of social experiments (games)

Happonomy has developed 2 games with which qualitative experiments are executed. Both games have two layers. The “game layer” defines the goal of the game and the rules which determine the way players interact with each other. The “money layer” determines how money is introduced in the game, how it is taken out of circulation and how players interact with the money system in use. The games are played with different monetary systems, to specifically test the impact of these systems on player’s behaviour.

The card game[33] is a simple game where players build up a pension during the game by trading cards among each other. There is also a donation cup placed in the middle where players can voluntarily make donations for a common cause. It can be played twice in about an hour (once with SuMSy and once with the standard money system) and is used in workshop settings.

[33] Card game rules https://docs.google.com/document/d/1ysWYkUYN1dwYMB3ZDCwy3rRPLl6s48X2tDMad2CP-AU/edit?usp=sharing

The board game[34] is more complex and comprises more real world elements such as production units, local and import/export markets, production processes, automation, scientific research (to upgrade production processes), pollution (and ways to diminish pollution), pollution impact and quality of life indicators. This game is used in longer sessions with 3 to 6 players.

Both games show similar results. Players report less stress when playing with SuMSy. They are better able to provide for their (in-game) needs. There is generally more collaboration and there is more attention to activities that serve the common good. During the board game sessions, “pollution” (a challenge created by the game system) is

[34] Board game rules https://docs.google.com/document/d/1R0OonE12HQCVrJ4cal9RLlzFJDQorLb1PdFmdg264_s/edit?usp=sharing

notably easier to control when playing with SuMSy than it is with the standard money system.

One notable anecdote: During a late phase playtest of the board game, it was played by a group of players who were all actively working on building a circular economy and reducing footprints. They played the game with the standard money system for a couple of rounds and produced so much in-game pollution that they would not have "survived" to the end of the game, had time allowed to play a full game. Afterwards they were in fact appalled by their own in-game behaviour as it was completely in contradiction with their personal value system.

These observations allow us to form the following hypothesis:

> "Human economical behaviour is mostly determined by the monetary system in which people function, not the other way around."

The implication here is that certain characteristics, such as greed and hoarding, should not just be attributed to human nature, but rather to suboptimally designed monetary systems that create effects like (artificial) scarcity and encourage problematic thinking like hyperbolic discounting[35]. These games also confirm our hypothesis that it is possible to design a monetary system with a specific type of human behaviour in mind as the end goal.

Currently, the implementation of digital versions of these games is under consideration.

Key advantages

Improved well-being

A SuMSy based system has a multi-dimensional impact on our well-being. A SuMSy based system holds the potential to reduce suicides[36], brain damage in children[37], depression[38] or divorces[39]. It avoids anti-social[40] [41] and unethical behavior. On top of that, reducing or even eliminating economic strain, frees people to be creative, find meaning in their activities and show sustainable behavior.

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[35] Grüne-Yanoff, Till (2015). "Models of Temporal Discounting 1937–2000: An Interdisciplinary Exchange between Economics and Psychology"

[36] https://www.cambridge.org/core/journals/the-british-journal-of-psychiatry/article/economic-suicides-in-the-great-recession-in-europe-and-north-america/DF85FA16DFB256F4DC7937FAEA156F8B

[37] https://www.berkeley.edu/news/media/releases/2008/12/02_cortex.shtml

[38] https://news.gallup.com/poll/158417/poverty-comes-depression-illness.aspx

[39] https://www.k-state.edu/media/newsreleases/jul13/predictingdivorce71113.html

[40] http://media.wix.com/ugd/80ea24_edd136e3b72b07c93775906aee3dfa35.pdf

[41] https://www.sciencedirect.com/science/article/abs/pii/S0749597815300352

Stable money supply

The design of SuMSy effectively decouples the stability of the money supply from the performance of the economy. Even in a time of lockdown, as has been experienced with the COVID-19 pandemic, the money supply and associated liquidity would still be guaranteed. This would help central banks to fulfill their goal of financial stability.

Lowering threshold for entrepreneurship

Becoming an entrepreneur is a challenging endeavor involving no small amount of risk. Success is not guaranteed and failure often leads to financial nightmares. This stops a significant number of people from starting a business.

The introduction of a GI and its corresponding personal financial security enables aspiring entrepreneurs to go into business more easily and sustainably. It reduces the potential for burn-out and thereby helps to improve the success rate of new companies.

Increase in healthy market competition

Currently, governments often intervene when large organisations get into financial trouble due to the fact that bankruptcy of those organisations would lead to massive job losses and therefore income loss for a large section of the population. This evidently leads to a skewed market advantage for large organisations in comparison to smaller ones.

Due to the GI, job losses have a far less dramatic impact on people's well being than is the case in the current system. This leads to a market which leans more towards fair and qualitative competition.

Nudge towards sustainable business models

Short term capitalisation is discouraged in the SuMSy model because of the accrued demurrage on large capitals. Long term investments however, with smaller but regular returns, are encouraged by the model. This aspect can easily lead to the adaptation of more sustainable business models and long term planning.

A prime example of such a business model is the 'product as a service' model, with its roots in 'software as a service', and which is promoted by the Dutch entrepreneur Thomas Rau[42]. Ownership of the product remains with the producer who is also responsible for repairs, replacements, end of lifecycle handling and any supplemental costs (like energy use) which are related to the product. In return they get a monthly fee from the customer for the service provided by the product. This automatically leads to the abandoning of planned obsolescence and to producing durable, upgradable,

[42] https://www.youtube.com/watch?v=oMhmjpXlDW8

repairable and energy efficient products. The income stream generated with this business model is a perfect match with the design of the SuMSy model.

Impervious to growth/degrowth

There is a lot of debate about degrowth. While there are quite some advocates for it[43], there are at least as many opponents who argue that it would destabilize our economy. This could actually be the case if it would cause the rate of lending to fall below the rate of bank debt settlements, which would jeopardize the money supply/stock, as argued before. That's a big risk to take.

On the other hand, if economic growth, measured by GDP, leads to the use of ever more natural resources, it would put humanity in an impossible situation in regards to the availability of those resources. Green growth, which decouples economic growth from using a growing amount of resources, has been put forward but this is also a topic that is at the centre of heavy debates[44].

SuMSy simply takes away the risk of financial instability, without being opinionated on what "growth" or "degrowth" should mean. Whether a transition to reduced use of natural resources is made by choice or by happenstance (or through the shock of a pandemic or other natural disasters), financial stability is guaranteed. Even when economic activity grinds to a halt, the mani stock remains stable.

Inflation/deflation resistant

The way SuMSy is designed counteracts the inflationary and deflationary forces in the economy which are related to the size of the mani stock. An argument that is often put on the table is that providing everyone with a basic income would have an inflationary effect on prices. The mathematical properties of SuMSy counter this effect due to the fact that the aggregate mani stock, which maximizes at SBA multiplied by the number of account holders (and which is reached and maintained after the run in period), remains stable. Inflation/deflation can only occur in case there is a change in the availability of the number of consumable goods and services, which occurs when production output increases or decreases. Inflation/deflation as a consequence of a change in mani stock per capita is however impossible.

An interesting behavioural aspect has been observed during the card game sessions. There was not a single session where the prices, which are negotiated between the players, inflated when SuMSy was used. There were however several sessions where the use of SuMSy led to a deflation of prices without the effect of postponement of purchases, which is usually the consequence of deflation within the current system. On the contrary, economic activity either remained constant or even increased.

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[43] https://degrowth.org/2018/09/06/post-growth-open-letter/

[44] https://eeb.org/library/decoupling-debunked/

Challenges

Price stability

In order to have real price stability, the mani stock and velocity should remain in sync with the size of the economy. Since the average mani stock per capita of SuMSy remains stable, only the use of the available production capacity has an influence on prices. Note that even when production capacity continues to grow there is no obligation to fully deploy it. With a growing economy, in a sense of increased output per capita, prices would fall. In a shrinking economy prices would go up and with a stable economy prices would remain stable.

But this is only the case with fixed parameters. These parameters could be used as a tool to achieve price stability even when the size of the economy fluctuates.

Changing GI has a direct influence on people's income and demurrage has a direct influence on people's personally available money stock and on the velocity of mani. These tools can therefore have a more direct influence on prices than the ones central banks currently have at their disposal and help them better to achieve price stability.

Labour availability

Some scholars[45] believe the introduction of a Guaranteed Income would lead to unwanted labour market disruptions as people would no longer be willing to take up jobs which are needed to keep society running. Preliminary conclusions from a variety of UBI experiments support the opposite thesis. First, experimental results from the Alaska Permanent Fund[46] and Canadian Manitoba 'Mincome' programme, have shown no meaningful impact on labour markets. A 2018 US meta-analysis[47] which analysed the impact of 16 trial programs supported the same conclusion.

Second, the results of the recent Finnish experiment[48] showed a minor increase in short-term working willingness and the experiment may positively impact work motivation at a later stage as the results signaled significant well-being improvements, a

[45] https://www.jstor.org/stable/j.ctt46mznr

[46] https://www.nber.org/papers/w24312.pdf

[47] https://ideas.repec.org/a/bpj/bistud/v13y2018i2p12n4.html

[48] https://www.sciencealert.com/latest-report-on-finland-s-universal-basic-income-trial-suggests-we-d-be-happier-with-it

determinant impacting the willingness to work[49]. Also, the results signaled an increased confidence to find work[50].

Design considerations

Based on play testing, discussions and technical development, a number of special considerations were made in regard to the basic design. These can be viewed as variations, addressing one or more issues.

These design considerations are primary candidates for further research, which includes:

- Play testing the impact on (social) behaviour.
- Simulating the macro-economic effects in an agent-based model.
- Implementing proof-of-concept applications.

Demurrage free buffer (DFB)

The idea of having to pay demurrage meets psychological resistance from most people due to the fact that it seems to threaten their financial security. Especially when SuMSy participants are still thinking in the framework of (standard) money, which gives no guarantee of financial security. To alleviate that fear a “demurrage free buffer” can be introduced. This is a set amount on which no demurrage is charged. As long as the balance of the account held by the individual is below the amount allocated by the demurrage free buffer, no demurrage is charged. As soon as the balance rises above this amount, demurrage is charged on the surplus, which equals the balance - the amount allocated for the demurrage free buffer.

Example:
DFB: 50 000 mani
Demurrage: 4%
Account balance: 53 000 mani

Demurrage is calculated on the 3 000 mani, which is the surplus above the DFB. Resulting in 120 mani being deducted (removed from the ledger) before the next guaranteed income is deposited.

A DFB raises the balance at which an account stabilizes by the size of the DFB and adds N x DFB mani to the aggregated stock limit of mani, where N equals the number of account holders.

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[49] https://journals.sagepub.com/doi/abs/10.1177/000169939904200203

[50] http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161361/Report_The%20Basic%20Income%20Experiment%2020172018%20in%20Finland.pdf

‘Lendable’ DFB

In certain circumstances, like when running an organisation, there may be a desire to raise the amount of mani that can be held in reserve. Giving DFB’s to organisations is not a solution for this due to the obvious reason that it would incentivise people to create phoney organisations in order to amass DFB’s, thereby jeopardizing the stability of the mani stock.

A workable option is to make it possible for people to ‘lend out’ fractions of their DFB to others or to organisations. It can be regarded as a new type of non monetary investment in an organisation, thereby increasing the DFB available to the organisation while lowering the own DFB. The return on investment is the value provided by the organisation. This can be a product, a service, being a good employer or making a contribution to society.

Ownership of DFB remains with the original custodian and the fraction of the DFB which has been lent out can be taken back by that custodian. The result of this is that lending out a fraction of one’s DFB becomes a relational investment. ‘DFB investors’ will only lend DFB fractions to those individuals or organisations which provide value to them or to society in general. As long as this value proposition is maintained the likelihood that the investor retracts their ‘investment’ is relatively small.

This nudges organisations towards higher value creation and can contribute to a more value based competition in the marketplace.

This does not change the aggregate of DFB’s available system wide and thus safeguards the stability of the mani stock.

Tiered demurrage (brackets)

Just as a flat tax on income is considered unfair by many, so might a flat demurrage. Therefore the notion of tiered demurrage can be taken into consideration. It would work the same as with tiered taxation on income. Demurrage is calculated on the amount which falls into the different brackets. The higher tiers have higher demurrage percentages than the lower tiers.

This results in a diminishing return on the accumulation of large amounts of mani, thereby reducing the role of mani as a goal. On a behavioural level this nudges people to think about the meaning of “sufficient”.

Example:
Account balance: 250 000 mani
Demurrage free buffer: 50 000 mani
Demurrage tier 1: 1%
Upper limit tier 1: 100 000 mani

Demurrage tier 2: 2%
Upper limit tier 2: 200 000 mani
Demurrage tier 3: 4%

Demurrage calculation:
Tier 1: 50 000 mani at 1% => 500 mani
Tier 2: 100 000 mani at 2% => 2 000 mani
Tier 3: 50 000 mani at 4% => 2 000 mani
Total demurrage: 4,500 mani

It can be taken into consideration to have a top demurrage tier with 100% demurrage. Psychological and behavioural impact of the existence of such a tier should be examined before this is implemented however, as it creates a strict upper limit on the amount of mani that can be accumulated.

Orthogonal parametrization

Obviously, one of the crucial choices to make is what numbers to assign to the guaranteed income, demurrage and other variables.

Reminder on abbreviations and their units:
GI: Guaranteed Income (mani/time)
D: Demurrage (percentage/time)
SAB: Stabilized account balance (mani)
DFB: Demurrage Free Buffer (mani)

For now, let's assume that GI and D are applied **every month** and that any surplus income on top of the GI is spent.

By definition, when the demurrage on the balance minus DFB equals the basic income, the SAB is reached:

$$SAB = (GI / D) + DFB$$

We can redefine SAB as GI multiplied by a constant:

$$SAB = \alpha \times GI$$

α is a constant, which is called the "run ahead factor". The higher α is, the longer it takes to reach SAB. It could be interpreted as how much of a "head start" people can have in the system, simply by having an older account.

Similarly:

$$DFB = \beta \times GI$$

β is a constant which could be called the “safety factor”. It is conceptually equal to the number of “wage cycles” that are reserved for emergencies.

For example, if β is set to 6 and a GI is again set to 2 000 mani, there is no demurrage required on the first 12 000 mani. It also means that, assuming the account holder earned *less* than they spent, no demurrage would be required for at least 6 months.

Substituting in the first formula, the following is obtained:

$$D = 1 / (\alpha - \beta)$$

Interestingly, it becomes clear at this point that the currency itself doesn’t have a “natural” value. GI can arbitrarily be set to “1”, “1 000” or any random number and SAB and DFB would follow (scale) linearly.

Another interesting thing to note is that, with time-related variables, this formula can also have an arbitrary **scale**. Simply put, the frequency of GI or D (once per month or once per week) doesn’t matter, it is the fraction α / β that will determine how “fast and far” people can accumulate within the system over a set number of cycles. It doesn’t matter if the cycle is set to months, weeks or similar.

If for example if

$\alpha = 12$

$\beta = 3$

Then (arbitrarily) setting

GI = 1 000

The system parameters become:

D = 11%

DFB = 3 000

SAB = 12 000 (which is approached asymptomatically)

This demonstrates that it is possible to substitute the GI and D parameters (which seem rather arbitrary) with more intuitive time-based parameters.

Variable parameterization

In both regular parameterization (GI/DFB/D) or time based parameterization (GI/α/β), there is a possibility to **vary** these parameters instead of fixing them to a specific number.

The reasons for doing so are in fact quite clearly policy decisions that could further ameliorate specific properties of SuMSy. One of the reasons to actively pursue this could be to ensure price stability.

There are a lot of options to explore here:

- The initial account balance for new accounts could be non-zero. This would help to create an incentive for users to open an account.
- α could be made to increase as more people adopt the system. This ensures that early adopters cannot “run ahead” too much.
- GI itself could be designed to be derived from the (individual) velocity of mani. This could have a large impact on behaviour however.
- GI could also be designed to scale with the adoption of SuMSY, effectively incentivising users to spread usage.

Mathematical exchange rates

It is imaginable that a geographically diverse parameterization of SuMSy implementations could arise, leading to the question of how to deal with exchange rates between these geographical zones. This is comparable to the exchange rates between currencies that exist today. Due to the mathematically controlled size of the mani stock, in comparison with the higher volatility of the money stock, it is possible to mathematically calculate exchange rates.

The SAB defines the average money stock per capita in a region where consistent parametrization of SuMSy is implemented. This SAB could be used as a basis to calculate exchange rates.

If region A has SAB_a for currency $mani_a$ and region B has SAB_b for currency $mani_b$ then the exchange rate between region A and B can be calculated as follows:

$1\ mani_a = (SAB_b / SAB_a)\ mani_b$

The advantage of using a mathematical exchange rate is that it reduces complexity when transferring mani between agents which use different parametrization. The exchange rate can simply be calculated at the time of transfer. When there is volatility of exchange rates an extra layer of exchange agents needs to be added which destroys $mani_a$ from the account being transferred from and creates $mani_b$ (according to the current exchange rate) on the receiving account.

Whether mathematical exchange rates would be workable in real life economies does however require more research.

Multiple/shared accounts vs demurrage

In a SuMSy implementation that allows for multiple accounts per person or accounts shared by multiple people, a question may arise on how to calculate demurrage. The most straightforward way to do this, is to keep track of who is “responsible” for which amount and to calculate demurrage on the aggregate of all mani that is associated with a “core” account that is tied to a single person.

It would be equivalent to say that **multiple accounts per person or shared accounts are simply "virtual views" on the primary accounts** and **demurrage is only calculated on the (non-virtualized) primary account**. Only when mani is actually transferred to another person, does the requirement to pay demurrage shift.

The private sector can offer several products in this segment with specialised functionalities, depending on the needs of the account holders.

Organisations and companies

One could make the remark in the section above that "shared accounts" become very similar to the concept of "financial stakes" in a company, which can be a cooperative or another known legal structure. When mani is (virtually) transferred to a shared account, it remains property of the original owner until something is done with it by the organisation that controls the "virtual account". This implies it would also be much easier to allow withdrawal from such a shared financial structure, thereby increasing the potential benefit of a market based system.

A few core questions would determine what type of cooperative/company/organisation such a shared account would reflect. This would include choices like the financial requirements for a share, benefits from co-ownership, the way decisions are made and how risk is distributed. A full SuMSy implementation could implement many of such options for shared accounts, allowing quick and easy ways to set up organisations, cooperatives and various kinds of companies.

This aspect provides opportunities for the private sector to create products which cater to the needs of specific types of organisations.

Large acquisitions (money flows & contracts)

A very common question is how large transactions, typical of the "standard" monetary system, would work. The most obvious example would be **how to buy a house** without having the money at hand or a (large) debt being created. Accumulating the required sum would be hard due to demurrage and the classical notion of bank loans does not exist in SuMSy.

This situation is usually looked at from the perspective of the buyer but can best be answered from the perspective of the seller. Receiving the entire sum for the sale of the house is not desirable from the perspective of the seller due to the demurrage which would be charged on that sum. It can be argued that the sale is done in order to make another large purchase but this just transfers the problem to the next seller. Too often, a seller will end up with a large amount of money in their account which can not immediately be moved elsewhere.

The natural approach for large financial commitments in SuMSy is to implement so-called "money flows", which are really **recurring payments** similar to down payments on a mortgage, without the bank as an intermediary. Instead of transferring large amounts of mani, a commitment is made to transfer a smaller amount at regular intervals over a specific amount of time. This would simply be covered by contracts which can be (digitally) embedded into the system itself, although this is not required for it to function. As long as a contract exists and there is a functioning legal system, that would be enough to enforce it, as evidenced by many real world examples.

Large transfers of mani would most likely be transformed into flows over time, thereby spreading risk over time and reducing large shocks to the system due to liquidity problems

In this way, SuMSy starts truly functioning as a "utility", similar to electricity or water. Instead of requiring large (and inefficiënt) storage solutions, a pipeline system is put in place.

Smart contracts could play a role here to ensure payments are executed or, in case of non payment, the necessary measures are taken. This could again be an opportunity for the private sector to offer services.

Risk/insurance

Risk of the type that is normally insured against, like accidents or calamities, has similar properties to large acquisitions in that it implies situations which need much larger amounts of mani than may be available to a person at a single moment.

An interesting solution here would be to **allocate** a certain percentage or fixed part of a primary SuMSy account to **risk insurance**. Essentially, a certain amount of mani is made available for calamities. If all these risk allocations are bundled and administered by an "insurance cooperative", it can be used to address any calamities that occur for its members.

Note that it is *not* necessary to set up recurring payments (money flows) in this case! The risk allocations do not actually get transferred until they are effectively needed. This would provide the system with very interesting properties:

- The mani made available for calamities can easily be very large. This is appropriate for e.g. natural disasters which could require a very quick allocation of enormous resources.
- As this system only spends what is needed to address the damage, it is maximally efficiënt.

Note that this insurance system still requires damages assessors and insurance fraud detection to function properly. It would also need software to manage these allocations. Another opportunity for the private sector.

Funding public services

Public services are paramount for the functioning of a well balanced and fair society which maximally supports people's well being. Moving these services towards the private market does not tend to pan out well, as can be observed with the healthcare system in the US and train system in the UK.

In the current system public services are funded by taxes. Among proponents of (neo) liberal ideology, which aims to reduce the role of the state and the associated taxes, there is quite some resistance against leveraging taxes for public services. Inadequate income from taxes to sufficiently fund qualitative public services often also lead to sub par performance of these services. Combined with the absence of agency as to where a tax payer's money goes, this leads to even higher resistance against the levy of these taxes.

Two solutions for funding public services are put forward.

Public services as 'risk/insurance'

Public services can be seen as something 'insured' by society. Allocation of money for these services is then handled in the same way as insuring against a risk. A certain percentage or fixed amount is made available for these services and is taken out of people's accounts when the expense for the services are made. To ensure adequate funding a minimum percentage/amount, preferably more than is needed under normal circumstances to account for crisis situations, can be required by the governance model. This percentage/amount can then be voluntarily raised by the individual if so desired.

To increase the sense of agency, SuMSy account holders could be allowed to designate this surplus percentage/amount to designated public services of their own choosing.

In game simulations, there is a notable tendency to voluntarily donate mani to public service projects, rather than to letting it be destroyed by demurrage. This behaviour does depend on the background of the players however. Players with a more economical background, like economics students and people involved in cryptocurrencies, express this tendency far less.

Funding by demurrage

Public services can also be funded directly by the demurrage which is collected from the SuMSy accounts. In order to ensure adequate funding during the run in and in case of crisis situations, public services would attain a special status. If not enough mani is received from demurrage to fund their activities, they receive the license to create the extra mani needed. If more mani comes in than is needed, the excess is taken out of circulation, thereby replacing the function of destroying mani and maintaining a stable mani stock, which is performed by demurrage in the base system.

All expenses made for public services should be made publically available in order to reduce the chance of fraud, which could be a consequence of the license to 'print mani'.

Under normal circumstances the cost of providing public services should be fairly stable from a 'per capita' perspective. Only during a crisis, or when a large one off investment is needed, will the expenditure rise significantly.

Injecting mani this way raises the maximum mani stock and at first sight it may seem that this would introduce an inflationary force in the system. This can only happen when there is an ever increasing rise in public expenditures per capita (PEPC). This is very unlikely to happen however. Public expenditures can only rise indefinitely if either ever more people are employed for public services or public servants receive constant pay raises. The first is impossible because there is no infinite population available to be employed. The latter won't happen because it would be visible in the expenses and lead to public protests. Furthermore demurrage charges would rise for those on the receiving end of the increasing wages.

Increases in expenses due to crises or large one off investments would temporarily raise the mani stock but would also coincide with higher economic activity. Once expenditures return to normal the excess mani is removed from the stock by destroying excess funding.

mani stock is elevated to a higher level though. When PEPC is paid out at the same time as GI is deposited on accounts, then the maximum mani stock becomes:

$$\text{max mani-stock} = (((GI + PEPC) / D) + DFB) * N$$

To increase the sense of agency, it could be made possible to allow SuMSy participants to choose one or more public services (education, healthcare, public transport, ...) where their mani should go.

Identity & fraud

A core problem in any financial system is the risk of all sorts of fraud. While many types of fraud can be addressed by the technical protocol and ledger design (see below), SuMSy has specific and obvious risks related to identity fraud.

Specifically, it would be very profitable to be able to create more than one primary SuMSy account, as this would allow someone to accrue more guaranteed income and avoid demurrage through (multiple) demurrage free buffers. In the case of tiered demurrage, this problem gets worse.

The only reasonable approach, so far, to this problem is to introduce some form of independent identity auditing into SuMSy. Simply put, candidates for SuMSy accounts would need to prove their identity to an independent party, which will check this

identity and the existence of other accounts under this identity. This auditing party can then “sign off” on a newly created account.

Identity auditing and fraud detection are possible in both a centralized and decentralized implementation, see below.

Having several competing private organisations providing the service of identity auditing and/or fraud detection would not only create opportunities for private businesses but would, because of the diversity of methods, strengthen fraud detection within the system.

Simulations

A simulation tool for money supply analysis in both the current monetary system and in SuMSy has been implemented[51] and is described in an accompanying paper[52]. These simulations have been written as tools to analyse systemic money flows between major aggregates in an economic system. Further development of these tools to improve their usefulness in economic analysis is planned.

In the context of the Loreco[53] project work is being done to implement agent based models with the goal to compare economies which use the standard monetary system to economies which use the Sustainable Money System. The work is in its beginning stages.

Technical implementation

Since SuMSy has fairly straightforward requirements, it can be implemented in various ways. The main choice to make is where to store participant’s ledgers.

If stored in a **central ledger**, the design would match that of a hypothetical centralized “Central Bank Digital Currency” as described in the Central Bank of England’s discussion paper. It is however also possible to have a fully **decentralized ledger** within SuMSy. Conceptually, this would function as if every participant is their own bank. Both options are detailed below.

The largest difference between a centralized and decentralized ledger design would be its vulnerability to censorship, which can take different forms:

1. Intentional censorship, by making the central service unreachable. This could occur as a governmental intervention, on the level of DNS (e.g. by legal ruling), etc.

[51] https://emu-simulation.herokuapp.com/
[52] https://www.academia.edu/39995035/Money_Supply_in_a_No-Growth_Economy
[53] https://www.esf-vlaanderen.be/nl/projectenkaart/loreco

2. Unintentional censorship, for instance due to networking issues or a technical failure at the central service.

Political control over the central ledger would additionally allow for all sorts of problems. Essentially, the SuMSY parameters could be changed or even inverted at will. Access to individual ledgers would of course allow for very intrusive and difficult to prevent governmental abuse.

Worse still, intentional censorship can be made to resemble unintentional censorship, a technique that is used for example in the Great Firewall of China[54].

Remarkably, technical failures at payment providers are also quite common[55].

Overall, there are good reasons to consider a decentralized approach.

Importantly, the technical requirements for neither option (centralized/decentralized) require a blockchain if the pseudonymity requirement is dropped. While there are obvious problematic use cases for a monetary system that allows fully anonymous payments[56], it can also be observed that it is in fact not a social requirement to have full anonymity between two parties in a transaction. Quite the opposite in fact, in all digital transactions in the current payment ecosystem, it is possible to see e.g. the name of the account holder.

To understand the proposed approaches, the concept of **ledger auditing** is crucial. Since the parameters of SuMSy are (presumably) agreed upon, the auditing of an individual ledger would consist of checking if:

1. Guaranteed income was deposited correctly (timing and amount). Note that mani can simply be created and cryptographically signed by the controller of the ledger for this purpose.
2. Demurrage was applied correctly. (Implicitly: destroyed mani is not found anywhere else in the network, etc.)
3. The ledger itself is correctly signed and associated with an individual that has no primary accounts elsewhere.
4. Transfers on the ledger match a symmetric transfer on a different ledger.

More complicated anti-fraud and anti-monetary laundering checks could be applied as well during a ledger audit.

[54] https://www.howtogeek.com/162092/htg-explains-how-the-great-firewall-of-china-works/
[55] https://www.theguardian.com/money/2019/mar/04/uk-banks-hit-daily-by-it-failures-halting-payments-says-which
[56] https://thenextweb.com/hardfork/2018/11/26/bitcoin-money-laundering-2/

Centralized

In the case of a centralized SuMSy, there only needs to be one central server that stores and controls the core copy of every ledger. mani can simply be created with a digital signature and deposited at will on SuMSy accounts, much like pure fiat money would be.

As suggested in the Central Bank of England proposal, it would also be possible to introduce (commercial) Payment Interface Providers as an intermediate layer to ensure some form of pseudonymity. These providers would then be subject to a regulatory framework not too dissimilar to that of commercial banks.

In fact, as long as these payment providers are subject to **ledger auditing**, they could generate GI mani themselves and the central service (Central Bank) would only need to execute regular and systematic auditing. This could be considered a **"semi-centralized" SuMSy**, where the creation of mani resembles that of "bank money" (which is currently generated from loans).

Decentralized

A fully decentralized SuMSy is effectively a logical continuation of the "semi-centralized" SuMSy as described above. Every participant in SuMSy simply becomes their own bank and custodian of their ledger.

To allow checks on the internal consistency of a ledger, **forward signing** would have to be added. This means that each new transaction includes a **cryptographic signature** based in part on the **last transaction on the ledger**. If implemented well, it becomes impossible to erase, change or add transactions to a ledger without destroying its internal consistency.

When a transaction is made, the systems of both transaction partners execute ledger audits on their mutual ledgers. There are different ways in which this could work:

- The ledger audit could be delegated to a "neutral" 3rd party that is trusted by both participants. This 3rd party would gain full and regular access to the ledger and digitally signs its validity after each transaction. If the 3rd party is trusted, the most recent audit signature could already be considered "sufficient proof" (see below) to allow the transaction to move forward.
- Even peer-to-peer ledger auditing is feasible to a certain extent. The only part that would be difficult to implement is step 3 of the audit, namely checking someone's identity and the possibility of a second (or third...) primary account for the same identity.

Sufficient proof?

One could argue that most current financial transactions do not in fact guarantee validity of the transfer at the time of payment, cryptographic or otherwise. Cash can be forged, credit cards can turn out stolen, even digital bank transfers can take a few days to effectively clear and can thus fail well after the contractual transaction was "completed".

In many ways it can be argued that monetary systems simply do not seem to need to completely exclude fraud to be operable. One way to model this is to think of fraud in the framework of **Nash equilibria**. Such a Nash equilibrium would occur if both participants have nothing to gain from changing their strategy (to commit fraud or not).

Even though the potential gain may be large (and Pareto efficient[57]), if the risk of discovery is high enough and the reputational, legal or financial penalty is large enough, the Nash equilibrium is simply "do not cheat".

The answer to allowing the possibility of fraud in a monetary system then becomes a question of pushing the Nash equilibrium as much as possible towards a cooperative mode (no fraud) for both participants.

The link with ledger auditing becomes immediately obvious: If a SuMSy participant manipulates their ledger, the chance of such fraud getting discovered increases with every audit, especially if the ledger auditing technology is allowed to evolve. Once a ledger is found to be "tainted", this would become obvious during nearly every transaction, which would cause huge social and/or legal repercussions.

Added to this, there is no "scarcity driver" in SuMSy, due to the guaranteed income. Combined with ledger auditing, the Nash equilibrium may tend much more towards cooperation rather than fraud compared to the standard monetary system.

To increase efficiency and reduce 'down time' of the system, strict peer to peer transactions could be made when no access to an auditing service is available. Depending on the functionalities offered, this could come with full peer to peer auditing functionality or with restricted auditing functionality, for privacy reasons, and security warnings.

A diverse and competitive landscape of trusted parties which provides these functionalities can emerge. Their diversity would strengthen the fraud detection mechanisms and thereby helps to push the Nash equilibrium even farther towards "don't cheat".

[57] Pareto efficient means that the situation can not be modified without inconveniencing one of the participants. Successful fraud is of course "maximally convenient" for the fraudster.

Positioning

Considering the current state of affairs of the monetary and financial system and the behavioral influences these have on both an individual and societal level, SuMSy is suggested to be considered as a mature alternative design proposal for a Central Bank Digital Currency (CBDC).

Due to the fact that the creation of a SuMSy based CBDC might be central bank, and therefore regionally, specific, localized implementation scenarios have been taken into account.

Money is still used to identify the national currency where the central bank is active, mani-CBDC is used to identify a SuMSy based CBDC.

Introducing the system

It is of course not trivial to introduce a completely new monetary system. Therefore possible transition paths, which can have a range of end goals, need to be considered.

In all transition paths it is recommended to maintain parity between money and mani-CBDC as much as possible. This can be cemented in monetary policies and legislation.

A couple of possible transition paths are presented. These are not exhaustive and serve as a base for dialogue.
The numbers used are purely for example purposes and are in no way definitive.

Incremental voluntary introduction without legal obligation for acceptance

Assume the following end goal for a full SuMSy implementation:

- Guaranteed income: 2 000 mani-CBDC/month
- Start capital: 5 000 mani-CBDC
- Demurrage free buffer: 25 000 mani-CBDC
- Demurrage: 2%

Setup

mani-CBDC can be introduced incrementally in the following way: everyone receives a personal, inactive account with, for example, 5% of the starting capital, being 250 mani-CBDC in this case. This capital sits in the account until it has been activated.

Activation

Upon activation, account holders sign in at a certain commitment level. The starting commitment level is 5%. The commitment level determines the maximum percentage of the price people are allowed to pay in mani-CBDC, and the minimum percentage they are required to accept in mani-CBDC.

The exact percentage which is used is always the lowest commitment level of the two parties participating in a transaction. Someone who has committed for 5% can only pay 5% of the price of an item in mani-CBDC, regardless of how much the seller wants to accept. The other way around, a seller who commits for 5% will only need to accept 5% of the price in mani-CBDC, regardless of the commitment level of the buyer. This protects participants with a high commitment level from 'mani-CBDC dumping' by users with lower commitment levels.

All parameters, except for demurrage percentages, are scaled down to the commitment level of the account holder. With the parameters for the full implementation used in this example this would result in:

- Guaranteed income: 100 mani-CBDC
- Start capital: 250 mani-CBDC
- Demurrage free buffer: 1 250 mani-CBDC
- Demurrage: 2%

The account is now activated and can be used freely with others who have activated their SuMSy accounts.

Increasing commitment

The account holder can opt to increase their commitment to mani-CBDC at any time. Raising the commitment level scales the parameters up to the new commitment level. This also results in depositing extra start capital on the account, equal to the amount which corresponds with the new commitment level minus the amount which corresponds with the previous commitment level. Raising the commitment level to 20% results in the following:

- Guaranteed income: 400 mani-CBDC
- Start capital: +750 mani-CBDC
- Demurrage free buffer: 5 000 mani-CBDC
- Demurrage: 2%

Effects and conditions

Due to the built-in reciprocity, abuse of the account (spending without willingness to receive) is excluded.

In order to have a successful start, it is important to assess which initial services or goods would be sufficient to entice people to participate in mani-CBDC. Being first is practically risk free because the people spending mani-CBDC will automatically accept an equal percentage.

Conditional commitment

A supplier might say that they are interested in participating in mani-CBDC, but only if they can, for example, purchase food, beer and web services. That way, they could commit without actually activating their account until these conditions are met. They could even have their initial commitment level be dependent on the commitment level of the providers of these goods or services.

Especially in the beginning, commitment would be met for entire economic networks at a time, which would lead to activation of groups of accounts which make up a viable economic sub-network.

In order to make this option available, services that support this functionality would have to be implemented.

Balanced introduction

There is a risk that suppliers of goods and services, who adopt the system on a voluntary basis, are overwhelmed by a massive influx of mani-CBDC when the adoption rate of consumers outpaces the adoption rate of suppliers by a significant rate.

This can be countered with the following two strategies:

- The suppliers can set their commitment level low enough in order to avoid having too much influx of mani-CBDC which they can not spend. Bilateral agreements in the supply chain could then be made with the goal to raise the commitment level of the entire supply chain, thereby increasing the system wide adoption rate.
- By providing the option for ‘conditional commitment’ as described above.

Introduction with legal obligation for acceptance

If mandatory (partial) acceptance of mani-CBDC were written into law, as is currently the case for money, the introduction process would be easier. Acceptance would be widespread and consumers would be able to spend their mani-CBDC everywhere.

A similar path as without legal obligation can be taken, where a minimal commitment level can be written into law. But because of the widespread acceptance, a different introduction strategy can also be adopted.

As long as acceptance of mani-CBDC is restricted to the UK, international supply chains have to be taken into account. It would not be acceptable that businesses would not be able to pay their foreign suppliers due to a disbalance of available money compared to

mani-CBDC. This is a situation which could occur with a high level of disintermediation, where the population switches to mainly using mani-CBDC.

One obvious solution for this would be the ability to exchange mani-CBDC for GDP but that comes with its own set of challenges as described below.

The most efficient way to avoid this situation is actually built into the design of SuMSy itself. By tweaking the parameters in such a way that the mani-CBDC stock would be sufficiently large to run the local economy of the UK but not so large as to completely take over the existing money system. Calculations would have to be made on a regular basis to determine the optimal size of the mani-CBDC stock for an evolving economy. Different combinations of values of these parameters can be constructed which all result in the same SAB, and thus in the same mani-CBDC stock, but the different sets of parameters would all result in different behaviour by their account holders. GI and, optionally, DFB influence the feeling of financial security, demurrage influences velocity of mani-CBDC.

When the use of mani-CBDC becomes more widespread throughout the world, the mani-CBDC stock can be expanded to reflect this.

Introduction with the intent to fully switch to mani-CBDC

When the intention would be to fully switch the monetary system to a SuMSy based mani-CBDC, and thus transition away from the current debt based monetary system we know today, the following path can be followed.

The start of a SuMSy mani-CBDC would be a “regular” 100% reserve currency, whose value would be pegged to the original currency. Regular money could be exchanged for (the early version of) mani-CBDC, which would allow the effective destruction of the original money by the central bank, keeping the total (money + mani-CBDC) stock equal. From there on, the introduction strategy would require a simultaneous and controlled build-up of both guaranteed income and demurrage fees. One could argue that this is in fact not dissimilar to QE with a negative interest rates on surplus reserves, which is already a real and acceptable monetary policy, albeit the recipients would be the population at large.

In this scenario, a gradual but final transition away from debt-based finance would also become possible, as contractual debt obligations can simply be converted into money flows whenever the total mani-CBDC stock + guaranteed income allows it. Some debt may simply need to be written off.

Exchange in the opposite direction (mani-CBDC to money) would have to be restricted while standard credit in money can still be obtained in order to prevent a high rise in loans that could then be paid off with GI. A scenario which would easily lead to hyperinflation.

This scenario would however be hard to implement for the UK only due to the money requirements for international trade. Worldwide cooperation between central banks would be a requirement for this transition path.

Introduction through pilots

Instead of immediately trying to go for a widespread introduction, an initial pilot can be executed in order to study the effects of the introduction of a SuMSy based mani-CBDC. 3 different scenarios can be considered:

- A small pilot with 400 individual actors participating and 15 commercial actors, similar to a small local complementary currency.
- A medium pilot with 1500 up to 5000 individuals and up to 800 commercial actors, similar to Bristol Pound.
- A large pilot with up to 20.000 individuals and up to 4000 commercial actors, similar to Sardex in Sardinia.

When working with pilots, the possible effects of the smaller scale need to be taken into account due to the fact that the currency will adopt some aspects of a local currency which might or might not be transferable to a larger scale. It is also advised to determine a minimal viable size for a working (partially) SuMSy based economy.

A pilot for a local SuMSy based complementary currency, funded by the European Social Fund, is currently being set up under the Loreco project[58].

Interaction between mani-CBDC and money

In the context of exchanges between mani-CBDC and money, it is important to take several considerations into account:

Exchanging money for mani-CBDC between private agents has no effect on either the mani-CBDC or the money stock since mani-CBDC would be used as it would in the purchase of any other product within the UK. The transaction transfers mani-CBDC from the account of the seller to the account of the buyer. In other words, the aggregate mani-CBDC stock remains unchanged. The money goes in the other direction and also leaves the money stock unchanged.

Even when there is no value parity between money and mani-CBDC, it is very unlikely that mani-CBDC would be bought for speculative purposes due to the design of SuMSy. Accumulating large amounts of mani-CBDC would only lead to high demurrage charges. Without parity there is however the risk that mani-CBDC could lose value relative to money. And even with official parity there is always the risk that an ‘under the counter’ market emerges where the official parity is not respected. Demurrage charges might counter this effect and this effect has not been observed with the demurrage based

[58] https://www.esf-vlaanderen.be/nl/projectenkaart/loreco

scrip money used in Wörgl[59] in the 1930's nor with the Chiemgauer[60], also a demurrage susceptible currency. But these are local currencies without a built-in GI. Therefore further research through simulations, games or small scale pilots is advised here in order to discover the real world effects.

A different story unfolds when mani-CBDC would be used to directly[61] pay off principal bank debt. The mani-CBDC used would be destroyed, in order to eliminate the money debt from the books as is the procedure with paying off bank debt, and the mani-CBDC stock would temporarily decrease while leaving the money stock untouched. In essence, 1 mani-CBDC would be transformed into 1 money which is immediately destroyed along with the corresponding debt, thereby avoiding the destruction of 1 money which was already in circulation. However, this would create an incentive for lending money and thereby increase the money stock, potentially leading to high inflation.

Allowing this type of transformation of mani-CBDC into money is strongly advised against since it would allow for an uncontrollable increase in money stock which would inevitably lead to hyperinflation.

If current commercial bank lending, in the form of money creation from debt, were to be intentionally phased out, direct payment of principal bank debt with mani-CBDC could possibly be allowed. This means no new money can be created through lending while the existing loans can be paid off with mani-CBDC as described above. This would gradually eliminate all existing bank debt from the balance sheets of banks while preserving the money stock when principal debt is paid for with mani-CBDC. Payment of principal bank debt with money would still diminish the money stock. This would eventually result in a residual money stock, which exists as equity. The fact that no new money can be created with loans eliminates the inflation risk which exists in a scenario where money creation through loans would still be possible.

Central banks then have two options:

- Completely transition to a mani-CBDC only system by doing one of the following:
    - Pull the residual money stock out of the economy by selling off the purchased debt they have on their balance sheets. This debt would obviously have to be paid for with money. The question is whether central banks have enough debt on their balance sheets in order to eliminate all of the residual money stock.
    - Issue a monetary policy which transforms all money into mani-CBDC. This would potentially raise the mani-CBDC stock above the theoretical maximum but demurrage makes sure this surplus is gradually taken out of circulation.

[59] http://www.lietaer.com/2010/03/the-worgl-experiment/
[60] https://en.wikipedia.org/wiki/Chiemgauer
[61] When exchange between mani and money is possible, these debts can always be indirectly settled in mani if enough money can be collected that way.

- Transition the credit service of banks to full reserve banking as has been described in the revisited Chicago Plan[62], thereby maintaining two parallel monetary systems and increasing monetary plurality in the economy. Increased monetary plurality has been touted as adding resilience to economic systems[63] by economists like Bernard Lietaer.

It is obvious that a full transition to CDBC can not be done by the UK alone and would require international cooperation between central banks. Which option would be best for the economy and human well being invites further research.

New roles for commercial banks

Collaboration by commercial banks is one of the key points of success for the introduction of a mani-CBDC. Therefore commercial banks need to get sufficient new opportunities to counteract the potential losses resulting from disintermediation.

With the low interest rates of today, which are not likely to change in the short term, commercial banks are already forced to look at new business models. What used to be their major source of income, providing credit, is hardly profitable in the current day banking world. The transition is already underway. Banking fees for holding accounts are on the rise, negative interest on savings accounts are being considered and some innovative players, like the fully online Aion bank in Belgium, are offering subscription packages that include a whole range of financial services.

With the introduction of SuMSy a whole new range of services can be developed. From helping individuals and organisations manage their mani-CBDC streams over helping to negotiate peer to peer contracts for larger purchases to developing entirely new investment schemes which are fully compatible with a long term, value oriented SuMSy economy. With the availability of a GI there is also a high likelihood that more people will be able to afford these services than is the case today, thereby increasing the customer base for these services. If commercial banks would find that these new services are more profitable/sustainable than the classical credit services they offer today, they might move away from offering those credit services voluntarily. That would result in a market driven disintermediation by commercial banks themselves. This shows that, for the commercial banks themselves, full disintermediation would not necessarily be a bad thing.

Full disintermediation would however mean the end of credit services as we know them today and would have an impact on the economy at large, especially on the international markets. As mentioned above, SuMSy based mani-CBDC would flow through the economy differently from money due to its design. It is feasible that large

[62] https://www.imf.org/external/pubs/ft/wp/2012/wp12202.pdf

[63] https://www.researchgate.net/publication/318878420_Book_Review_-_Money_and_Sustainability_The_Missing_Link_A_Report_from_the_Club_of_Rome_-_EU_Chapter_to_Finance_Watch_and_the_World_Business_Academy

amounts of mani-CBDC for purchases or investments would no longer be needed if businesses get the time to transition to these new business models.

This does not necessarily mean that credit services are no longer needed. Just as large purchases can be done in a peer to peer fashion in SuMSy based mani-CBDC, with optional support from contract brokers, so could credit provision also become a peer to peer aspect of mani-CBDC. Holders of large accounts would benefit from offering credit to those in need for zero or even negative interest. It can even be imagined that everyone who holds demurrage susceptible mani-CBDC would be willing to offer credit to those in need. Getting zero interest is still better than paying demurrage.

Services could be developed which matches these credit providers with those who are in need of mani-CBDC, thereby providing new opportunities for banks or other fintech organisations to serve as intermediaries between both parties.

Although the full impact of such a transition to the world economy can not be fully predicted, it is clear that possible solutions are available within the context of the SuMSy model. This aspect would be a topic for further research.

The impact of a fully digitised currency

As noted in the discussion paper of the Central Bank of England, the disappearance of cash could have a negative impact on inclusivity when people do not have access to smartphones, tablets or computers that run the software needed to use the currency.

Technically this could be avoided by developing the equivalent of bank cards which can be issued to people who don't have access to the necessary technological tools. But this does not solve the problem of reaching people who do currently not hold bank accounts. This issue needs to be taken into account when rolling out any fully digital currency to the population at large to make sure everyone is included.

Another aspect of a fully digital currency is the aspect of anonymity. A tradeoff needs to be made between security and anonymity here. It is technically impossible to have both. When working with trusted third parties which handle identity control, which is a necessary aspect of SuMSy, high levels of privacy protection can be implemented however. One could for example hold a pseudonymous key which is issued and signed by the trusted third party and use that as the identifier. All identity checks would then go through the trusted third party.

Conclusion

Fulfilling design goals

Support a resilient payments landscape	The proposed designs support a resilient payments landscape by offering the private sector plenty of opportunities to offer payment services. This guarantees a non monopolistic payment landscape.
Avoid the risks of new forms of private money creation	This would need further research. It has to be noted however that SuMSy currencies could potentially live alongside a plethora of other currencies without their stability being jeopardised. This follows from the fact that the mani-CBDC stock is not dependent on credit provision, as is the current money system. New, possibly private, currencies might even be supportive for financial stability when they serve specific purposes like the Saber[64], an educational currency which was proposed by Bernard Lietaer or the Fureai Kippu[65], a currency used for elder care in Japan. Furthermore, successful new currencies arise from a need. Research into the needs that would still remain unfulfilled in a full or partial SuMSy economy would create more clarity on this topic.
Support competition, efficiency and innovation in payments	SuMSy would provide ample opportunities for the development of payment services, fraud detection tools and privacy services in order to foster a healthy market with a diversity of players.
Meet future payment needs in a digital economy	No one can predict the future but as long as payment needs are quantitative (vs qualitative), mani-CBDC offers plenty of options for the development of new tools to fulfill these future needs.
Improve availability and usability of central bank money	The GI would clearly increase availability of mani-CBDC for all those who hold an account. Making sure accounts are available to as many people as possible requires a variety of easily usable and accessible tools, including low tech solutions which can be made available to those who do not have access to computers, tablets or smartphones.

[64] http://www.lietaer.com/2010/01/the-saber/
[65] https://en.wikipedia.org/wiki/Fureai_kippu

Address the consequences of a decline in cash	When it is achieved to make the new mani-CBDC available to as wide a range of people as cash is today, one consequence of this decline of cash would already be addressed. A consequence that can not be countered however is the behavioural difference in regard to spending which occurs when using a different payment system[66] . This effect also needs to be taken into account with the development of these payment services by the private sector because they could be designed to intentionally induce a specific type of behavior[67].
Building block for better cross-border payments	If further research would indicate that the above mentioned mathematical conversion rates between differently parameterized SuMSy implementations are viable to use in real world situations, cross-border payments could be executed faster and more predictably than is the case today.

Being compliant to design principles

Reliable and resilient	**Resilient:** a decentralised implementation of the ledger would have the highest level of resilience. Liquidity risk is ruled out by design. **Secure:** although no ironclad security can be enforced, the fact that constant improvement in fraud detection would lead to a “do not cheat” Nash equilibrium, it can be stated that security will at least be at the level of physical cash, which has proven to be adequate. **Available:** availability would be highest with a decentralised design. For

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https://www.researchgate.net/publication/24099075_Effects_of_Payment_Mechanism_on_Spending_Behavior_The_Role_of_Rehearsal_and_Immediacy_of_Payments

67

https://www.researchgate.net/publication/340005851_Influence_of_Mobile_Apps_on_Household_Saving-Spending_Behavior

	maximum availability a trade off with security might have to be made. **Scalable:** a centralised design would need to be very efficiently implemented in order to process high volumes of transactions. The more decentralised the design is, the higher the transaction capacity of the payment network becomes. **Compliant:** more research needs to be done in this area. **Private:** compliance with GDPR can be easily implemented, especially when working with trusted 3rd parties.
Fast and efficient	**Fast:** a tradeoff between speed, privacy and security will need to be made. Very fast speeds can be achieved when pure peer to peer transactions are allowed but this will have a negative impact on either the privacy (when full auditing of the ledgers of both parties is executed) or security (when only minimal auditing is allowed). A mix of options tailored to the type of transaction and the need for speed, security and/or privacy would be best. **User friendly:** this is wholly dependent on the providers of the payment services. **Efficient:** more research needs to be done in this area. **Transparent:** more research needs to be done in this area. **Inclusive:** in order to be inclusive, easily distributable low tech solutions need to be made available.
Innovative and open to competition	**Designed around comparative advantage:** the design of SuMSy supplies central banks with powerful tools to help them reach their goals of price stability and a stable financial system while at the same time offering ample opportunities to the private sector to develop a wide

	range of services. **Open to competition:** competition on the market is inherently promoted due to the fact that a diversity of service providers would be beneficial for the stability and security of the SuMSy model. This win/win aspect is very likely to be a key driver in making sure the market is open to competition. **Interoperable:** an international standards body, like the IEEE, which defines a universal and extendible API for SuMSy based payment services is likely the best solution to ensure this. **Extensible:** the most advisable road to follow is that of the development in the internet protocol. New functionalities are constantly added while safeguarding interoperability and compatibility. The aforementioned API can best be regarded to be the foundation of 'the internet of payments'.

Supplemental advantages

SuMSy has the advantage of fulfilling a wide range of goals 'by design' rather than by continuous intervention, which results in a more stable financial system which is less demanding in 'maintenance'. As a surplus it comes with a range of additional 'by design' advantages which would be beneficial for society as a whole.