What is CoFi in practice?

In Slovenia, there is a system that the government runs a piece of software that allows all the businesses in the country to submit their invoices to the government. The government runs an algorithm to find all the loops. It takes the minimum amount from all the loops, calls that a set-off notice and sends that notice back to all those businesses.

At the end of the day, you submit an invoice to the government, and the government sends you your invoice back with a potentially lower amount. Now the amount you owe and the amount you are owed goes down. And that's the sort of default baseline. Informal Systems is re-implementing that system but in an optimized way using modern techniques that are privacy preserving.

Informal is building it on a blockchain substrate, so they can access not just the clearing of cycles but also for injecting liquidity from different sources because they want to be able to clear everything as much as possible, not just what's in loops. What do you do with everything left over? You still want to discharge that debt with the least amount of money.

Using the same algorithm or mechanisms from graph theory you applied to clear these loops, you can use them to find out the least amount of money needed and where it needs to enter the system to discharge the maximum amount of debt. It's the firms with negative net position who are injecting their own liquidity. Using MTCS guarantees maximum debt reduction for that amount of liquidity. This is a precision injection of liquidity exactly where it needs to go to optimize to discharge the most amount of debt. You can use this as a substrate to inject liquidity from any source.

So it could even be banks injecting dollars through loans, and it benefits them because now they are lending to individuals, but the network benefits and therefore fewer firms will go bankrupt and the overall risk level decreases. The banks will benefit too, although indirectly and after some time-lag. They can reduce their credit risk as they have more information they can depend on. Also more people might be eligible that weren't eligible before because there are mitigating factors in the risk calculus.

The Art of Exchange & The Science of Payments

- The Art of Exchange - How do we balance the payments graph?
- The science of payments - Network science and optimizing flows within these grafts

These two things are key to this new world of money and credit.

A sustainable system is one that has an effective representation of its environment internally within its structure, it encodes the environmental system that drives it.

Everything is running down in this universe. If you want to not run down, you need a model of where energy is coming from so that you can take advantage of it and build yourself up. That's what human beings and other organisms are doing, they encode internally in their structure models of their environment, so they can respond to and capture energy and store it to be able to use it later.

What's interesting about money and the payments graph is that it seems like that is one of the places where we as a society encode our world in the payments graph, a replication of all the activity we engage in. We do a really terrible job right now of actually representing the world we are embedded in and encoding it correctly, and that is leading to our un-sustainability and demise. However, if we can correct that representation a bit, it might be a necessary but not sufficient step to a more sustainable future.

This is why we have honed in on payments graph and network science to see what we can do to correct this representation of the world. In particular, try to make this problem of circular flows because so much of what's happening in organisms and sustainable systems are circular flows. Circular flow is a term from Schumpeter, and it refers to a whole economy at zero growth: every economic actor buys and sells the same things following their steady-state routines. Thus, a medium of exchange is not needed, only a unit of account is. A circular economy is something quite different, as we know, and clearing the cycles in the payment graph enables us to come closer to a perfect circular flow with only a unit of account.

You have a driving signal and energy from the sun it's coming into the earth, and it's going to bounce it. What is going to do on earth? If you want it to do something interesting, you have to trap it and make it move in cycles. That is what is happening inside all of us. You try to get the energy to flow in cycles before it dissipates out.

We want to do the same thing with the payments graph, try to trap the energy in cycles, so it can move in these loops before it's dissipated in some type of imbalance and maybe from that we can build up. A foundation of sustainability.

The Problem of Money

- Money is where the payments are
- Money is for payments

- Money vs Credit - money only needed so long as there are “imbalances” in the credit graph. Clearing vs. Settlement
- Why are there imbalances? The structure of power and production

Money is for denominating and discharging debt - unit of account for denominating debt and medium of exchange for discharging debt. Store of value for discharging debt elsewhere and later.

There is a distinction between money and credit. It is not the case that all credit is money. I might extend some credit to you, but you might not be able to use that to pay someone else. “It is easy to create money, the problem is getting others to accept it.”

The key is that money is only needed so long as there are imbalances in the payments graph. If there are no imbalances, and you can all net out credits with each other, than you don’t need any money. Money arises from this problem of imbalance. If we can focus on this problem of balance and map it out and make it explicit, we might have a better understanding of how much money we actually need.

Arguably this is the quality theory of money which is based in structures in the network, these cycles in particular.

The difference. Between money and credit also offsets the difference between clearing and settlement. Clearing is what we can do if there is balance, if you don’t need money we can off-set our debts with each other. Settlement is what we do with the leftover balances, we make payment.

Why are these imbalances present in the first place? We want to expose where the balances are, so we can work at this art of balancing the graph. The existence of the imbalances reflect the structures of power and production, so we can’t be naive to the existence of power and the very powerful states or interests we are up against. But by working together and collaborating, perhaps we can work up against that.

The problem of balancing the payments graph hasn’t been lost completely to history. The exchange fairs in the 16th century, they were balancing the graph not out of the goodness of their heart but for profit and pragmatic reasons. That balance came to an end. The Spanish-Genoese alliance entrenched a systematic imbalance we have been suffering ever since. But in the 20th century we have seen a few efforts, especially from Europeans, to assert we need to rebalance the graph.

Bancor the proposal at Bretton Woods based on EF Schumacher’s work on multilateral clearing. Bancor was a proposal to balance the payments graph. Thereafter, Europe was failing to recover because there wasn’t enough money to go around, there were all of these multilateral clearing system that allowed them to rebound. However, the US wanted the USD to be the global reserve currency. The Bancor system was too democratic. So they allowed it after the war to help Europe rebuild (especially Germany and Italy), but in 1958 they had already decided it would be shut down. From there on the system was replaced by the Eurodollar system of the last 50 years.

The Science of Payments: Money in Economics

- Most economics is blind to liquidity and problems of the payment system
- Game Theory ⇾ Graph Theory
- Why should banks get to do all the clearing?

This is some of the more interesting stuff we are working on, the network science of finding the cycles and do something about it and what you do with the stuff that’s not in cycles. And that is the interesting question which allows this work to connect to mutual credit, mesh credit and these other interesting mechanisms.

Framing the problem

Most economics is blind to liquidity and the problems of the payments graph. Economics grew up in parallel to this very advanced banking system and emerged in terms of theorizing about trade. They ignored the temporal dimension of credit component of all this and became blind to the problem of liquidity. Liquidity is a fundamental constraint to the payments graph, it derives from the imbalances in the payments graph and the needs to settle your debts.

The goal is to move us from a theory of game theory, rational selfish agents all competing with each other, to graph theory and network science. There is a lot we can do with this concretely and apply it to monetary economics in particular. Banks are already taking advantage of this between themselves. Every day the banks are doing clearing at the end of the day, netting out balances and saving themselves trillions in liquidity. These mechanisms are only available to the banks and financial markets, however.

Bankers, Blockchains, CoFi

- Bankers: settlement for thee, clearing for me
- Blockchains: Only settlement for everyone

- CoFi: Clearing and settlement for everyone

The bankers say we are going to do the clearing ourselves and everyone else will use our settlement rails. Blockchains emerge to see bankers taking advantage of trust and now provide open settlement for everyone without trust. CoFi says this trust stuff is very important. There are deep trust networks across the world that we should be able to expose and take advantage of. Let's bring clearing and settlement for everyone.

Decentralized Clearing - Loops

If there is a loop you can clear the minimum amount in the loop, what do you do if you are left with a chain. Now you need to introduce money, there is an imbalance in this graph. We call this a liquidity provider. The liquidity needs to enter the system somehow. The question is where does that liquidity come from and how much of it do we need. There are different places this liquidity can come from. We have internal liquidity, which is money already available to one or more of the network nodes.

It is also possible someone has access to a loan or external liquidity. What we want to do is minimize the amount of external liquidity that must enter the network. That is a sign that there is not enough value or trust already existing in the network to clear all of its debts. Another possible source of internal liquidity is mutual credit. You can use mutual credit as a liquidity injection mechanism to minimize the amount of money needed to discharge all of these debts. You can use the same graph theory and network science you use to find the loops and clear them, as you do to find out how much liquidity needs to enter the system.

All of this debt is denominated in dollars, but you can use any medium to discharge it, so long as someone is willing to accept it. If you can view the network and different preferences in the network, you can optimize over people's preferences for liquidity, which exposes more potential to use different currencies and mechanisms to make liquidity available.

We have a network that we introduce additional nodes in the network called liquidity nodes that connect the nodes with a negative net position that need some liquidity to discharge their debts. They can use their own liquidity or a loan/overdraft. Many/most firms will not use any liquidity, they will use set-offs in the MTCS to lower their balance sheets. Another minority with positive net positions will store away their money as bank account deposits. Imagine every node in the network is also connected to a liquidity source. We differentiate these four nodes within a liquidity source as two are the outflow and two are the inflow. We also differentiate internal (money in your pocket) and external liquidity (money you get as a loan) going out and coming in.

Any kind of mechanism can be used as liquidity source even if its bilateral mesh-credit, which opens up really profound ways to start to optimize liquidity across these graphs and connect to other mechanisms.

Multiple liquidity sources

You can inject these different liquidity sources into the system and use them to discharge debt, where the goal is to use the least amount of money to discharge the most amount of debt in a way that optimizes for people's preferences of which currencies they want to use. Even if you have people that don't want to sue crypto, the existence of crypto as a liquidity source within the network can actually benefit them without them knowing about it, so long as they are connected to someone who does.

Collaborative finance for sustainability

We begin by recognizing that money can be understood in two different ways, either as a social relation of credit and debt or as a commodity or asset. In the first case, it works best as a unit of account. In the second it supports all three functions of money; Unit of account, medium of exchange and store of value. Here we will focus on the first case.

A good example of money as a social relation is provided by mutual credit where the credits are issues by a participant, a mutual credit circuit, going into debt by the same amount as the amount issued. Mutual credit distributed the power to create money to the circuit members. A consequence of this creation mechanism is that when a member with a positive balance buys from a member with a negative balance, the money used to pay is destroyed. Therefore, mutual credit is a circular currency, create-spend-destroy, create again etc.

How big is Sardex? About 28 Million euros were spent on the island of Sardinia in six different business sectors, with retail and services are the largest. Over time, we can see that in 2017 Sardex had about 2800 members. The B2b transactions volume shows about 28 M for 2017. The B2E (business to employee) volume is the sum of the employees salaries plus what they spent with those credits. The total is about 40 M Euros. This is nice, but it has a pretty small macroeconomic impact, fractions of 1% of Sardinia's GDP.

Multilateral Trade Credit Set-off (MTCS)

MTCS can have a large impact. MTCS is an algorithm that looks for closed cycles of invoices in an obligation network and subtracts the smallest amount from each cycle.

An obligation network is a set of bilateral debts (invoices for example) between a number of participants. For example, I owe you 100, and you owe me 50. I can send you 50 and our obligations are cleared. MTCS generalizes this idea to three or more counterparties as long as they are obligations for a directed cycle.

In this cycle, we can subtract the smallest amount of 20 units on the left without effecting the net position of the firms involved. On the right, you can see that A was at -10 before setoff and still minus 10 after the setoff. Therefore, setoff can be performed without the use of liquidity, it simply decreases the debt burden across the network. It decreases the size of the balance sheet of the affected companies and therefore the individual and overall risk.

How large an effect is this? We performed a simulation with Sardex data. To set up the analysis we pretended that, 12,302 transactions that took place in May 2019 across 3199 firms, had not been paid yet, i.e. that rather than payments they are still invoices. How many cycles were there, and how much could be set-off? About, 5600 or 45% of the invoices were in cycles involving a bit more than 1/3 of all the companies. Cycles can be very long and complex.

The volume for May 2019 was 2.8M euros of which about 690k were set-off or 25% this is pretty large. Depending on how closed or open an economy is, this can change a lot. For example, in a Kenyan village most of the trades are internal to the village, in this case the amount. Setoff is closer to 80% of the total debt, where total debt is just the sum of all invoices. For the Sardex economy, it's about 25%. For a data set of 35,000 Italian companies it's about 8% which corresponds to about 100M euros cleared without liquidity over one month. All of these simulations were performed by Tomasz F.

Since there are about 3.5M SMEs in Italy and extrapolate these numbers we get 100M * 12 * 100 is about 120 Billion Euros that can be cleared which is on the order of 3-5% of Italian GDP, about the same order of magnitude as the stability and growth pact.

Sardex and MTCS support the view that Money is not a neutral instrument

- According to neoclassical economics, money is neutral because an increase in monetary mass affects only prices, not real economy productivity
- But money does not influence just economic factors, it also influences lives of people
- And if we include money creation by banks, then the choice to issue or not issue a loan has a real time impact, not just on the lives of people but also on the real economy.

Whether money is neutral or not depends upon a subjective interdisciplinary point of view. However, If we include money creation by banks, then the decision of whether to issue a loan does not affect only the lives of people but also the real economy. Money is not objective on neutral grounds, then.

The consequence of the non-neutrality of money is that depending on the design of the monetary instrument different kinds of finance and economies will be supported, in each case supported by different mathematical theories.

- For example, Money as a commodity is effective at supporting extractive finance, which is consistent with neoclassical economics and underpinned by game theory.
- By contrast money as a social relation is the best kind of instrument to support CoFi which is compatible with the view of economic anthropology which views the economy as composed of four domains of value; market, capital, social relationships, and the commons.

In other words social relationships in the commons are not outside the economy, they are important centers of value creation on par with market and capital as aptly demonstrated by the open source phenomena over the last forty years. This framework is underpinned by graph theory. Clearly, we can't just dispose of investment capital, which is essential to entrepreneurship. And we need to support working capital and the circular economy. Therefore, we need a sustainable synthesis between these two different ways of organizing our economic and financial monetary systems.

Half-way to synthesis

The final slide shows how the economy of economic anthropology where you can see the four domains of value can be visualized in increasing order of abstraction of value along the y-axis, and in terms of scale from local to global along the x-axis. In this depiction, money as a social relation is most effective in the lower left part of the figure, and money as a commodity is dominant on the upper right. The problem is that in the current system, there is a vacuum or suction effect from the financial economy that depletes all the other domains by turning everything into money.

Mutual credit acts as a protective barrier (Thomas Grecko) against the suction of financial capitalism as long as it is nonconvertible (non-securatizable). Whereas MTCS promises to act as a bridge. The reason is that MTCS acts on the unit of account, and therefor it is agnostic to the kind of money it operates on or on the scale it operates at. It is equally effective everywhere, but it still requires a significant level of cooperation and trust. It has the potential to right the balance and demonstrate a new way of thinking. We have more or less understood how to tackle the lower boundary, but we are still struggling with the upper sustainably.

Right now capitalism acts like a black hole, you get to close it sucks you in, and you never get out. Clearly, greater monetary literacy is needed.

Resources

- Graph Flows & Liquidity Injections
- CoFi Day 2 Multilateral offset
- CoFi Notes
- MTCS and Mutual Credit - the “founding paper” of CoFi
- Math Behind MTCS
- Original Sardex Paper