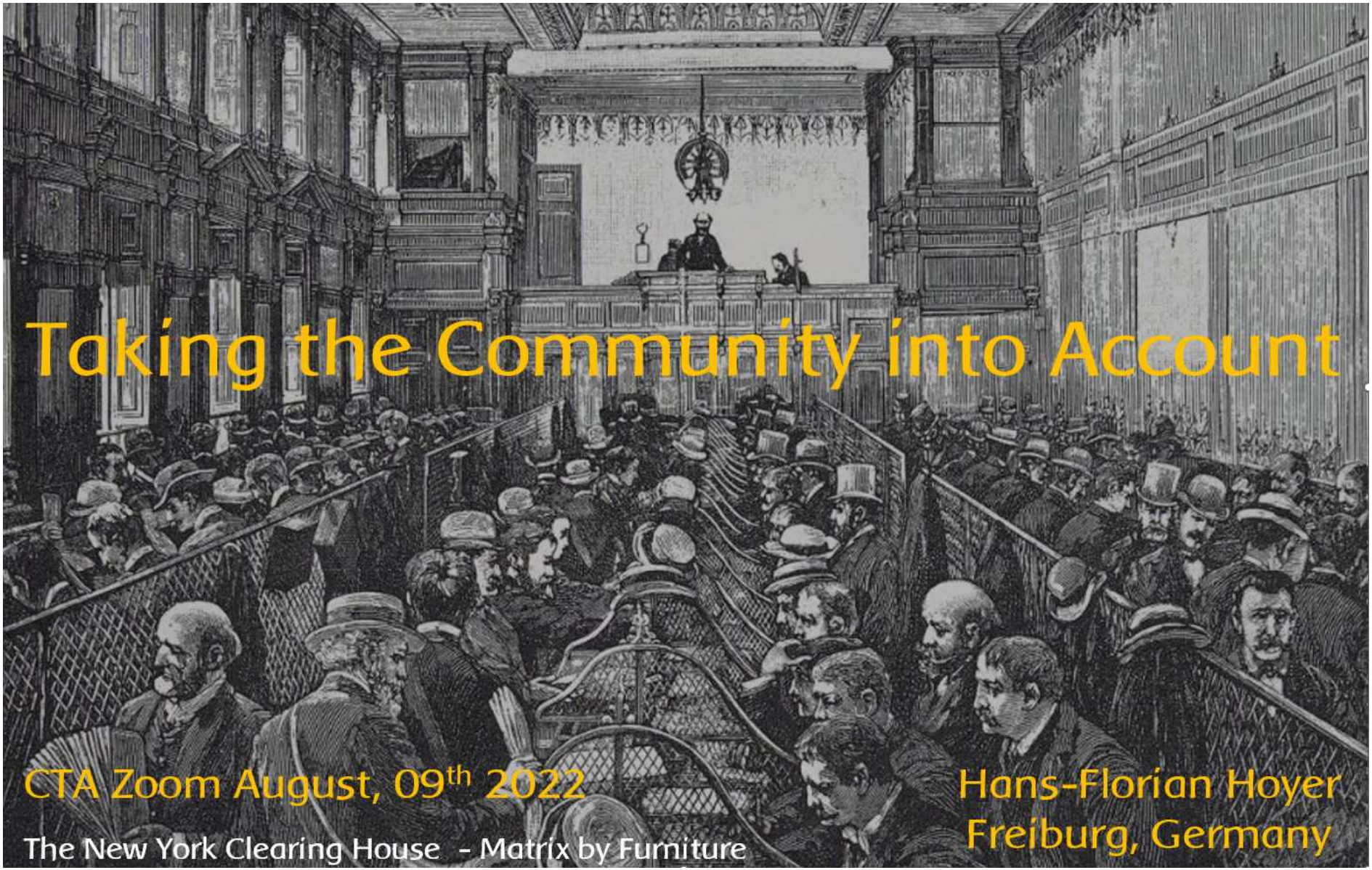

Taking the Community into Account
CTA Zoom August, 09th 2022
Hans-Florian Hoyer
Freiburg, Germany
The New York Clearing House - Matrix by Furniture

Outline

- Spoiler
- Notation
- Real Economy
- Volumes
- Contracts
- Setting up a table
- Relations
- Coding Delegation
- Two Ways to find the NID
- Emerging Status Quo
- Literature

Spoiler

I hope to offer you herewith an opportunity to convince yourself (if not already convinced) of the following statements:

1. the smaller the horizon of consciousness (bilateral only) and span of time of the actors (here and now) is, the more means of payment are required, et vice versa
2. an open obligation is a widening of the time horizon
3. consciousness saves money $\Leftrightarrow$ money replaces consciousness
4. once the mathematics of delegation is understood, the three involved actors do not have to agree to every single novation and assignment
5. as regional currencies are 'cash' without being legal tender, community clearing and settling is 'cashless money transfer' without a banking license

Notation

- $\boxed{\Sigma}$ total of one side of an account sheet
- $\boxed{\Delta}$ balance, making the totals on the sheet equal
- $\{1_i\}$, $\{1_j\}$, $\{1_k\}$ a single actors
- $\{1_i\} \rightleftharpoons \{1_j\}$ two actors with mutual claims
- $\{1_j\} \rightarrow \{1_k\}$ two actors with single claim
- two actors i, j completed by k for delegation
  case 1: $\{1_i\} \rightarrow \{1_j\} \rightarrow \{1_k\}$
  case 2: $\{1_k\} \rightarrow \{1_i\} \rightarrow \{1_j\}$
- $|N - \{1_i\}|$ the rest of the community without $\{1_i\}$
- $|N - \{1_i\}| \rightarrow \{1_i\}$ the community owes one member
- $\{1_i\} \rightarrow |N - \{1_i\}|$ one member owes the community

Societary Circulation

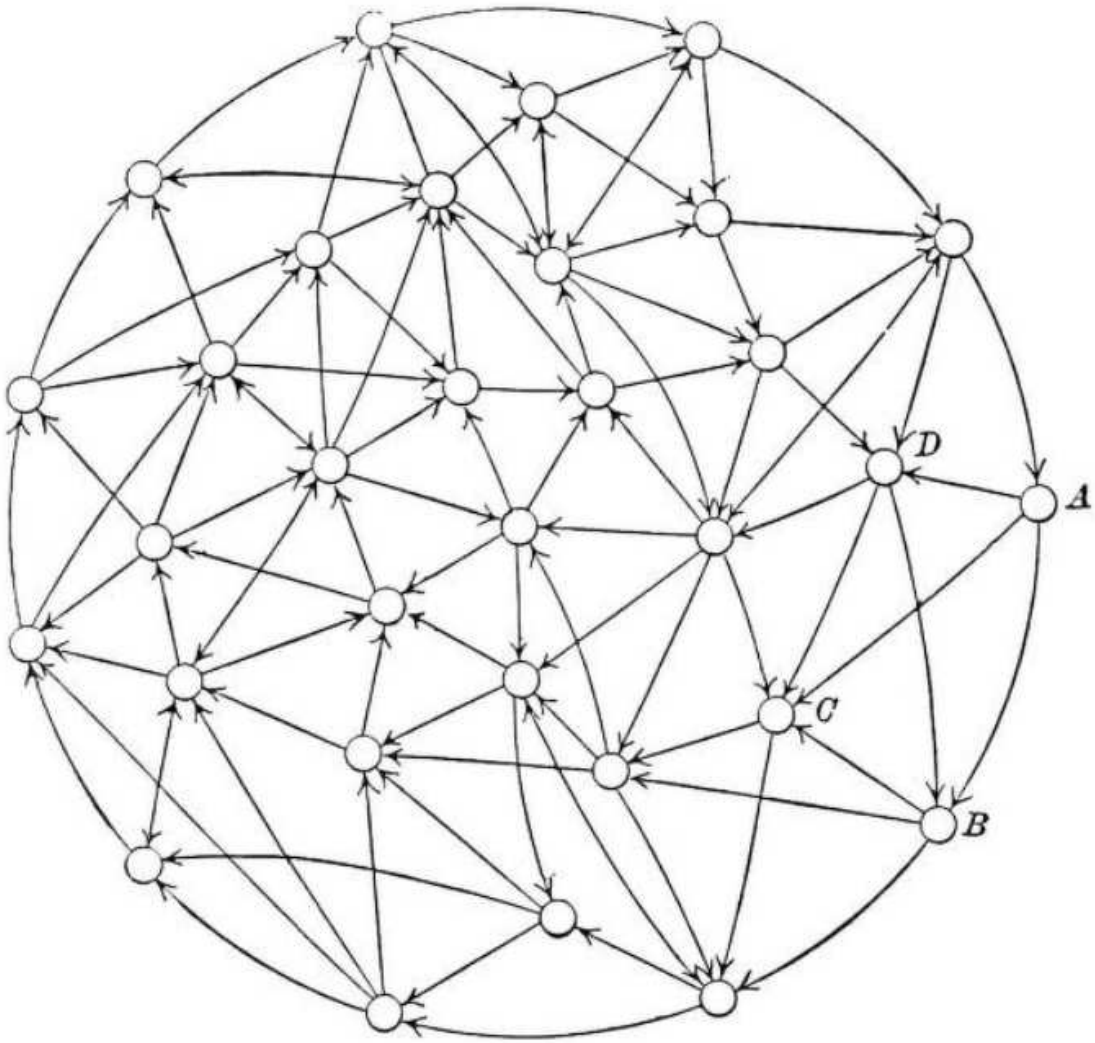


Figure 1: Simon Newcomb: Principles of political economy. 1885

Societary Volumes

One can distinguish four volumes of necessary means of payments to mirror the re-distribution of goods:

VOL : when paid on delivery (total of prices of goods exchanged)

$^*VOL$: when paid on delivery and some means are used to pay more often than once ("velocity of money")

BIL : when open obligations are settled by bilateral compensation

NID : *net internal debt*[1] i.e. the minimal volume needed to settle all open obligations in a community formed for this purpose

$$NID \leq BIL \leq {}^*VOL \leq VOL$$

Depending on the density of the relations between the actors and the placement of values, *NID* can be as low as 5% of *VOL*.

[1] Tomaž Fleischman, Paolo Dini: Mathematical Foundations for Balancing the Payment System in the Trade Credit Market

Non paying Society?

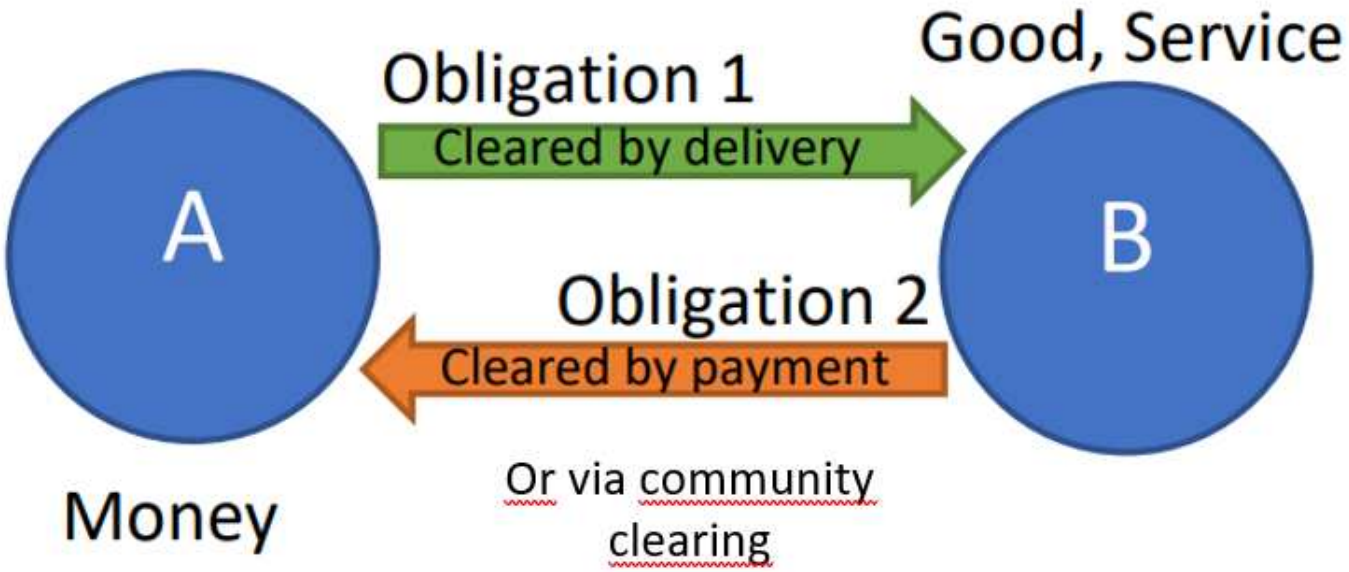
What economic relationships would lead to a matrix that would have $VOP > 0$ and $NID = 0$? This would be a cashless society or better a 'non-paying' society, because all, what the members owe each other is balanced on the society-level.

Starting Matrix

		A	B	C	D	E	F
		1	2	3	4	5	6
A	1		476.778	488.597	452.095	465.526	387.854
B	2	868.018		316.234	405.432	284.434	242.170
C	3	494.015	488.995		466.447	89.160	93.190
D	4	103.601	188.288	308.296		678.926	844.642
E	5	490.700	475.524	83.980	394.243		438.533
F	6	314.516	486.703	434.700	405.536	364.934	

VOP	100%
12.032.067	12.032.067
BIL	25%
2.971.421	2.971.421
NID	0%
0	0

Single contract $\{1_i\} \rightleftharpoons \{1_j\}$



Real Economy : Change of ownership of a real good
Obligation fulfilled in same instant or later.
Trust in bilateral relationship needed to keep the obligation open.

Multiple Contracts in same Relationship

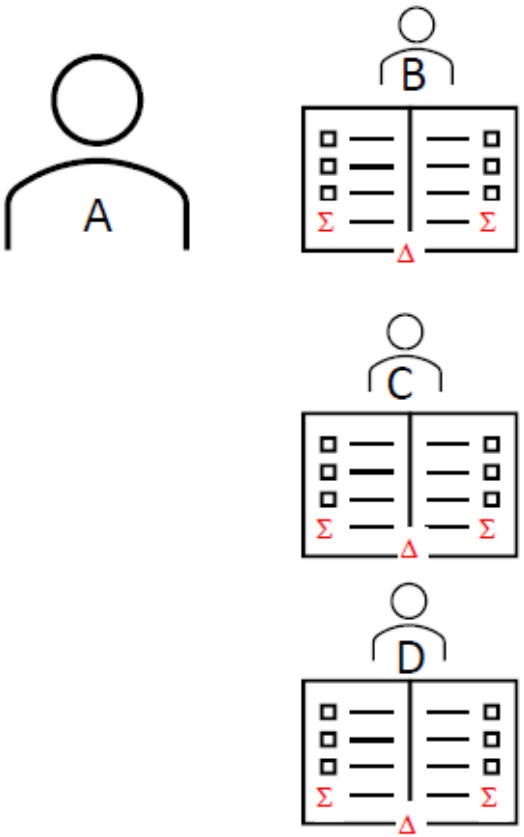
The books of J. Black, at the account of J. White.

Date.	Goods.	Dollars.	Cts.	Date.	Goods.	Dollars.	Cts.
1850, Jan. 1	To mdze....	1000	00	1850, Jan. 5	By mdze....	2200	00
" Feb. 2	"	1100	00	" Feb. 6	"	2100	00
" Mar. 3	"	1200	00	" Mar. 7	"	1950	00
" April 4	"	1300	00	" April 8	"	1800	00
" May 5	"	1400	00	" May 9	"	1750	00
" June 6	"	1500	00	" June 10	"	1600	00
" July 7	"	1600	00	" July 11	"	1500	00
" Aug. 8	"	1700	00	" Aug. 12	"	1400	00
" Sept. 9	"	1800	00	" Sept. 14	"	1250	00
" Oct. 10	"	1900	00	" Oct. 16	"	1100	00
" Nov. 11	"	2000	00	" Nov. 17	"	1050	00
" Dec. 12	"	2100	00	" Dec. 20	"	1000	00
" " 31	To bal. cash	100	00				
		18,700	00			18,700	00

Bilateral trust for all single contracts. Agreement, that all single contracts are settled, when the balance only is paid at a due date. The account of J. Black in the books of J. White is mirror-inverted.

Accounts payable / receivable

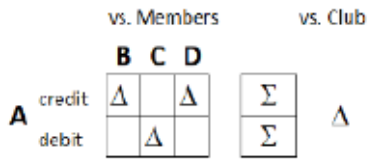
Community gain

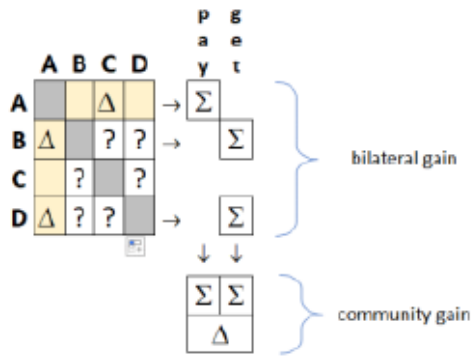


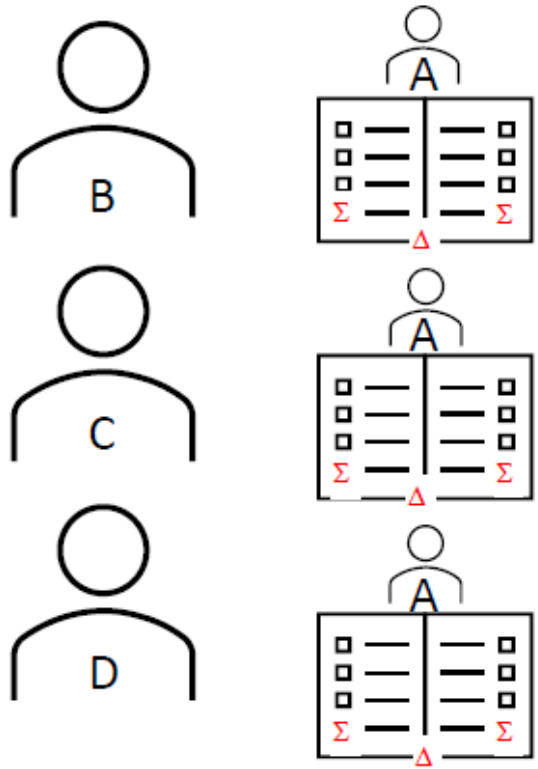
Σ = Total of each side

Δ = Balance of the sides

Member A has complete control via his ledger over his bilateral savings.



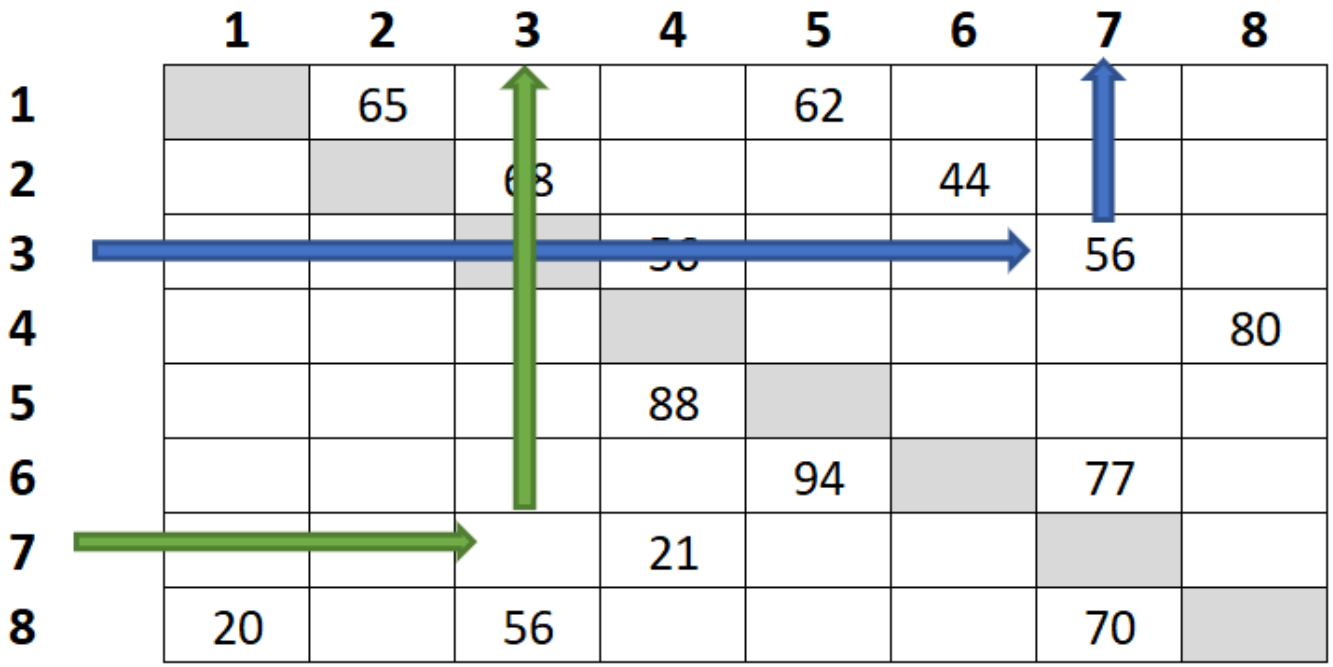




The additional gain by compensating bilateral results can only be realized via the community.

Putting it in a Table / Matrix

Reading convention of matrix 'open obligations' $OO(i,j)$
The matrix is square ($N = 8$) and the diagonals are empty $OO(i,i) = 0$.



Actor $i = 3$ owes to actor $j = 7$ $OO(i,j) = 56$ units, and actor $i = 7$ owes actor $i = 3$ $OO(i,j) = 0$ nothing.

Single Actor's Horizon

Since the ledgers of all actors contain, what they owe and what they can claim, they contribute their part of the matrix in their ledgers. Actor 5 communicates these totals (Σ) of the accounts to the matrix provider.
He already knows, that he would have to pay 17.508 and would receive 40.796 if he did not do it through the community.
In doing so, he will receive 23.288.

	j=	1	2	3	4	5	6	7	8	
i=	1	0	3.019	0	7.607	0	0	4.140	0	
	2	0	0	0	9.495	5.248	0	5.924	2.981	
	3	6.478	2.793	0	0	9.860	0	6.951	0	
	4	5.338	9.994	157	0	7.988	456	3.820	9.485	
	5	0	2.782	1.628	4.100	0	6.331	1.860	807	17.508
	6	9.057	7.852	2.896	0	6.276	0	6.944	0	
	7	0	5.433	0	6.779	5.137	3.534	0	2.438	
	8	0	3.902	4.898	4.744	6.287	1.563	0	0	
						40.796				
						-17.508				
						23.288				

When actor 4 communicates his numbers, $OO(5,4) = 4.100$ needs to correspond to what actor 5 communicated.

Complete Matrix

The matrix assembles numbers (here totals of the account sheets: $\boxed{\Sigma}$) from the ledgers of the participating actors.

		j= 1	2	3	4	5	6	7	8	i owes	i claims	i pays	i gets
i=	**1**		3.019	0	7.607	0	0	4.140	0	14.766	20.873		6.107
	2	0		0	9.495	5.248	0	5.924	2.981	23.648	35.775		12.127
	3	6.478	2.793		0	9.860	0	6.951	0	26.082	9.579	16.503	
	4	5.338	9.994	157		7.988	456	3.820	9.485	37.238	32.725	4.513	
	5	0	2.782	1.628	4.100		6.331	1.860	807	17.508	40.796		23.288
	6	9.057	7.852	2.896	0	6.276		6.944	0	33.025	11.884	21.141	
	7	0	5.433	0	6.779	5.137	3.534		2.438	23.321	29.639		6.318
	8	0	3.902	4.898	4.744	6.287	1.563	0		21.394	15.711	5.683	
		20.873	35.775	9.579	32.725	40.796	11.884	29.639	15.711	196.982	196.982	47.840	47.840
										VOL		NID	

column totals: $|N - \{1_i\}| \rightarrow \{1_i\}$ the community owes one member
line totals: $\{1_i\} \rightarrow |N - \{1_i\}|$ one member owes the community

A Simple Law

The simple fact, that the difference between two numbers X and Y does not change if both are decreased (or increased) by the same number z, or expressed mathematically

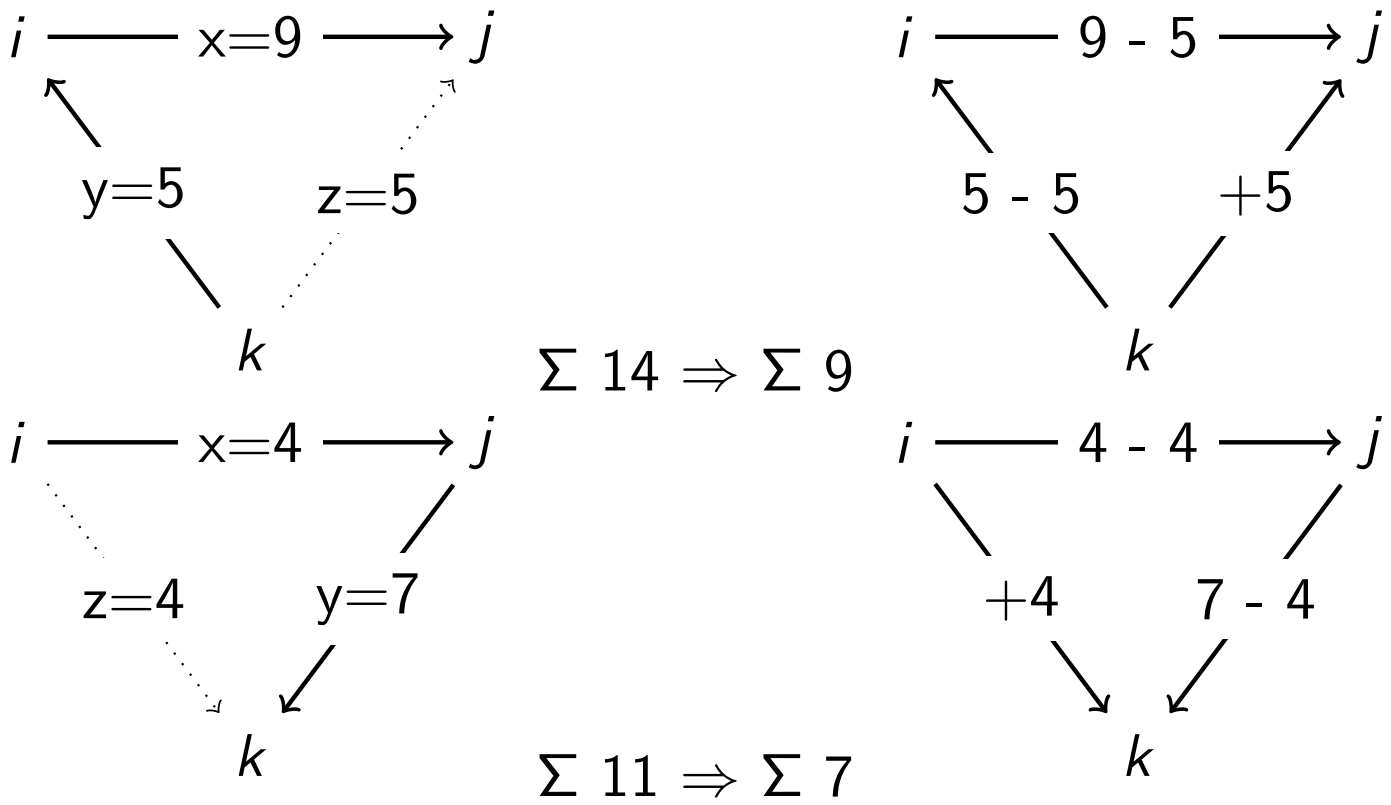
$$X - Y = (X \mp z) - (Y \mp z)$$

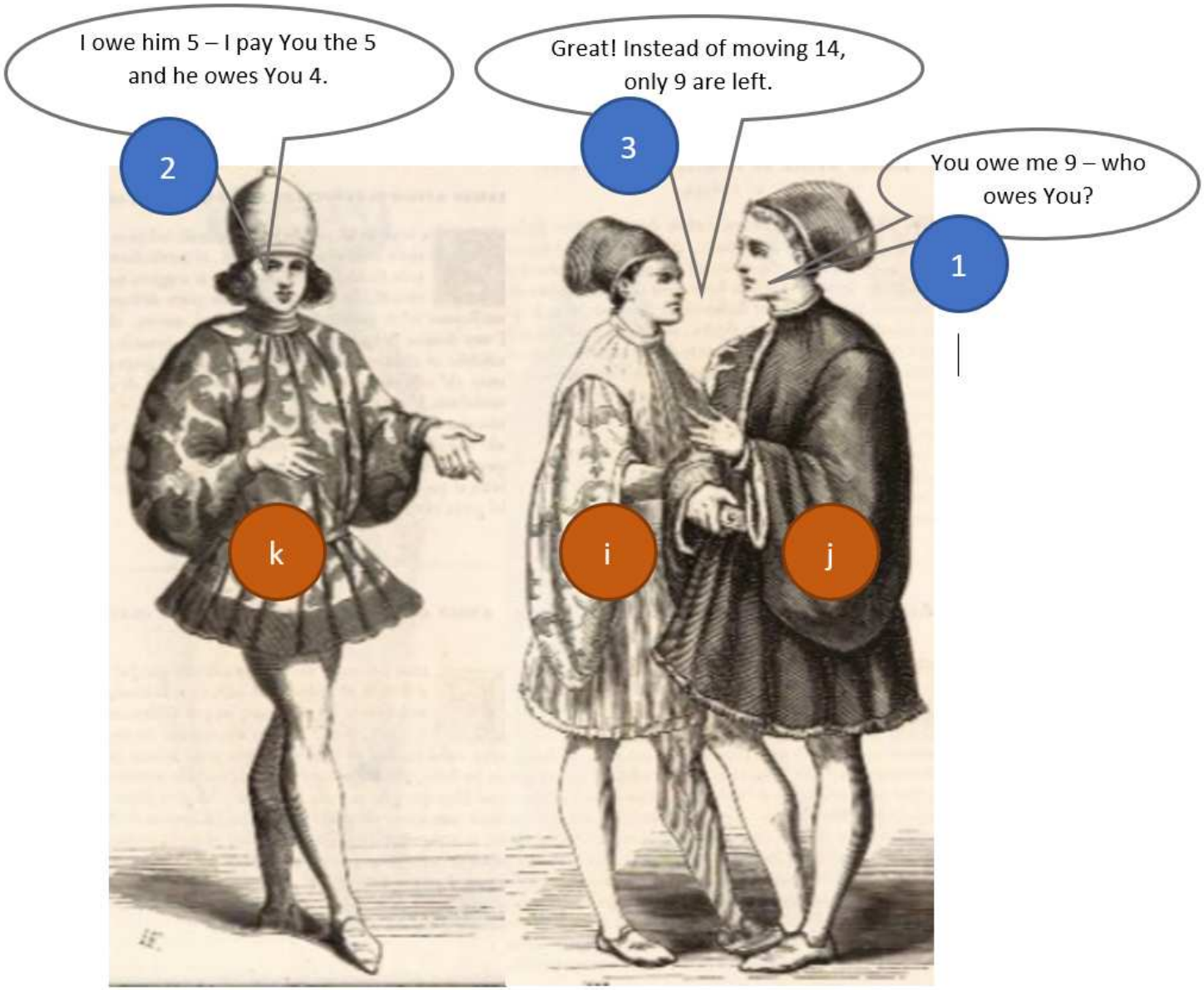
allows, under consideration of the node balances, to decrease the necessary volume of money to settle the complete *VOL* by *NID* in a community. Only *NID* is payed for, $(VOL - NID)$ can be considered as bartered.

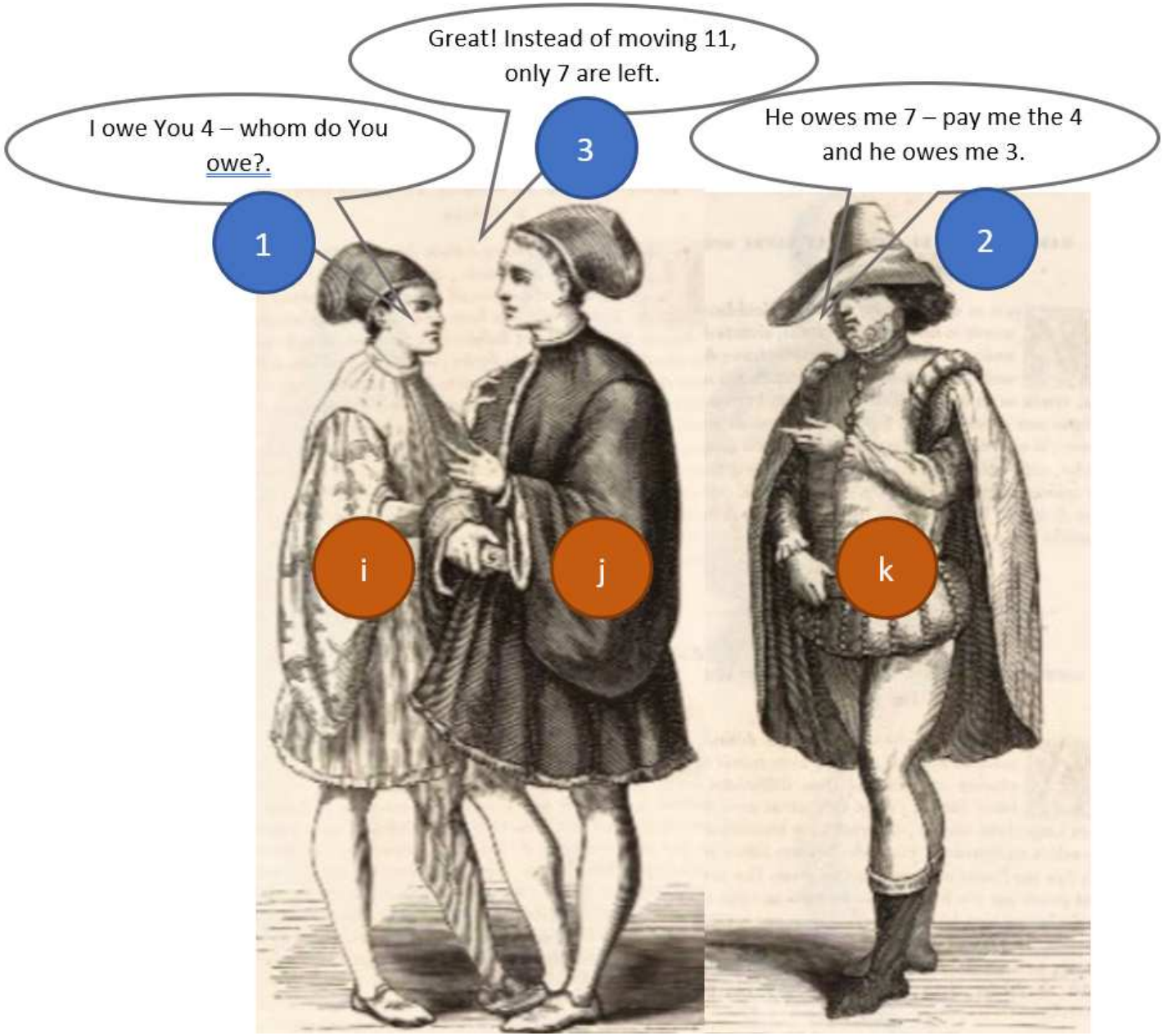
The techniques practized for long times to decrease the numbers are called compensation (between two), scontration (between three and more) and delegation (beween three).

Compensated Binary Relations - Delegation

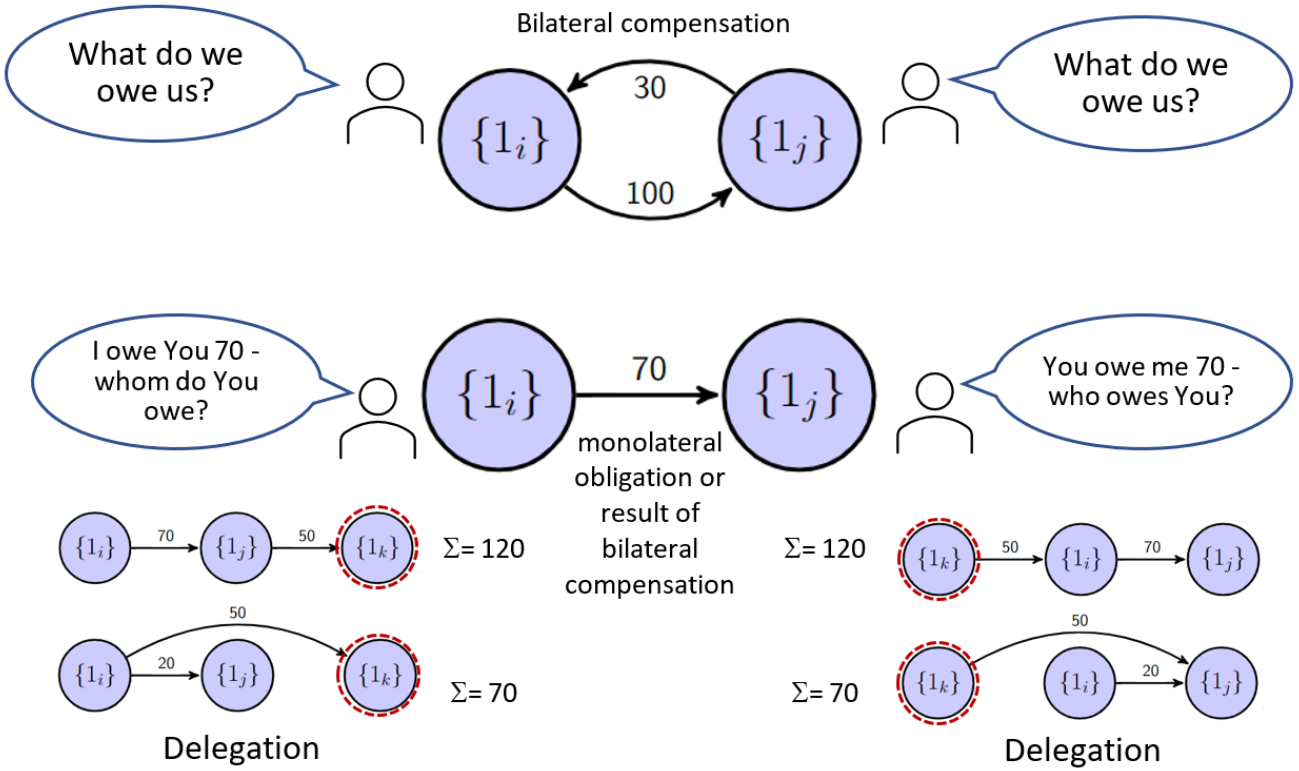
Let z=minimum(x,y). By adding a third party (k), the amount of required payment means can be further reduced, because z can be removed twice and is added only once.




I owe him 5 – I pay You the 5 and he owes You 4.
Great! Instead of moving 14, only 9 are left.
You owe me 9 – who owes You?
2
3
1
k
i
j


Great! Instead of moving 11,
only 7 are left.
I owe You 4 – whom do You
owe?.
He owes me 7 – pay me the 4
and he owes me 3.
3
1
2
i
j
k

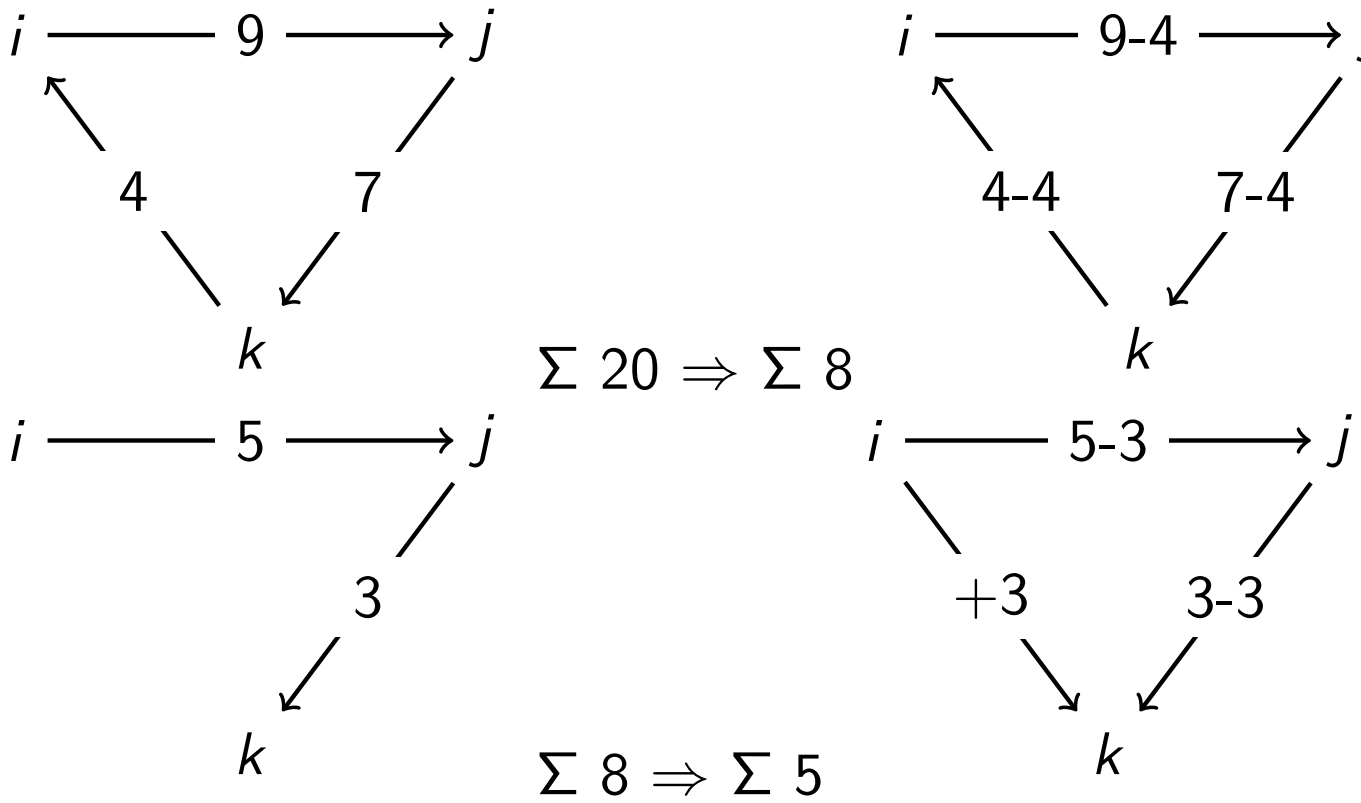
From Binary to Ternary to Community



At the fairs in the Middle Ages, two actors asked these questions which third party they could add so that they would have to take as little money home as possible. They called it: Paying with closed burse.

Special Case : Circle and Scontration

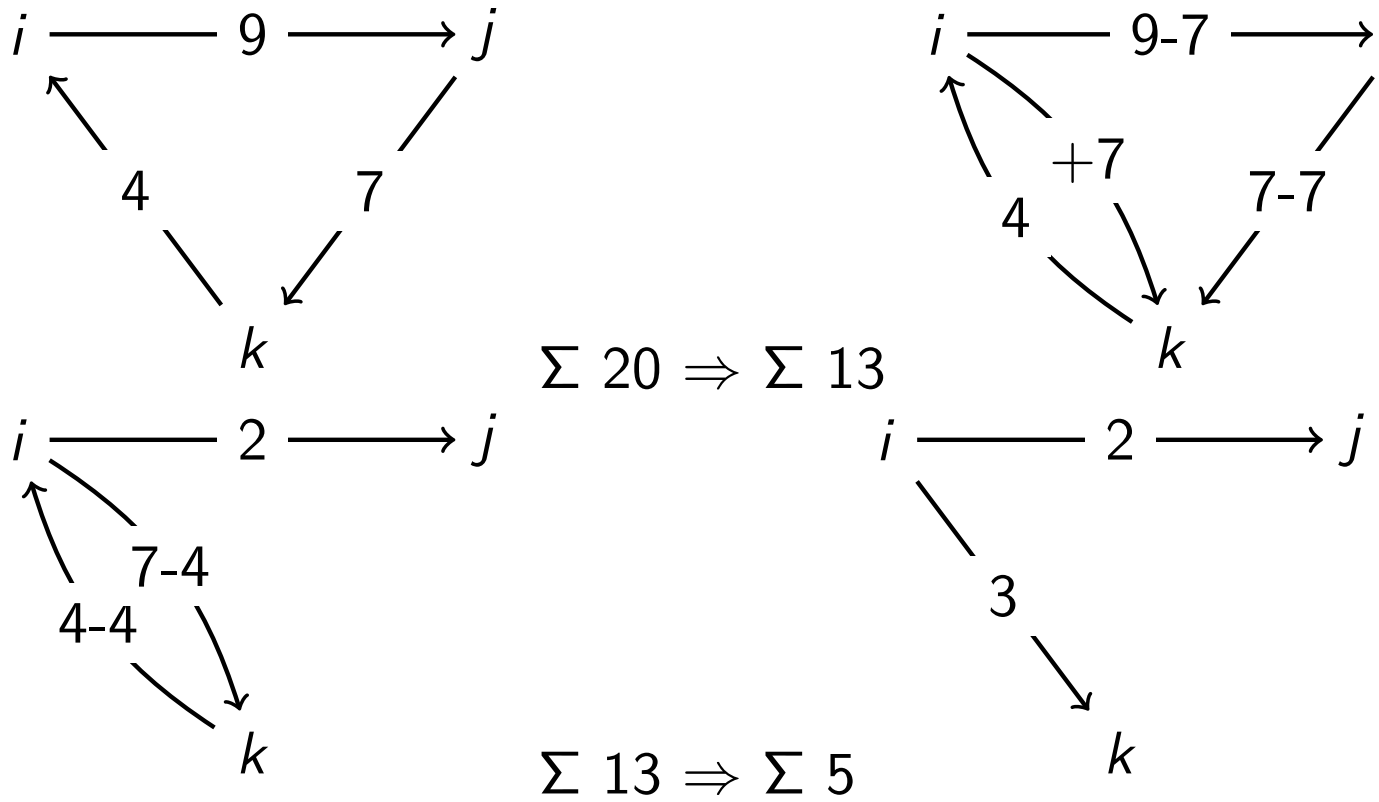
Circles are the special case when the third party (k) has relations to both. The smalles value can be removed three times (scontration) and the remainig relation can be reduced by delegation.



Scontration needs to find circles, what may take time. Delegation is still needed afterwards.

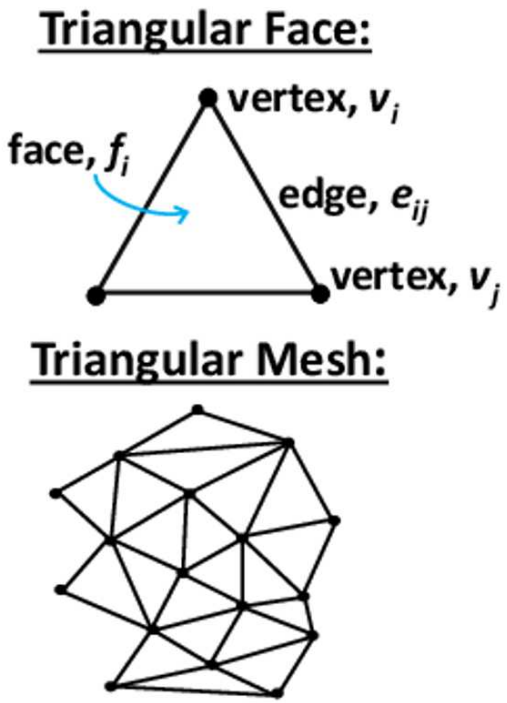
Reducing a circle with delegation and bilateral compensation

A scontration imitates a delegation, and is a method both of establishing an obligation and of dissolving it.



Finite Element Approach (as a personal side note)

Taking binary relation and adding a debtor to the debtor or a creditor to the creditor opens the opportunity to reduce two obligations an add a new one by delegation. It is the same simple operation applied to the same type of object.



Finite Element Analysis can not only be applied to engineering structures, but also to societary relations.

Conjectures about the Matrix

1. If there is an element $OO(i,j) > 0$ and $i \neq j$
   any non-zero element $OO(k,i)$ or $OO(j,k)$
   and $k \neq i$ and $k \neq j$
   will open a reduction of VOL in the amount of the smallest of the two values compared with $OO(i,j)$.
2. The more such ternary relations exist, the more possibilies for reduction are present. The sparcer the matrix, the less.
3. The larger the span of Values, the lower the relative savings, since only the smallest amount is used to reduce.
4. Since delegation changes the structure by deleting old and creating new relations, there is no way to make predictions about the final graph for the *NID* other than to solve it.

Nucleus of Code

```
'i: debitor - j: creditor  -  k: debitor of i or creditor of j'
'N: number of club-members'
'OO(d,c): open obligation to pay for "d" to "c"'
'min: amount to be removed twice and added only once'
For i = 1 to N
For j = 1 to N
   if i<>j then
   if OO(i,j)<>0 then
   For k = 1 to N'    look for delegation-partner'
   If (i<>k and j<>k) then
        If OO(k,i)<>0 then'is debitor to i'
            min=OO(i,j):if OO(i,j)>= OO(k,i)then min = OO(k,i)
            OO(i,j)= OO(i,j) - min 'subtract twice'
            OO(k,i)= OO(k,i) - min
            OO(k,j)= OO(k,j) + min 'add once'
        end if'     OO(k,i)<>0'
        If (OO(j,k)<>0 and OO(i,j)<>0) then'is creditor to j'
            min=OO(i,j):if OO(i,j)>= OO(j,k)then min = OO(j,k)
            OO(i,j)= OO(i,j) - min 'subtract twice'
            OO(j,k)= OO(j,k) - min
            OO(i,k)= OO(i,k) + min 'add once'
        end if'     (OO(j,k)<>0 and OO(i,j)<>0)'
        end if'     (i<>k and j<>k)'
        If OO(i,j)=0 then exit FOR'   nothing left for delegation (i,j)'
        Next k
    end if'     OO(i,j)<>0'
    end if'     i<>j'
Next j'   look for next delegation pairing'
Next i
```

Two Ways to find the Net Internal Debt

If the table containig the open obligations between the members of the community is assembled using their accounts payable/receivable, the *NID* can be calculated in two ways:

A: by balancing the total of column i with the total of line i and writing the result in line i to a payers or receivers column. The total of one column is the *NID*.

B: by letting the code process all open obligations between i and j and find a third actor k, which either connects to i or to j to enable delegation.

Both ways yield the same *NID*, but "B" yields it as *VOL* of a minimal subset of the initial network. This net consists of nodes with incomming arrows only or outgoing arrows only, not both and nodes without any arrows.

Possible Organisations around the Matrix

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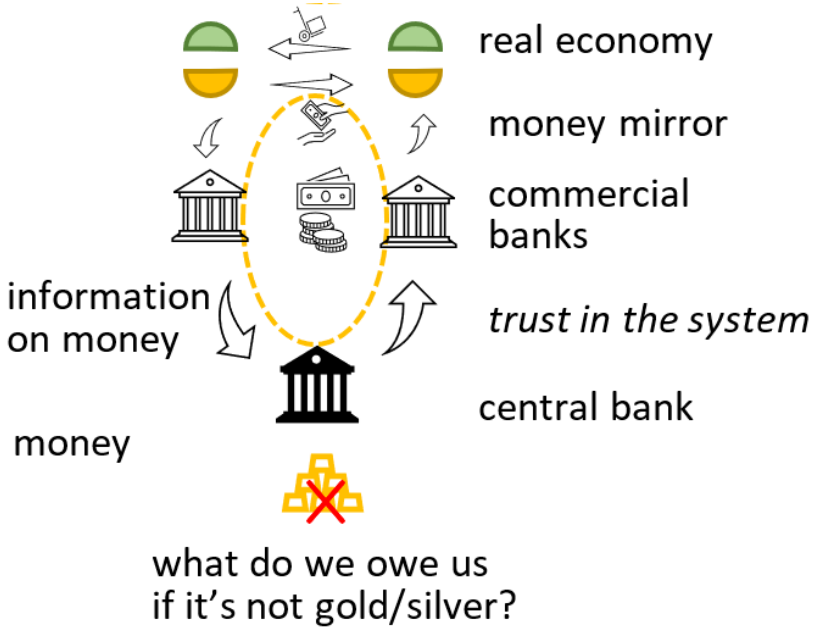
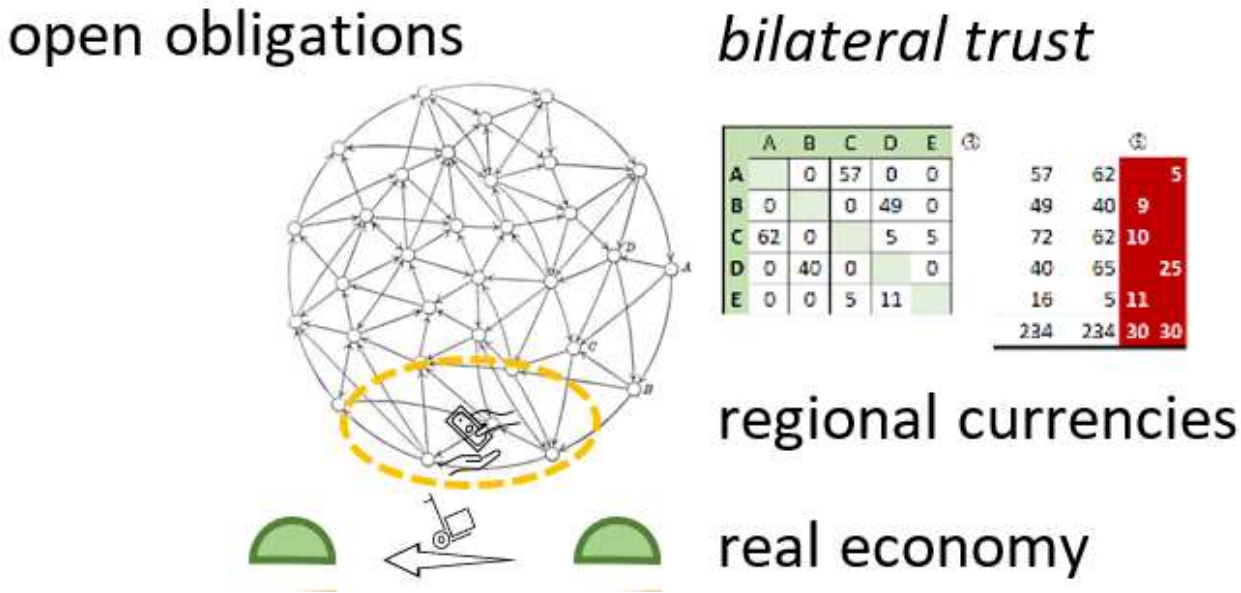
Status Quo with Banks



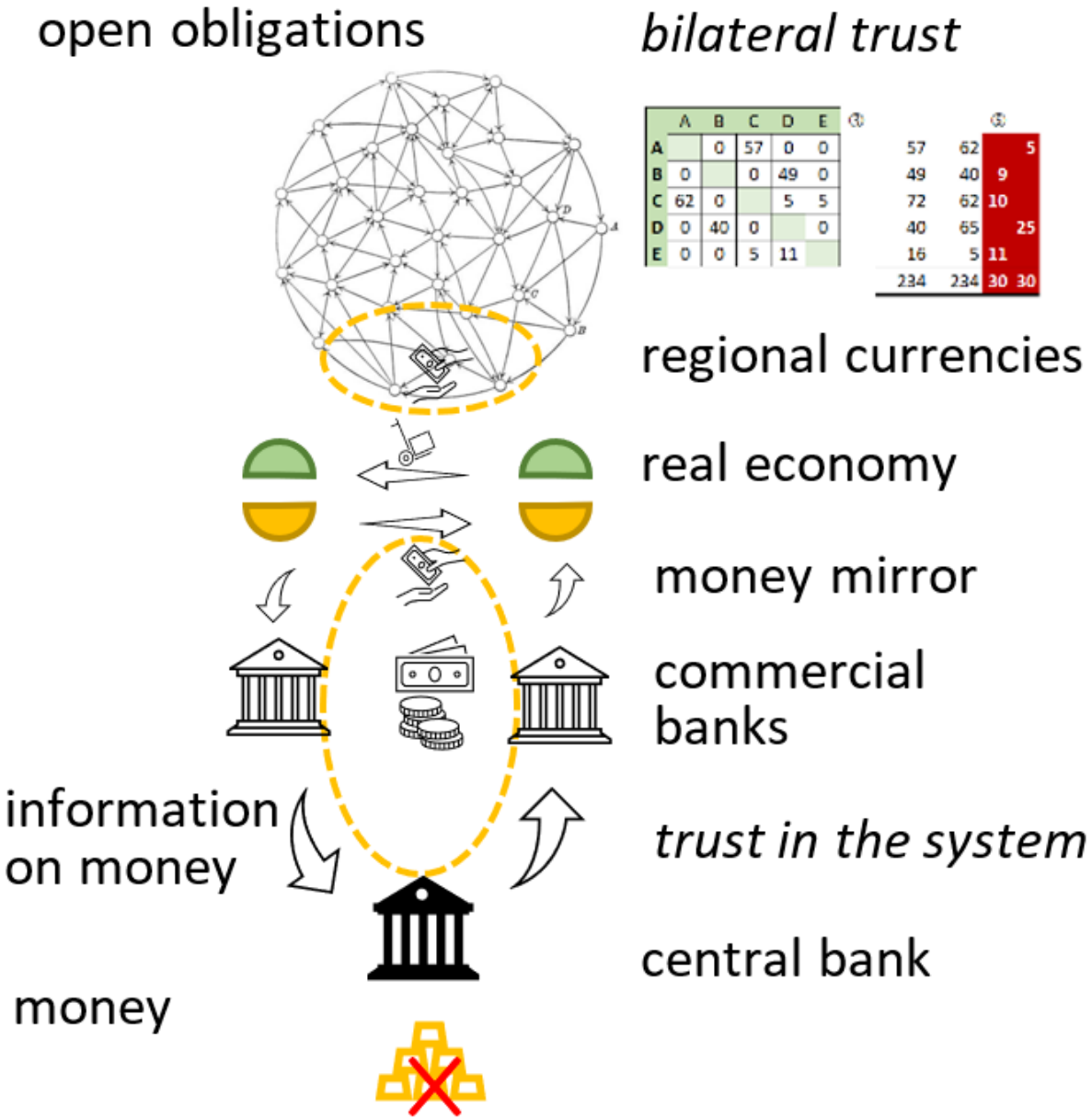
The redistribution of goods, services and rights is mirrored in the redistribution of money. In circulation cash is transferred, in cashless "transfers" the information on how to re-write the books of banks is exchanged. The information points to the liquidity of commercial banks, not to physical value (gold).
The banks have to rewrite their mutual claims too. They make use of "the matrix" via Real Time Gross Settlement Systems (RTGS).

Emerging Status Quo - P2P without Banks



The use of open bilateral obligations in a societary net of relations opens the opportunity for the actors to make use of the "matrix" like banks do and save the employment of means of payment in paying. The unemployed money stays employed in the hands of the actors like regional currencies stay in the region.

Status Quo - New

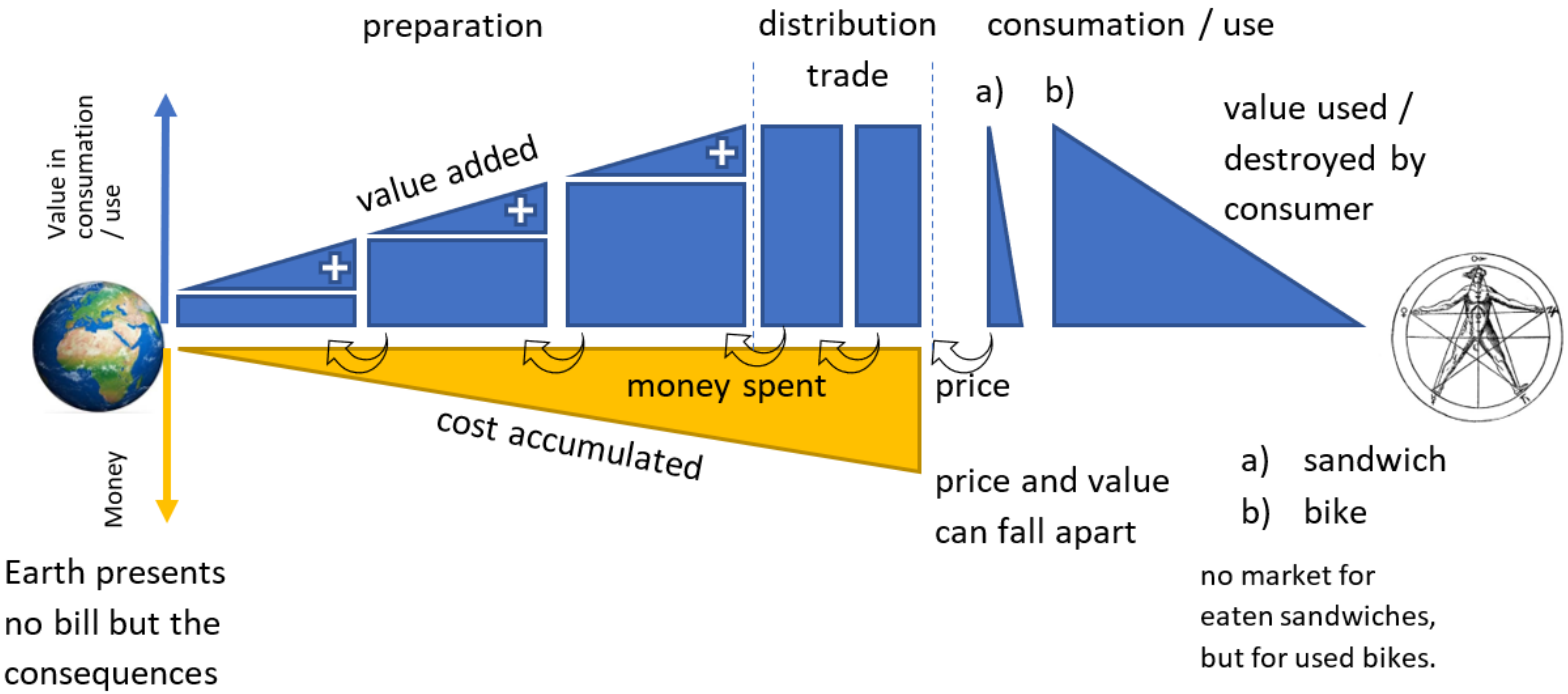


	A	B	C	D	E	①
A		0	57	0	0	
B	0		0	49	0	
C	62	0		5	5	
D	0	40	0		0	
E	0	0	5	11		

		②	
57	62		5
49	40	9	
72	62	10	
40	65		25
16	5	11	
234	234	30	30

No Money Creation

By saving means of payment no additional money is created, but existent money is freed for other use. This may decrease the need for credit by commercial banks.

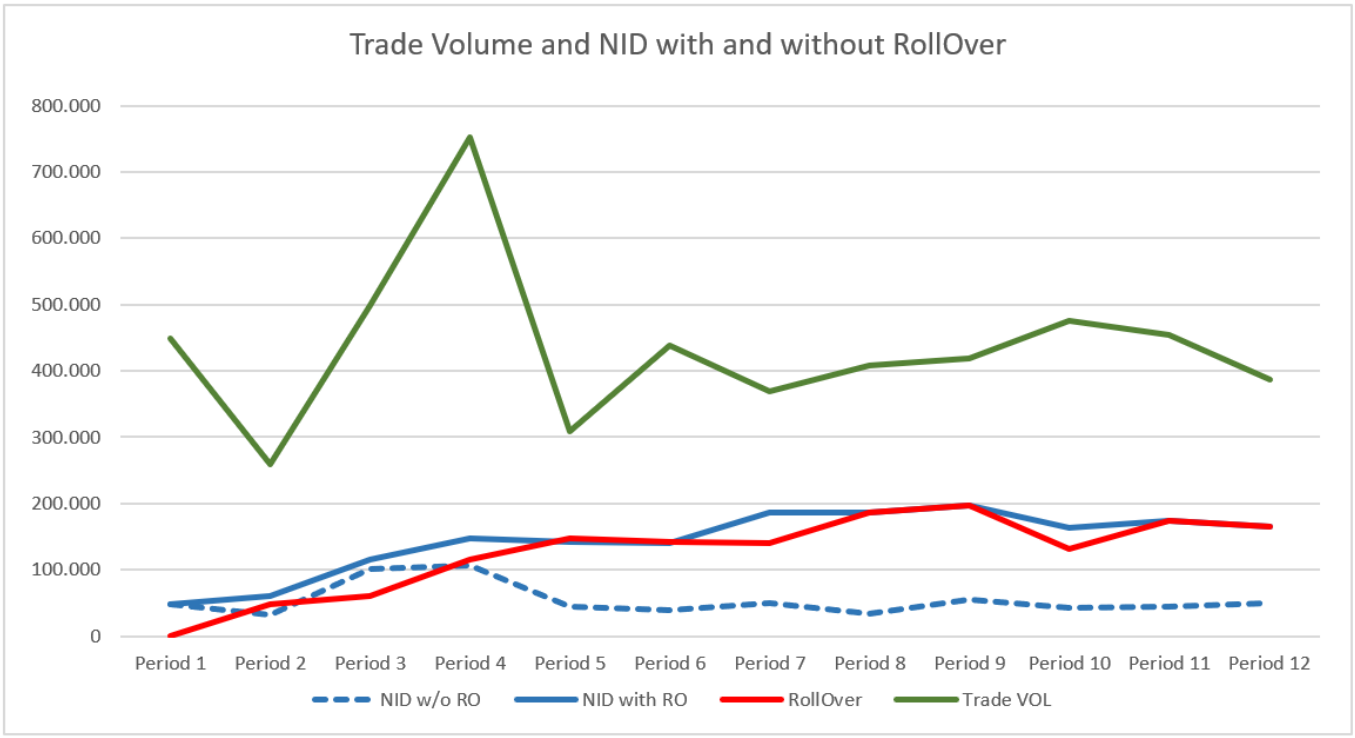


Banks needed to create new means of payment

Matrix saves existing means of payment
Community might lend money

Rollover - Preliminary Simulation

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12
NID w/o RO	47.475	33.016	101.338	107.321	44.071	38.788	50.479	33.150	54.456	42.019	43.884	49.397
NID with RO	47.475	59.735	115.443	147.032	142.295	141.191	186.005	186.005	196.746	162.967	174.155	164.452
RollOver	0	47.475	59.735	115.443	147.032	142.295	141.191	186.005	196.746	131.271	174.155	164.452
Trade VOL	449.609	258.484	498.590	751.937	308.376	438.477	369.756	408.123	418.729	475.911	453.660	387.118



	Threshold	Amounts from	Amounts to
Period 1	0,3	3.358	8.262
Period 2	0,3	3.037	4.145
Period 3	0,3	5.005	9.862
Period 4	0,3	9.707	9.826
Period 5	0,3	3.261	5.477
Period 6	0,3	6.416	6.849
Period 7	0,3	3.560	7.524
Period 8	0,3	1.385	5.619
Period 9	0,3	1.446	3.545
Period 10	0,3	7.336	9.191
Period 11	0,3	4.804	5.082
Period 12	0,3	9.498	9.626

↑
low number:
full matrix

A rollover of the claim or obligation vs. the community into the next period can both add up or compensate. Using the pseudo-random numbers of EXCEL may not be appropriate.

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  Some Remarks on the Use of Matrices in Settling Obligations 2022.
  https://www.academia.edu/66973577

Postscript

Comments are welcome: hfhoyer at posteo de
A prezi with a similar perspective on the topic can be seen here
https://prezi.com/view/qxdFVuDrDECoGonSuQFo/