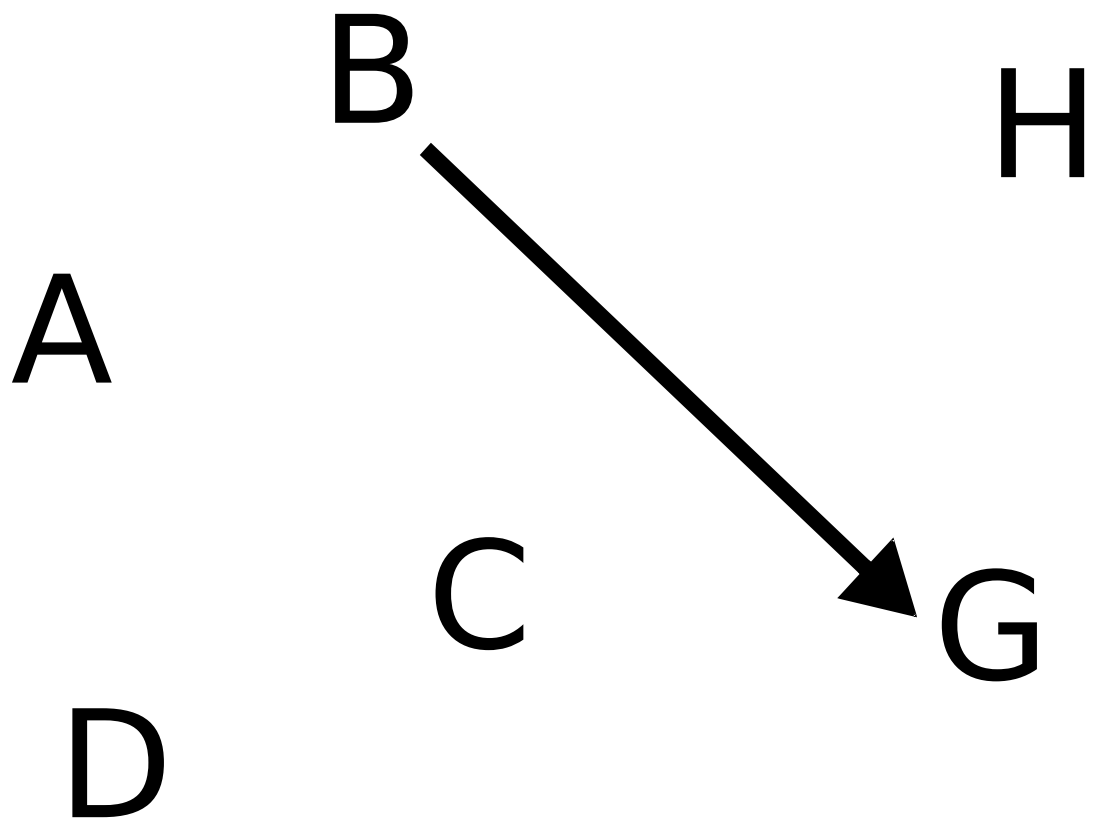
How does Money Memorize Social Interactions?

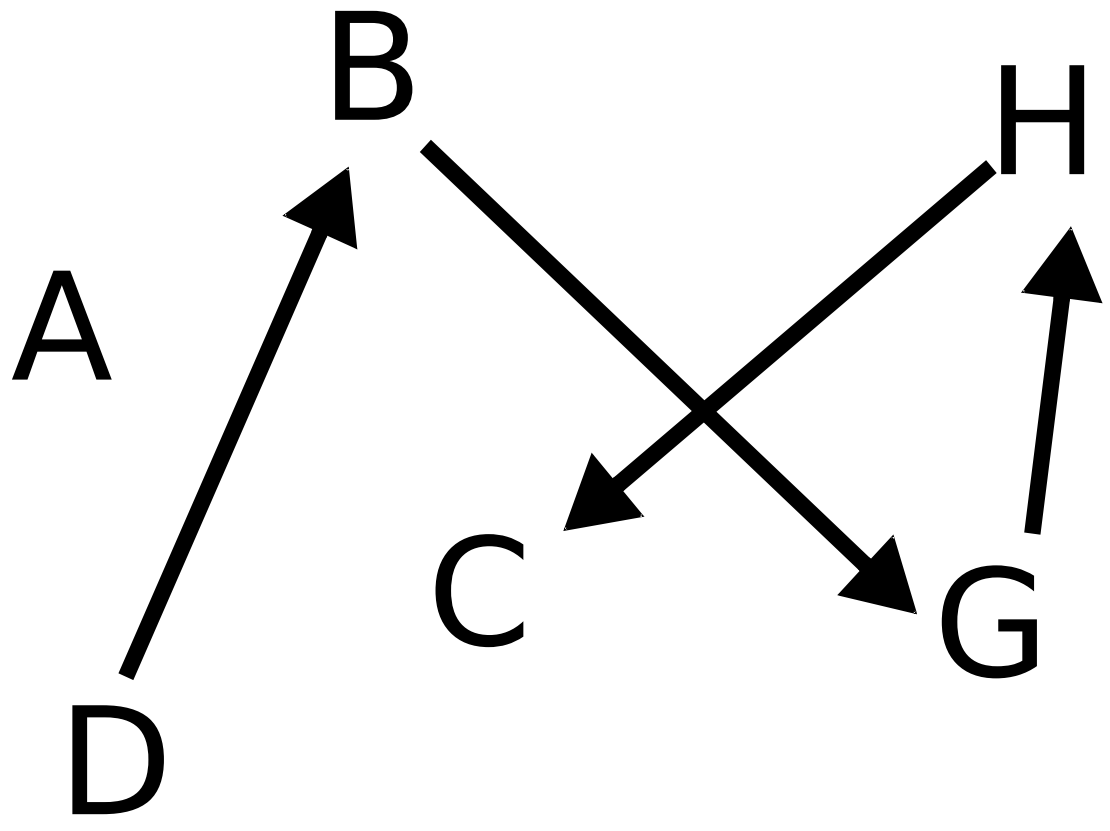
Understanding time-homogeneity in Monetary Systems

Andreas Schacker, Matthias Schmitt
and Dieter Braun, Systems Biophysics

Social Networks



Social Networks



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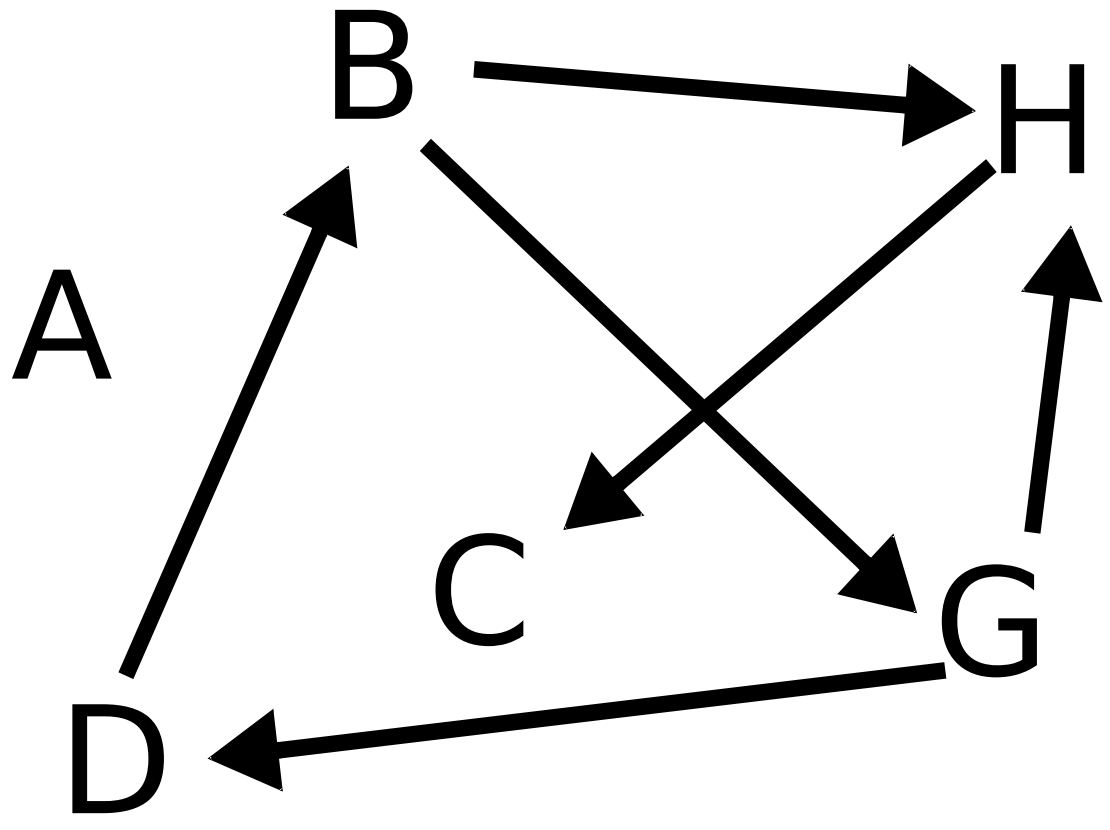
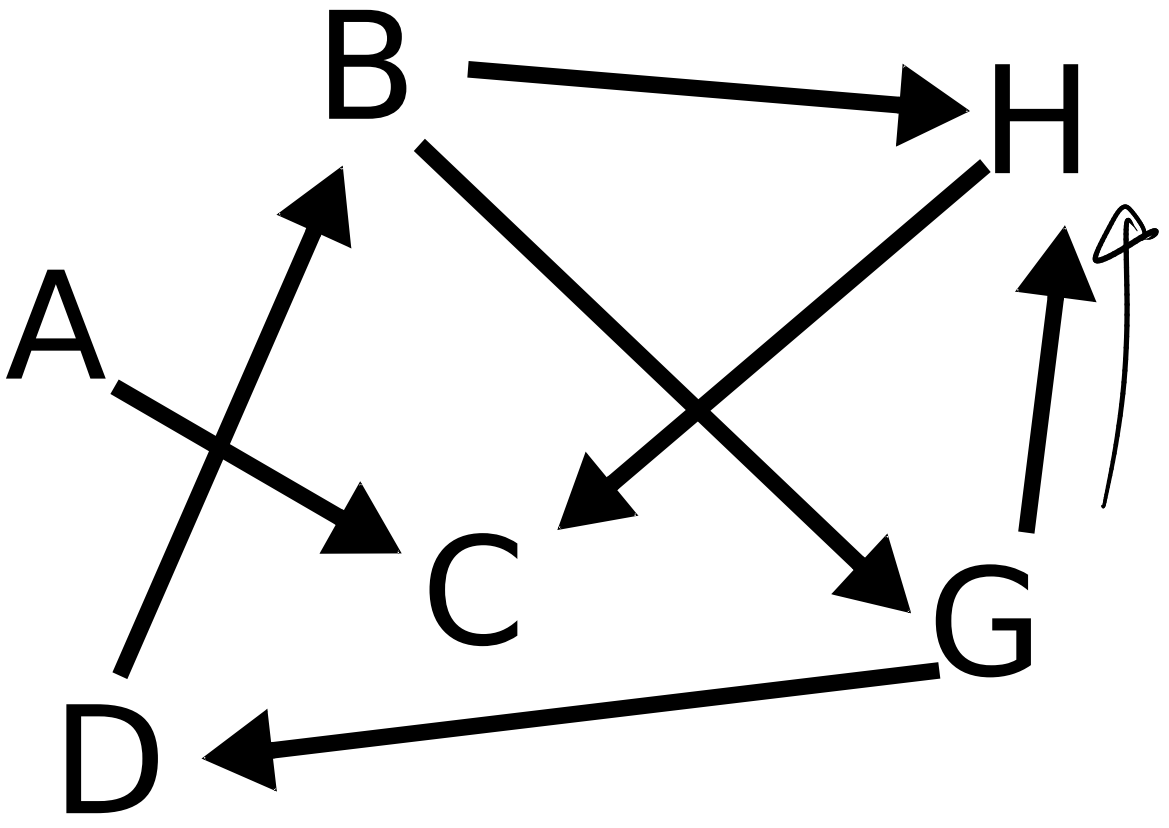
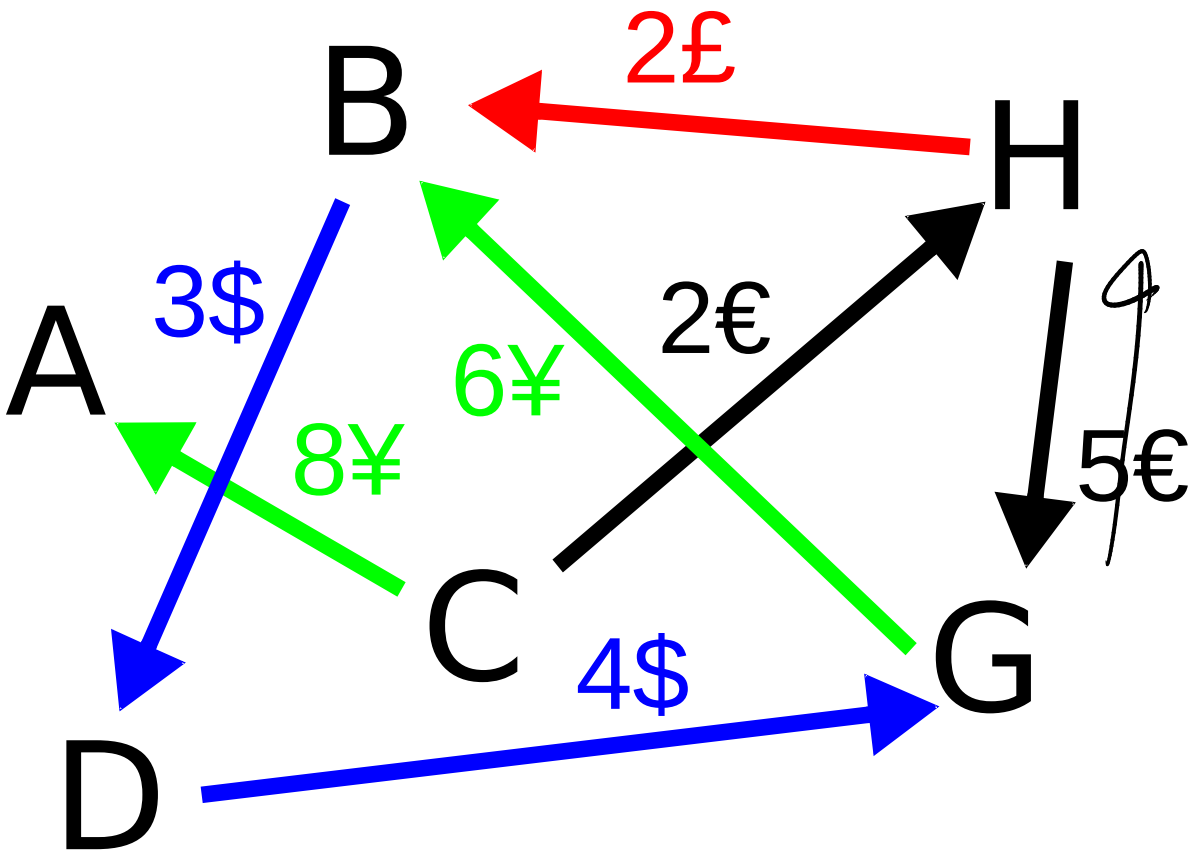


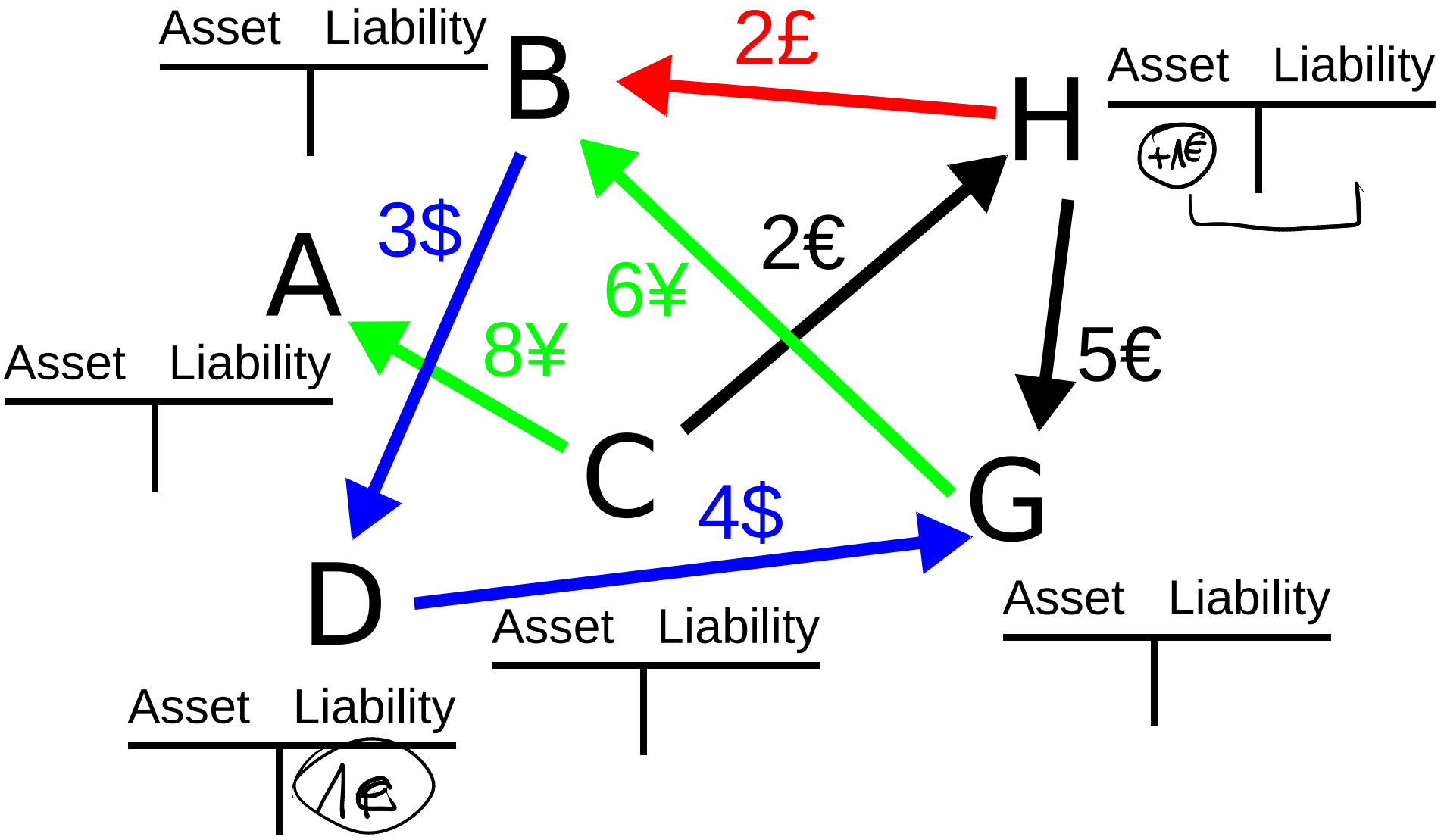
Social Networks



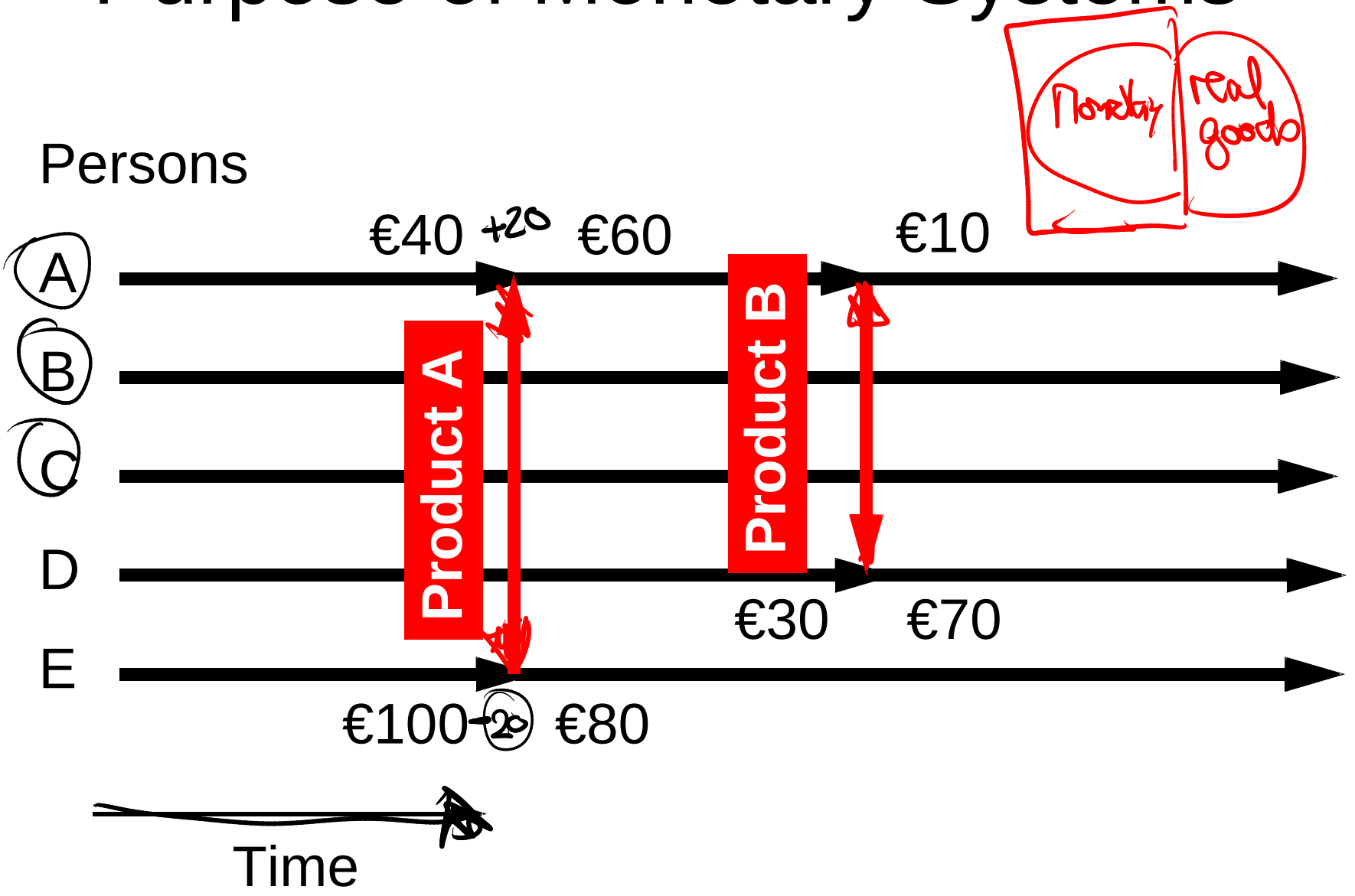
Social Networks of Money



Social Networks of Money are memorized by Bookkeeping



Purpose of Monetary Systems



Memory of Transactions

Network → Money Deposits

Bilanz zum 30. September 2003
mit Gegenüberstellung der Vorjahreszahlen in tausend Euro (TEUR)

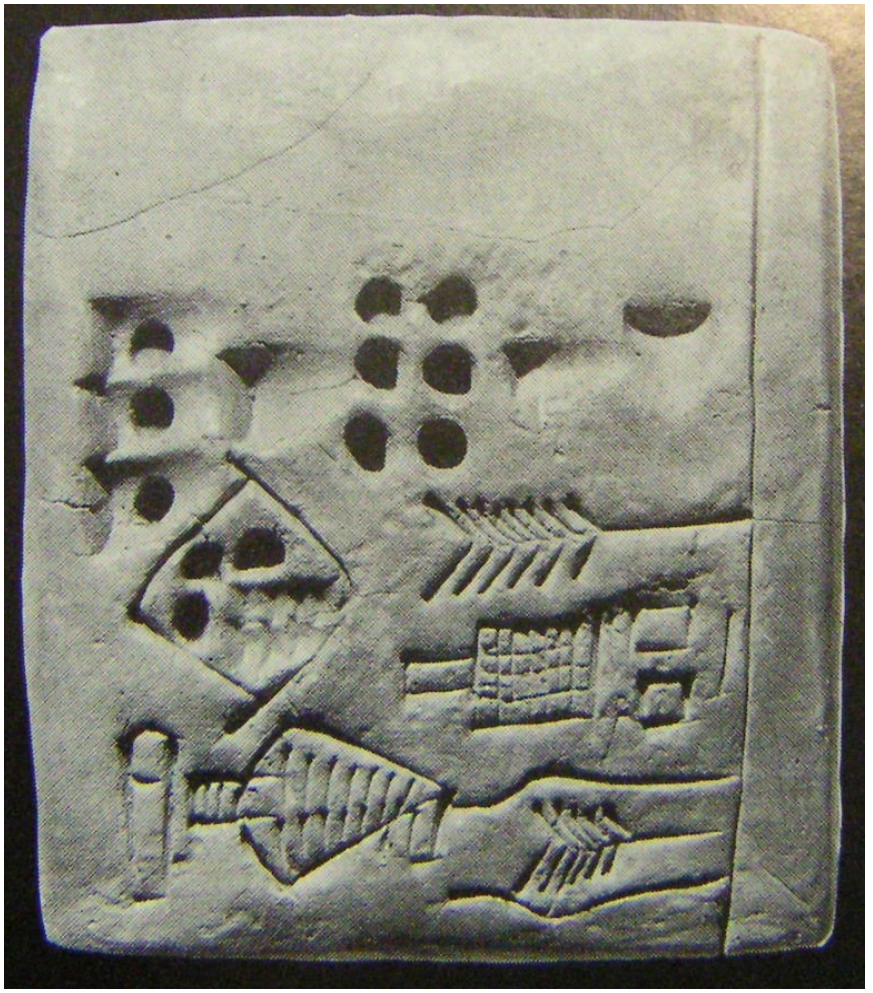
Aktiva:

	Stand am 30.9.2003 EUR	Stand am 30.9.2002 TEUR
A. Anlagevermögen		
I. Immaterielle Vermögensgegenstände	1.537.974	1.077,7
II. Sachanlagen	197.806.479	229.189,4
III. Finanzanlagen	448.339.036	579.672,0
	647.683.489	**809.939,1**
B. Umlaufvermögen		
I. Vorräte		
1. Roh-, Hilfs- und Betriebsstoffe	22.540.745	25.029,0
2. Unfertige Erzeugnisse	10.042.972	8.754,4
3. Fertige Erzeugnisse und Waren	12.423.942	6.824,9
4. Noch nicht abrechenbare Leistungen	105.565.228	102.016,4
5. Geleistete Anzahlungen	31.478.993	13.173,4
6. Erhaltene Anzahlungen auf Bestellungen	–97.769.723	–83.144,7
	84.282.157	**72.653,4**
II. Forderungen und sonstige Vermögensgegenstände		
1. Forderungen aus Lieferungen und Leistungen	151.375.196	164.065,3
2. Forderungen gegenüber verbundenen Unternehmen	596.717.308	1.103.437,4
3. Forderungen gegenüber Unternehmen, mit denen ein Beteiligungsverhältnis besteht	22.281.241	24.675,6
4. Sonstige Forderungen und Vermögensgegenstände davon aktivierte latente Steuern: EUR90.470.000; Vorjahr: TEUR97.570,0	120.751.243	129.676,9
	891.124.988	**1.421.855,2**
III. Wertpapiere und Anteile	**578.883.271**	**9.638,3**
IV. Kassenbestand, Schecks, Guthaben bei Kreditinstituten	**5.980.646**	**12.532,1**
	1.560.271.062	**1.516.679,0**
	2.207.954.551	**2.326.618,1**

Passiva:

	Stand am 30.9.2003 EUR	Stand am 30.9.2002 TEUR
A. Eigenkapital		
I. Grundkapital	**125.925.000**	**125.925,0**
II. Kapitalrücklagen		
1. Gebundene	33.310.968	33.311,0
2. Nicht gebundene	7.441.704	7.441,7
	40.752.672	**40.752,7**
III. Gewinnrücklagen		
Andere Rücklagen (freie Rücklagen)	**251.241.048**	**241.241,0**
IV. Bilanzgewinn	**180.186.809**	**221.404,5**
davon Gewinnvortrag: EUR1.404.476; Vorjahr: TEUR296,1		
	598.105.529	**629.323,2**
B. Unversteuerte Rücklagen		
1. Bewertungsreserve auf Grund von Sonderabschreibungen	49.424.901	45.948,6
2. Sonstige unversteuerte Rücklagen	3.230.543	5.241,7
	52.655.444	**51.190,3**
C. Rückstellungen		
1. Rückstellungen für Abfertigungen	103.276.686	147.474,1
2. Rückstellungen für Pensionen	9.726.660	15.149,7
3. Steuerrückstellungen	103.555.526	152.239,9
4. Sonstige Rückstellungen	656.417.297	617.361,3
	872.976.169	**932.225,0**
D. Verbindlichkeiten		
1. Verbindlichkeiten gegenüber Kreditinstituten	69.699.407	59.123,2
2. Erhaltene Anzahlungen auf Bestellungen	108.858.060	68.995,1
3. Verbindlichkeiten aus Lieferungen und Leistungen	168.059.721	173.958,4
4. Verbindlichkeiten gegenüber verbundenen Unternehmen	102.795.481	190.175,0
5. Verbindlichkeiten gegenüber Unternehmen, mit denen ein Beteiligungsverhältnis besteht	5.907.977	7.756,1
6. Sonstige Verbindlichkeiten davon aus Steuern: EUR43.068.941; Vorjahr: TEUR34.135,7 davon im Rahmen der sozialen Sicherheit: EUR72.504.100; Vorjahr: TEUR72.018,9	224.300.687	210.216,0
	679.621.333	**710.223,8**
E. Rechnungsabgrenzungsposten	**4.596.076**	**3.655,8**
	2.207.954.551	**2.326.618,1**
Verbindlichkeiten aus Haftungsverhältnissen	10.368.441	25.242,1

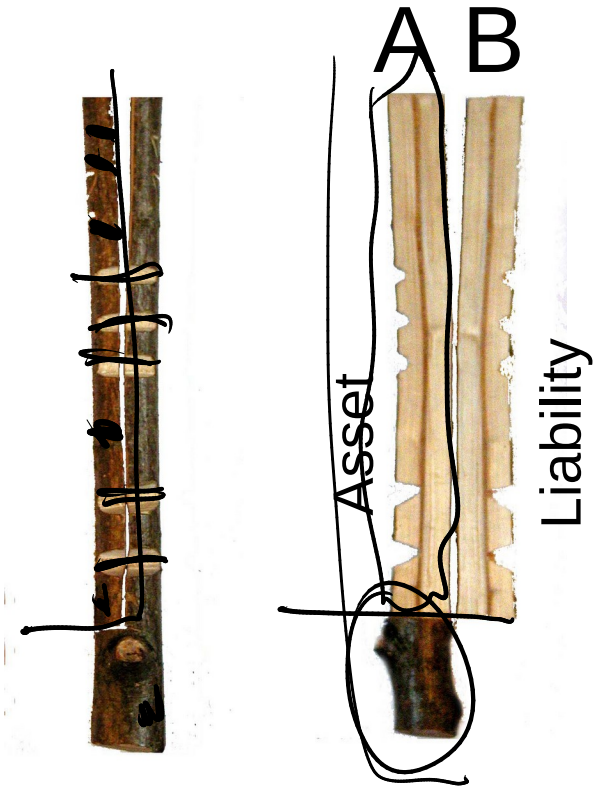
Bookkeeping Networks



Clay Tablets

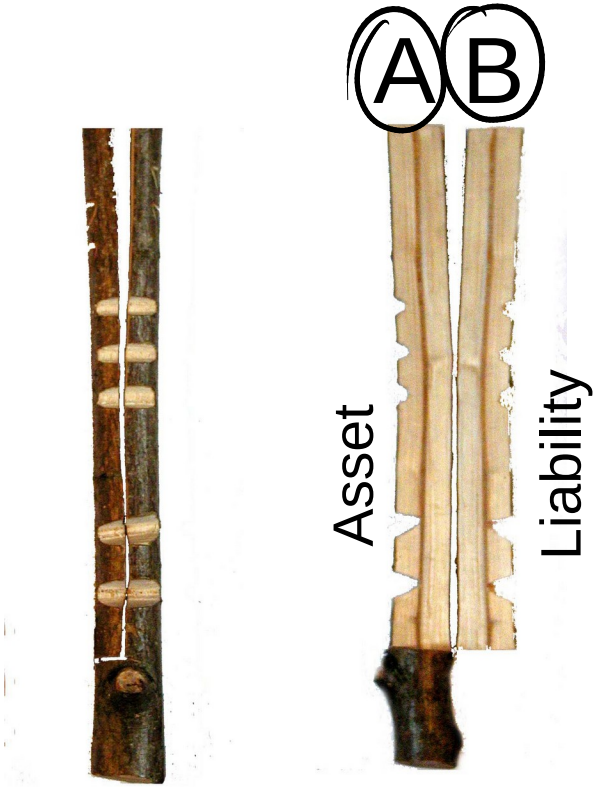
Bookeeping Networks

Tally Sticks



Bookeeping Networks

Tally Sticks



Network

B → A

A

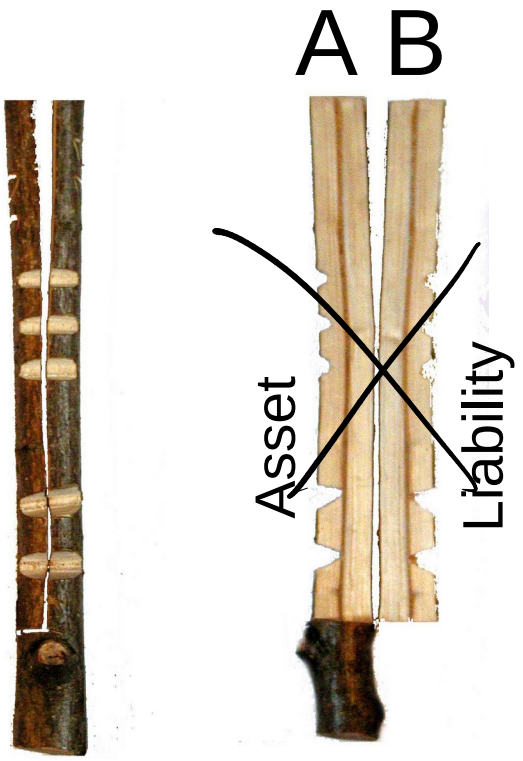
+1$

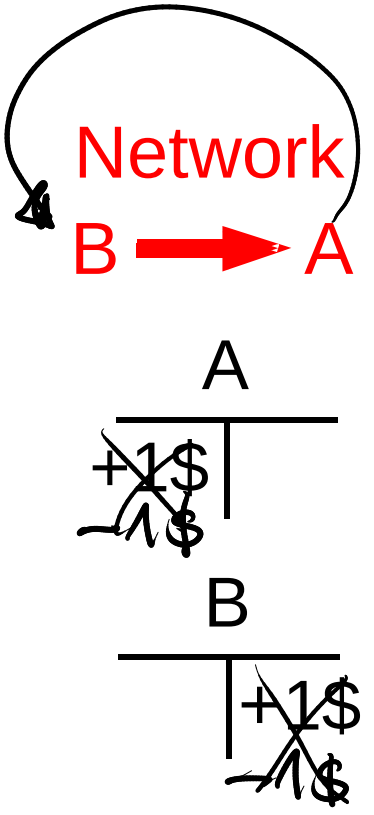
B

+1$

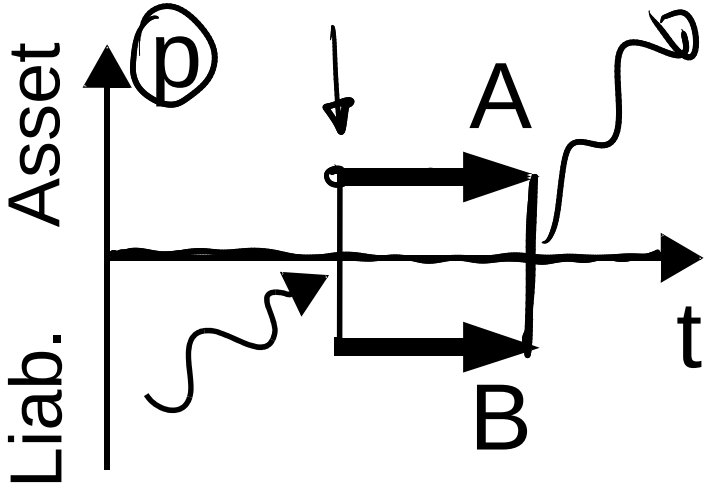
Bookeeping Networks

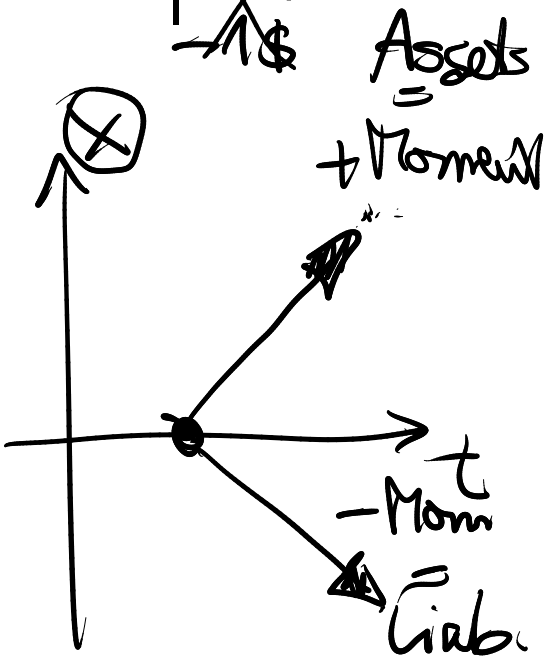
Tally Sticks





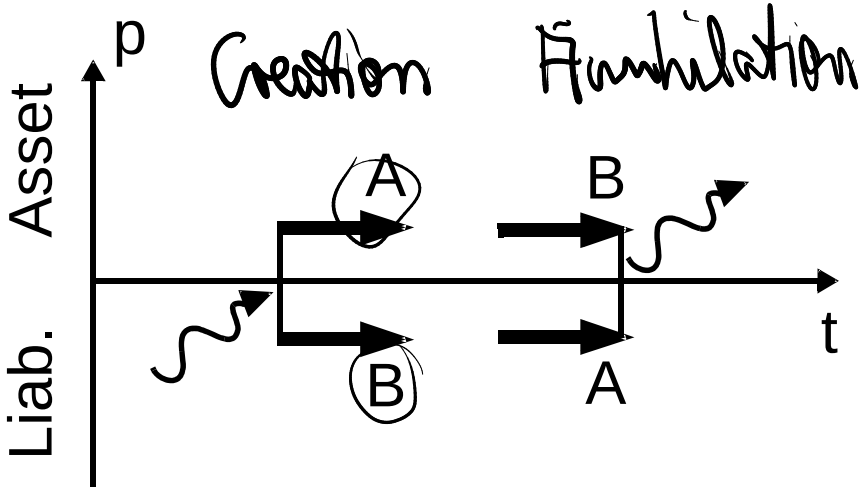
Map to Particle Excitations

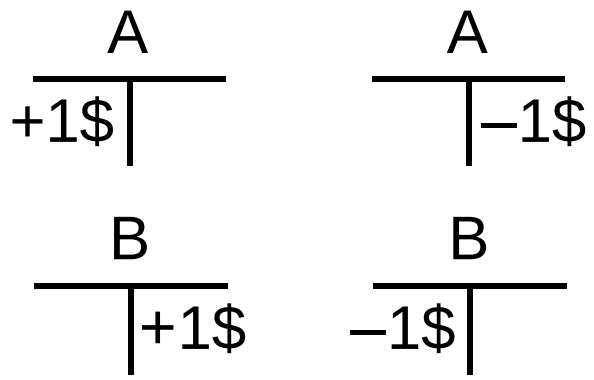




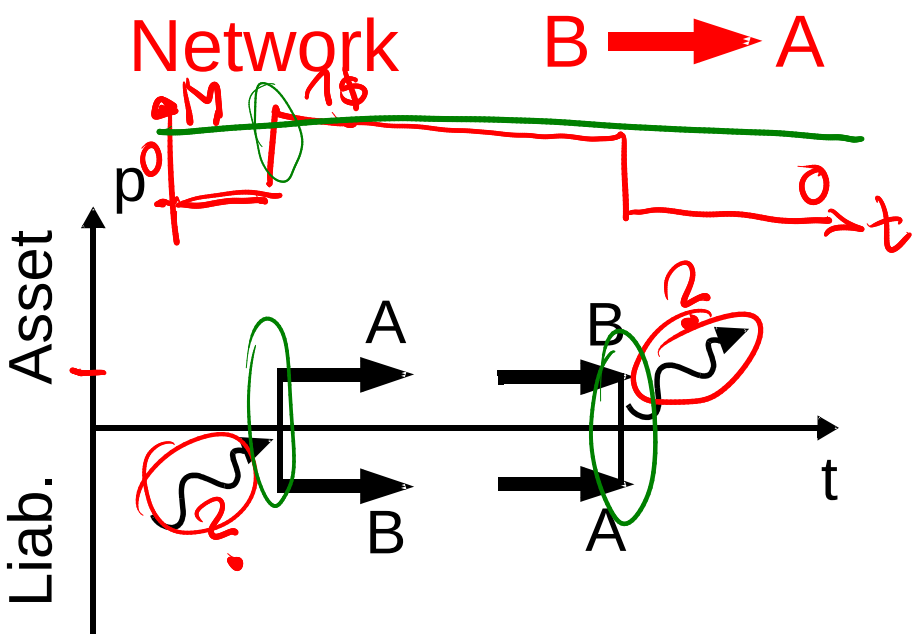
Bookeeping Networks

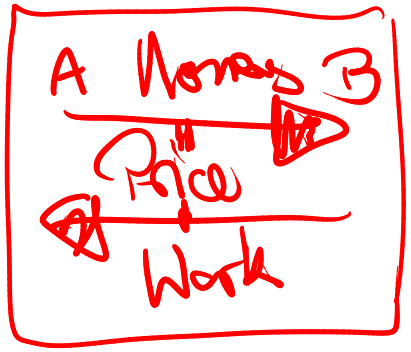
Network B → A

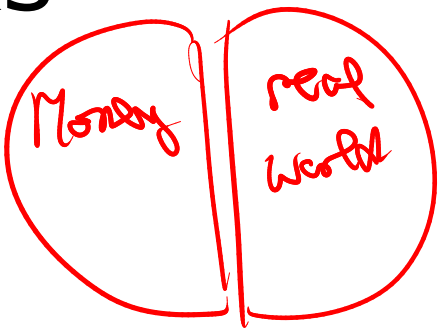




Bookeeping Networks

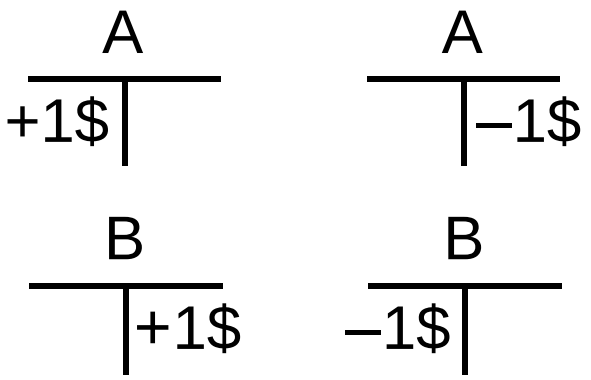






Mapping

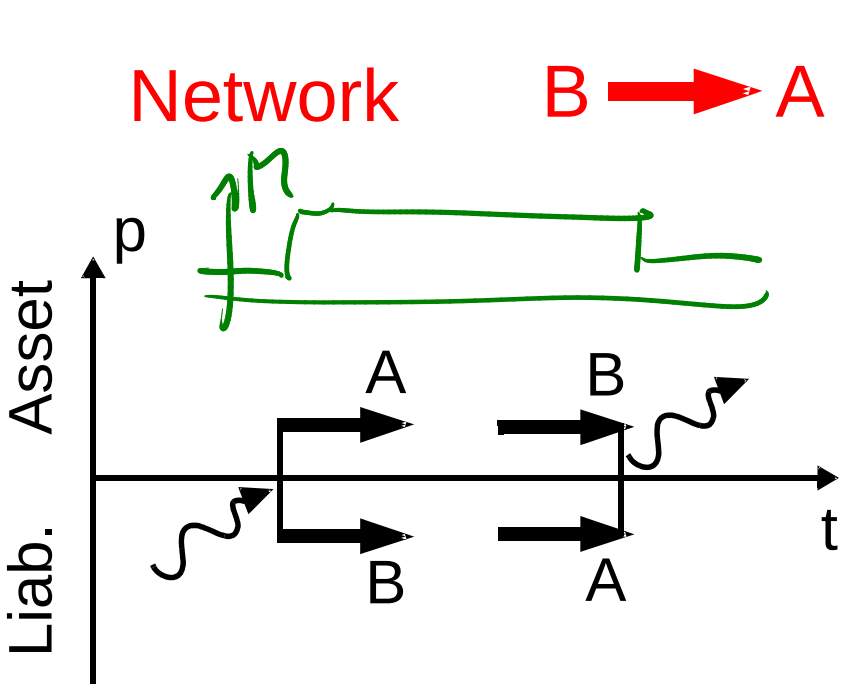
Value	Momentum
Asset	$p>0$
Liability	$p<0$
Profit	Force dp/dt
Quantity	f(Energy) $\frac{1}{2}mv^2$

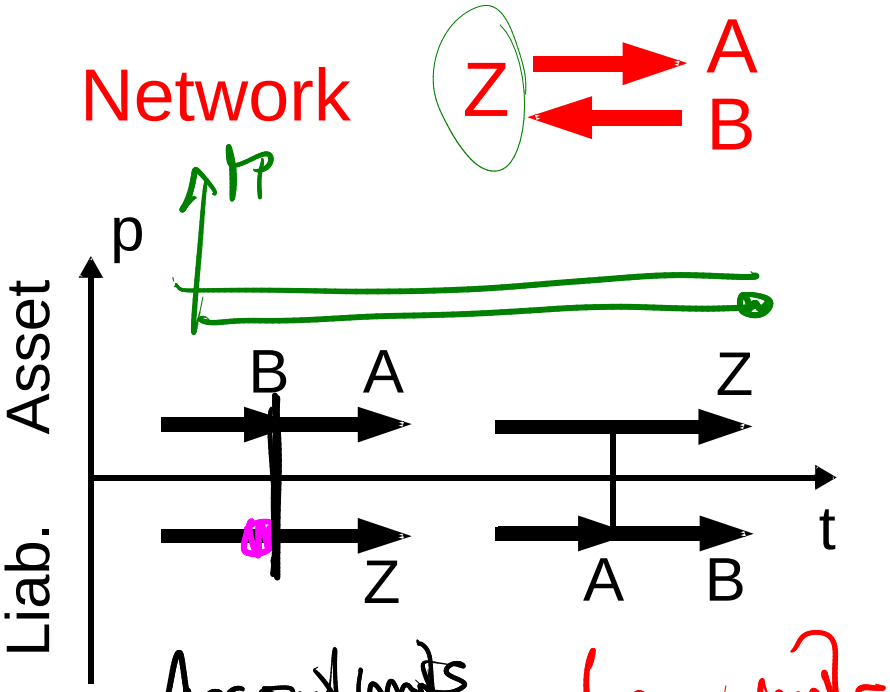


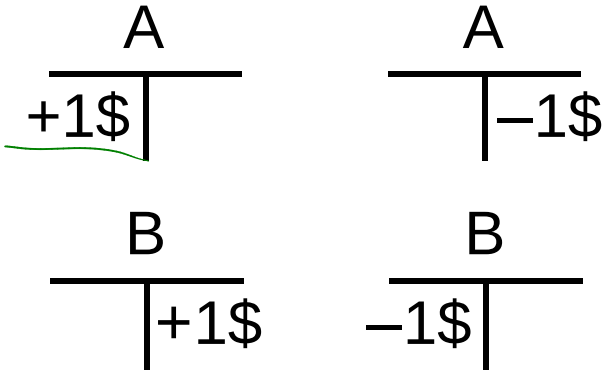
Physica A 290:491-500 (2001)

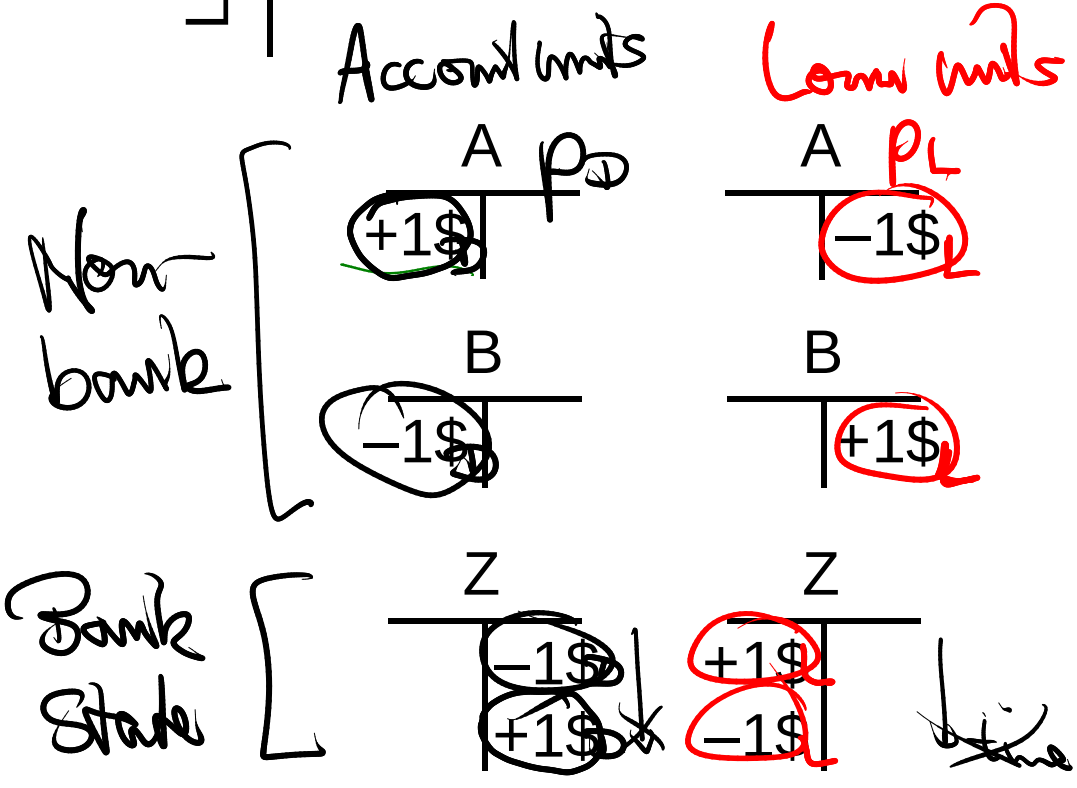
Physica A 324:266-271 (2003)

Bookeeping Networks

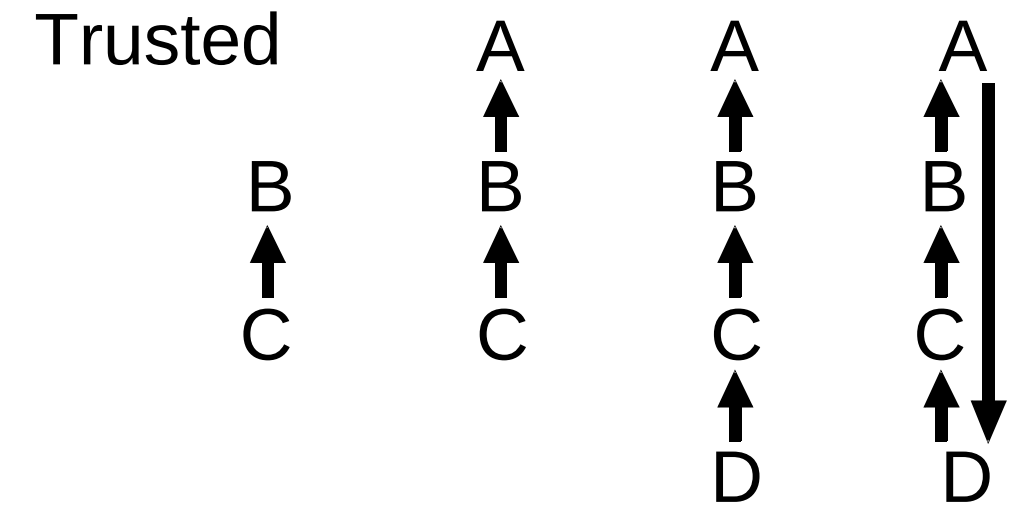


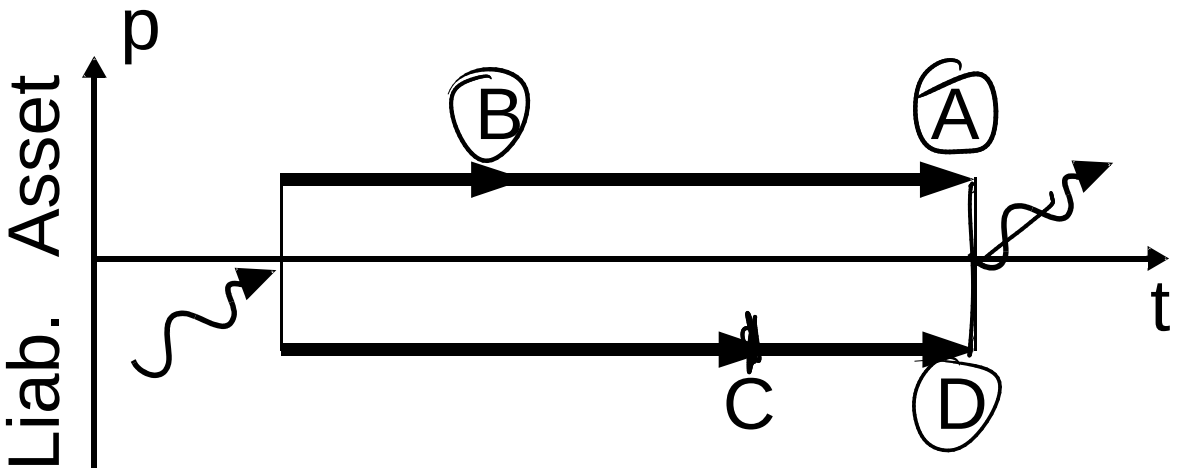






Circular transfer





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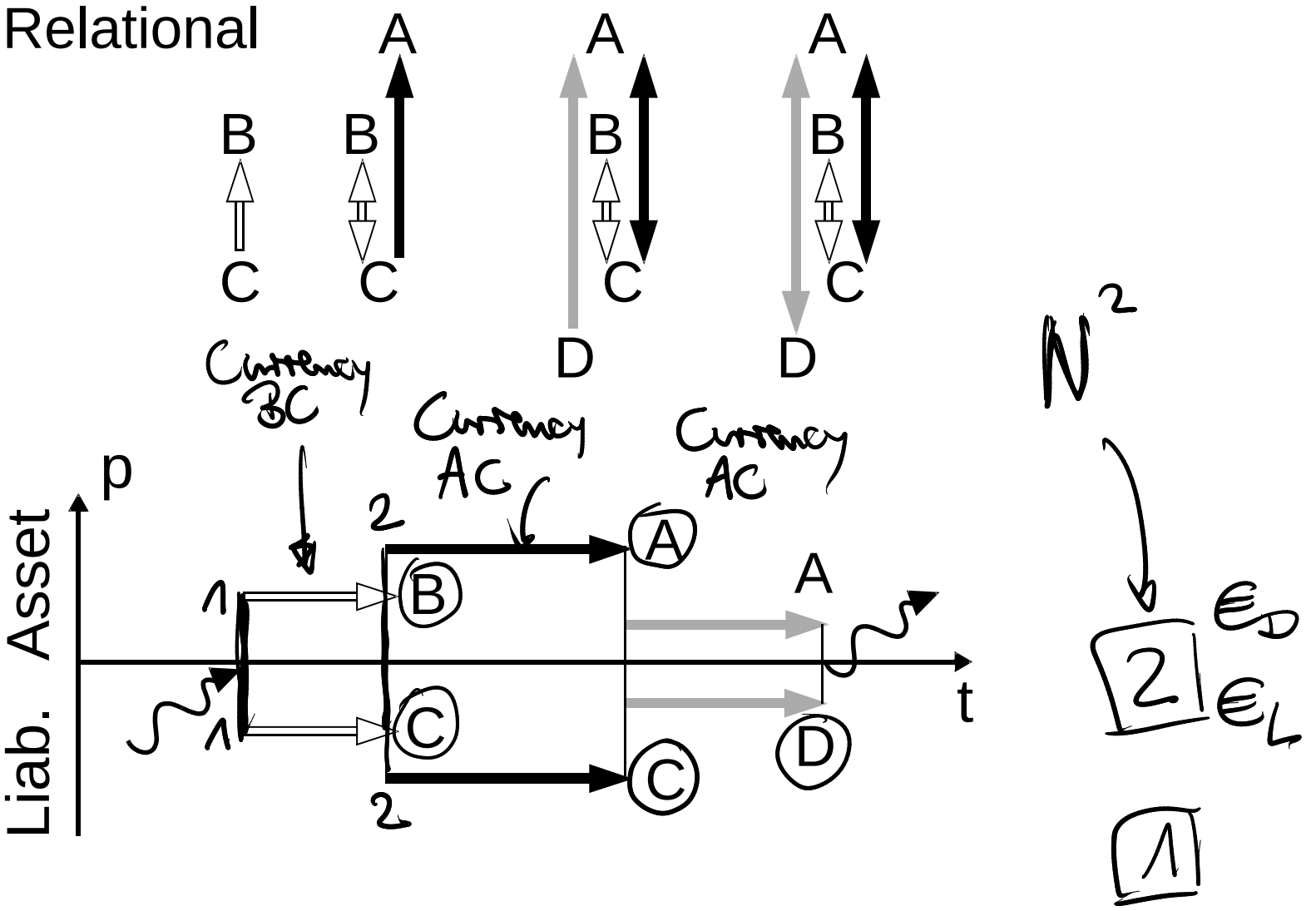
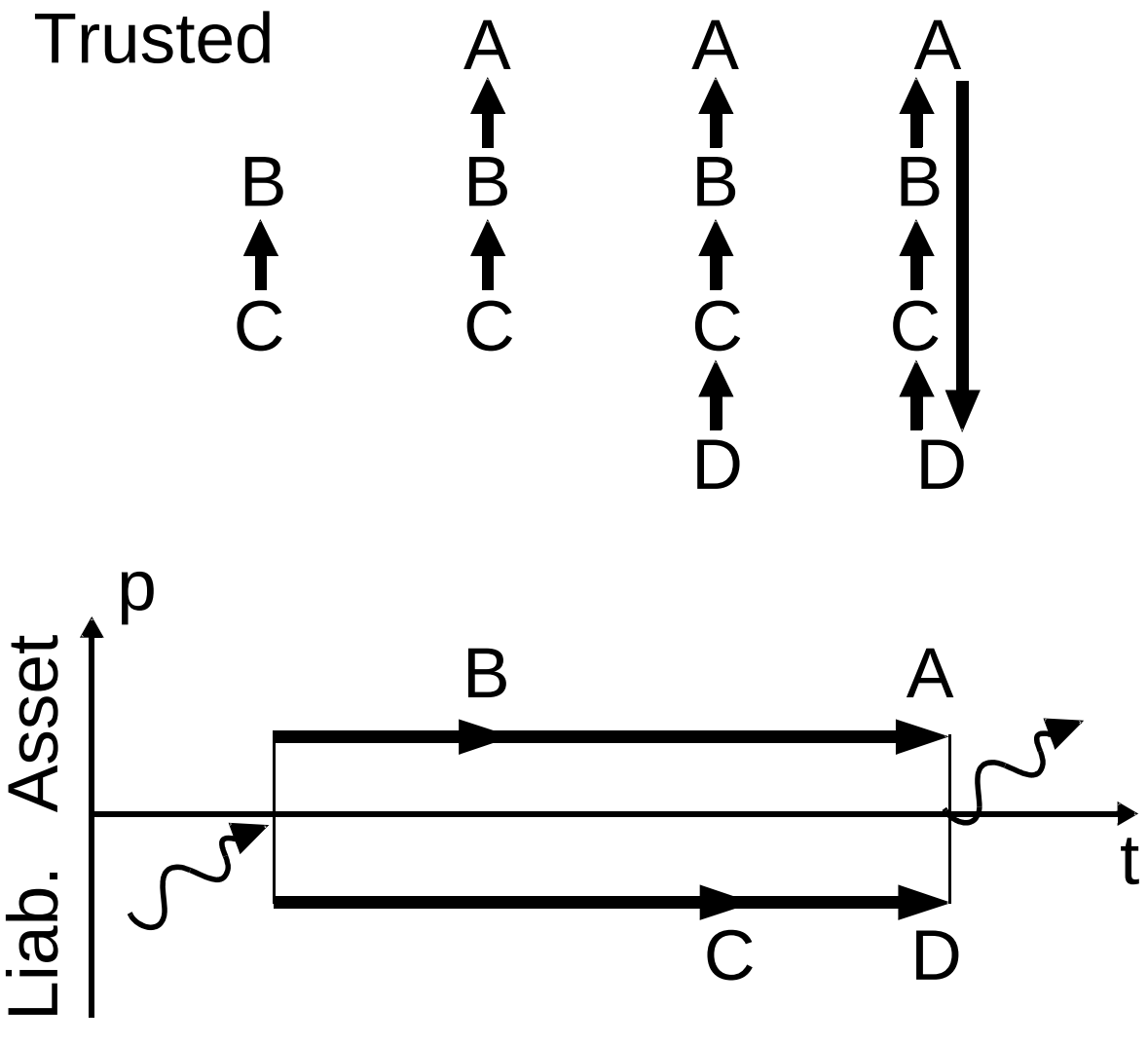


Circular transfer



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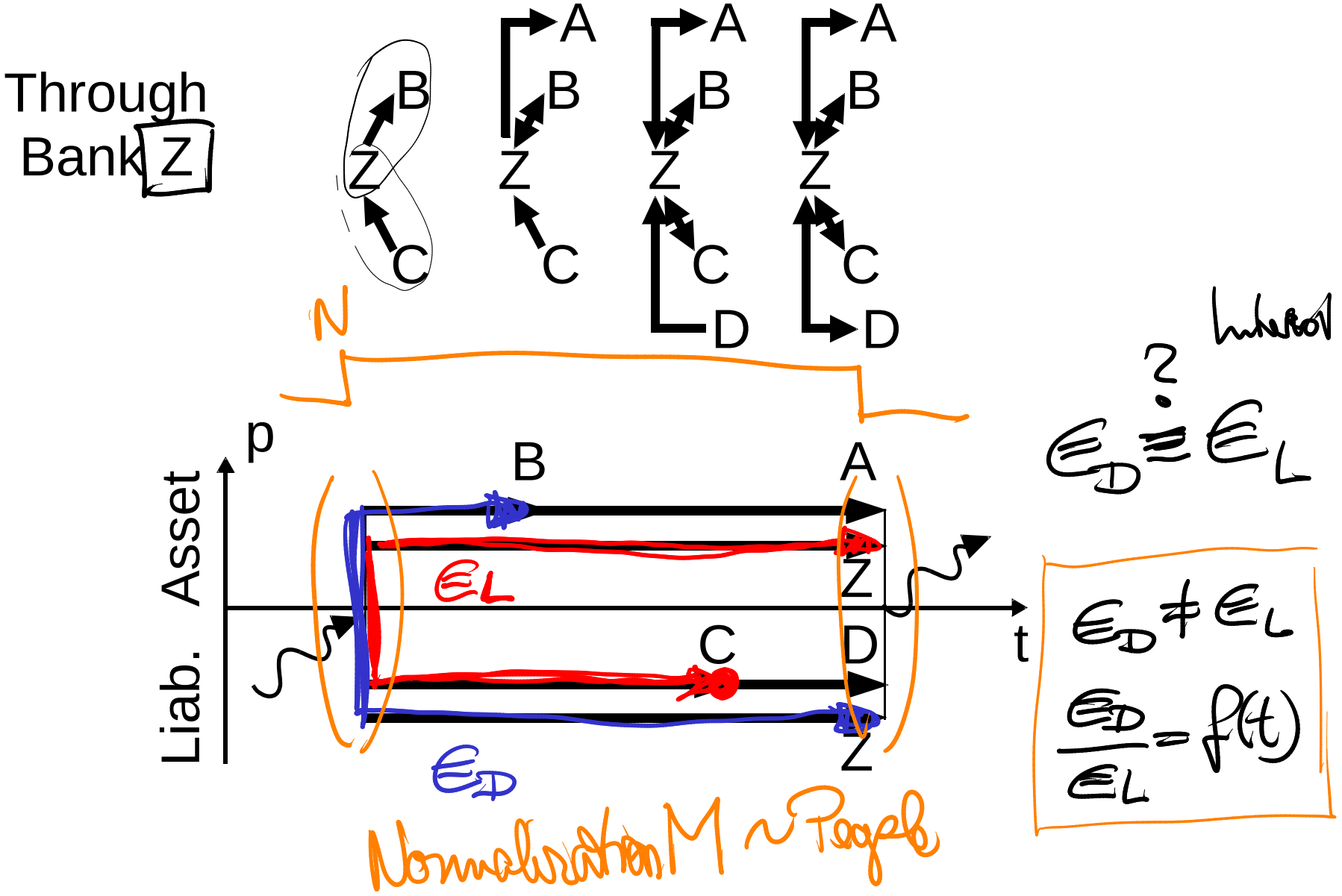
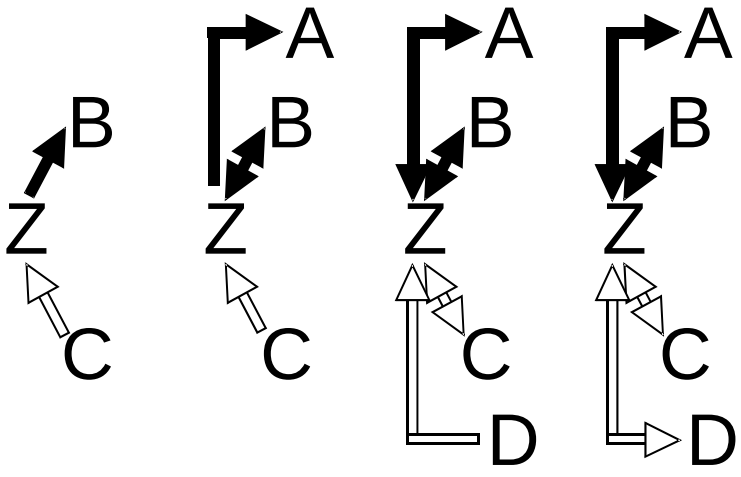
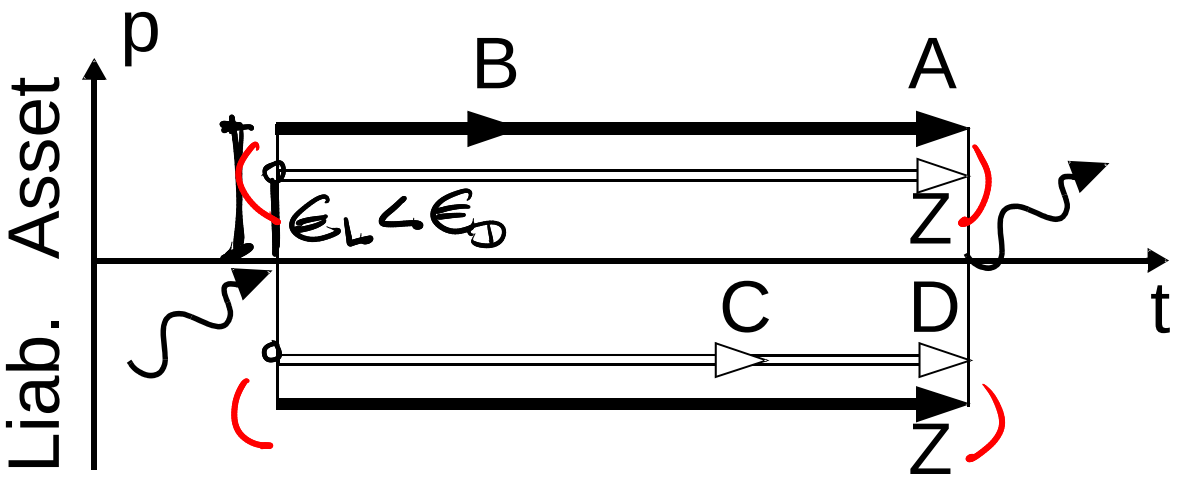


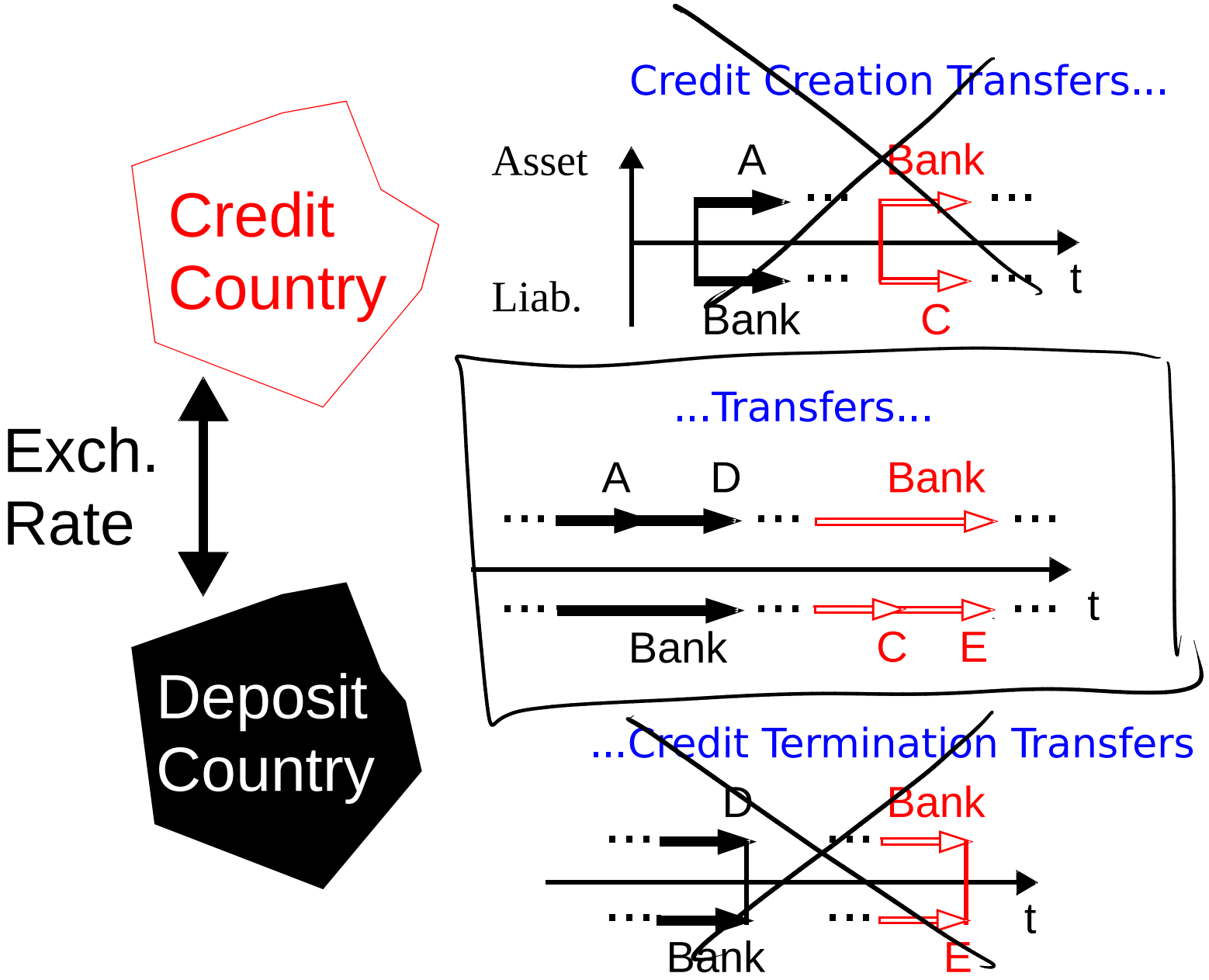
Circular transfer

Through
Bank
with free Rate
Deposits : Credits

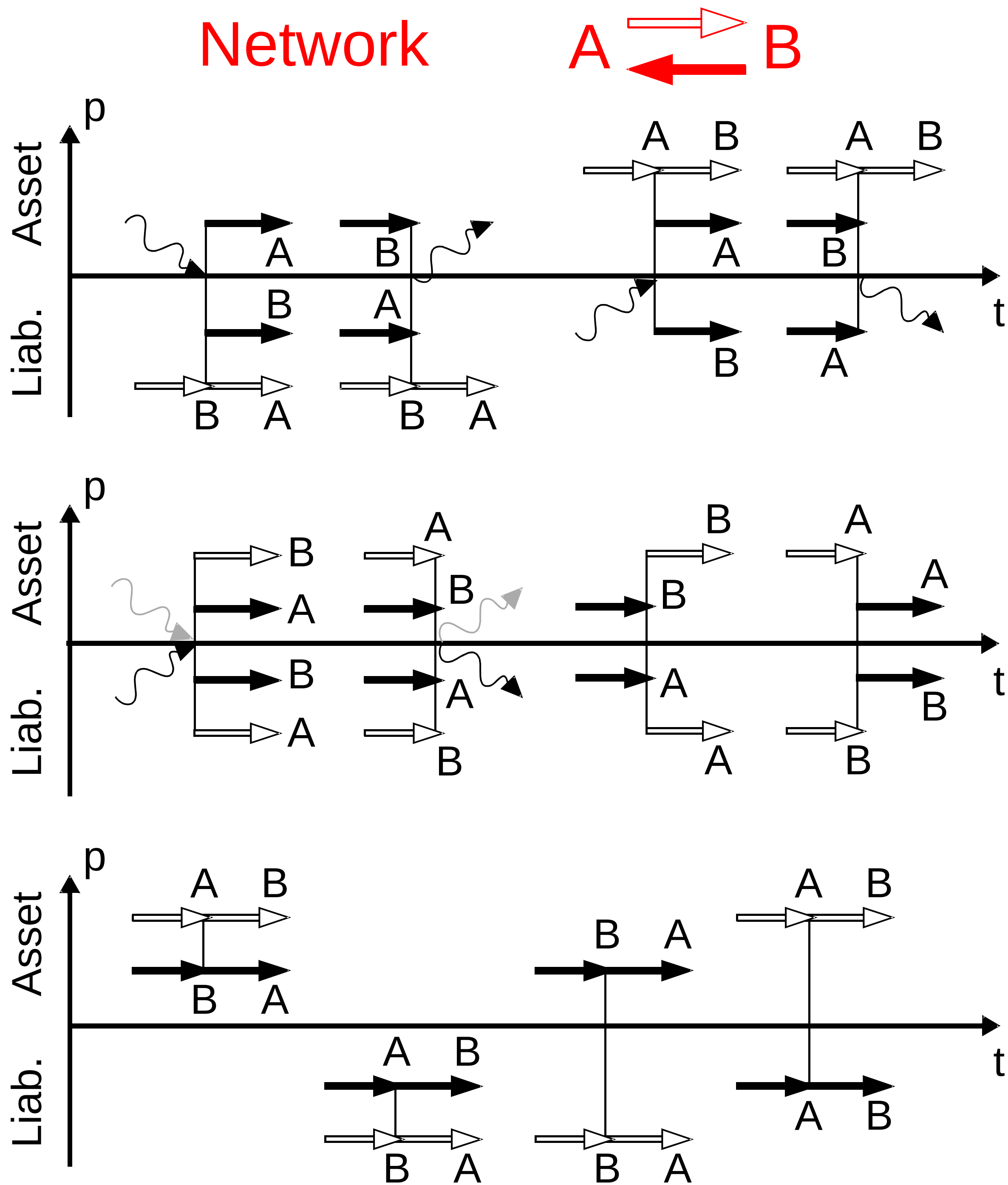




Traditional Banking ... has two currencies



Bookeeping Networks



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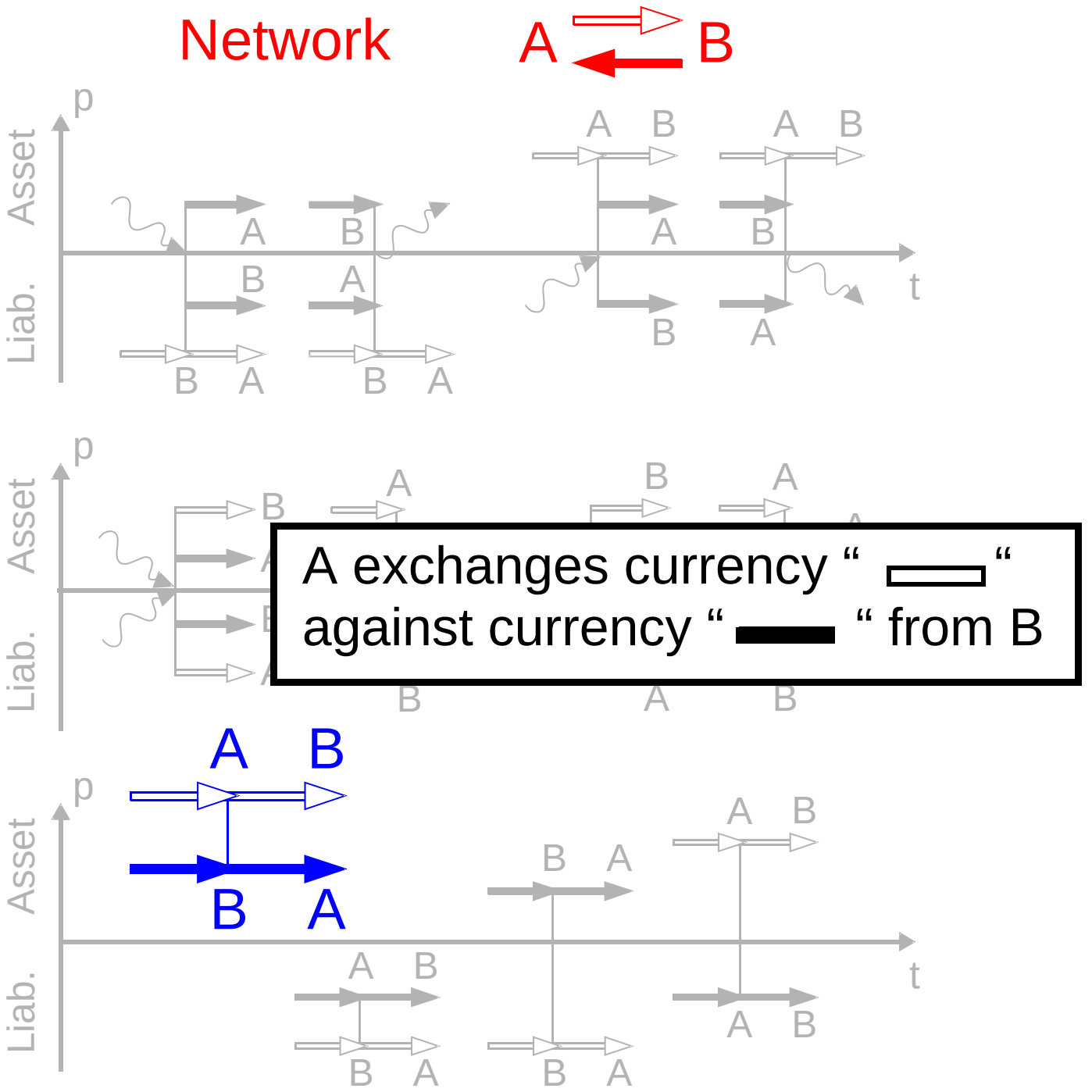

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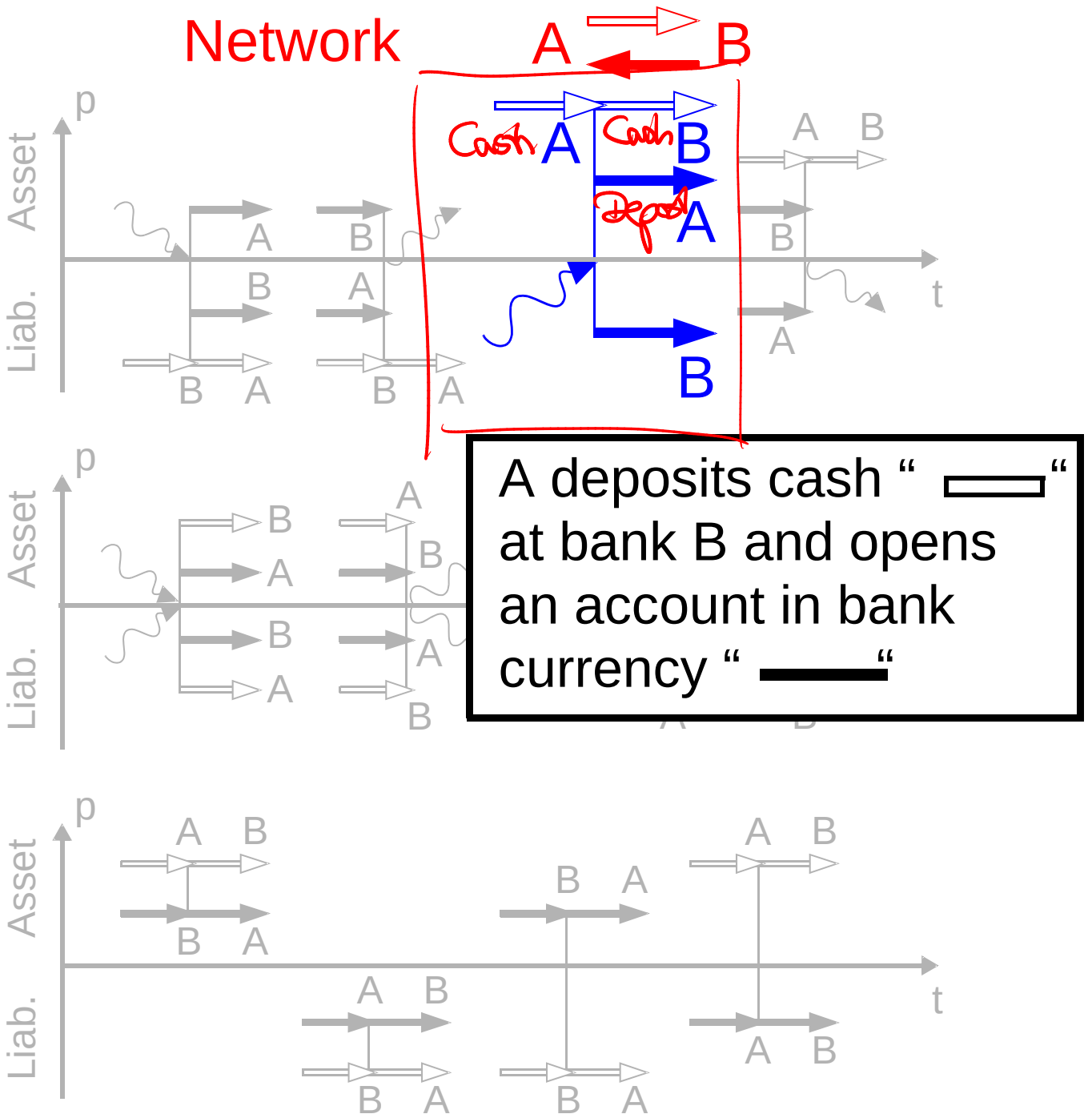

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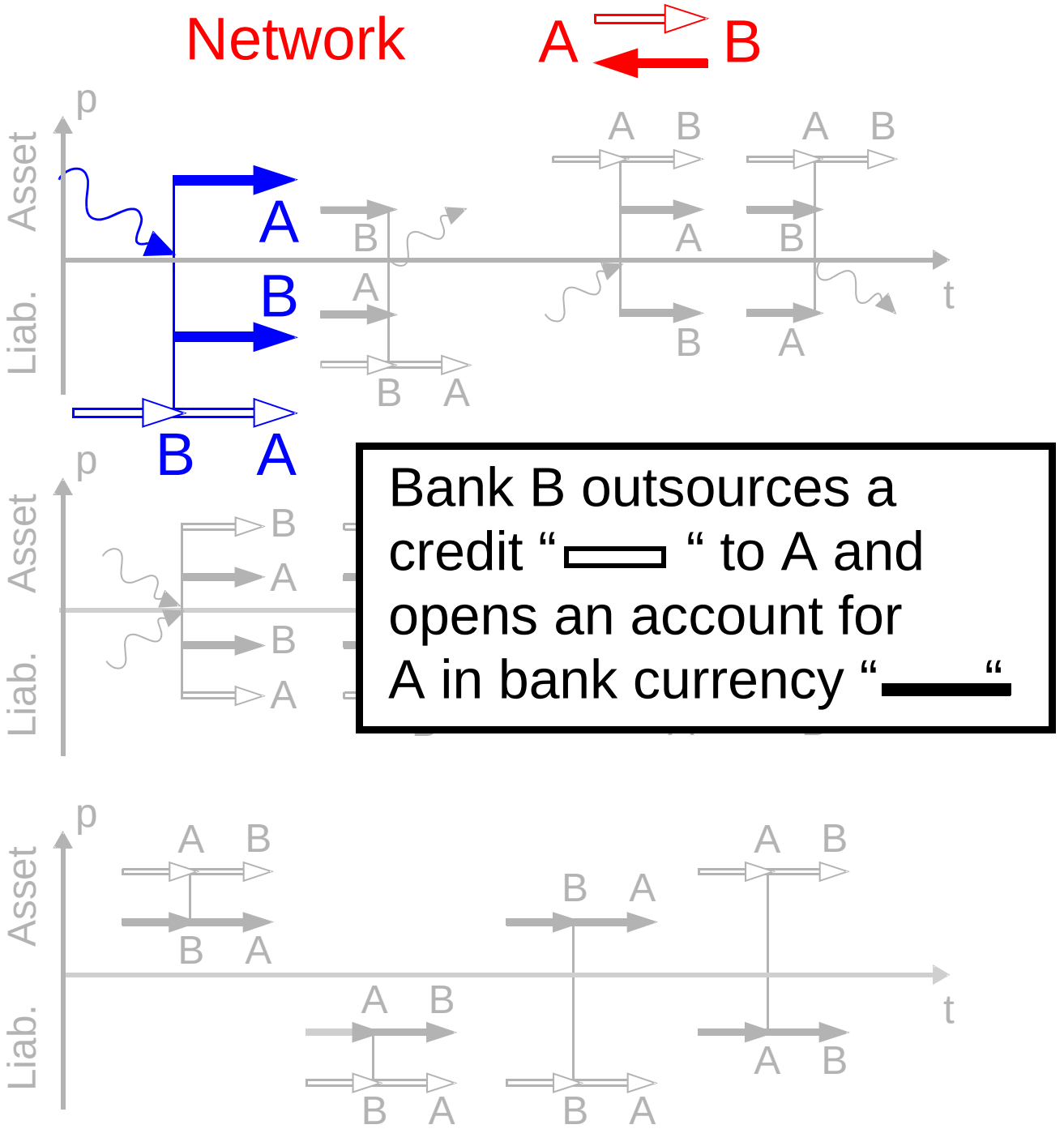

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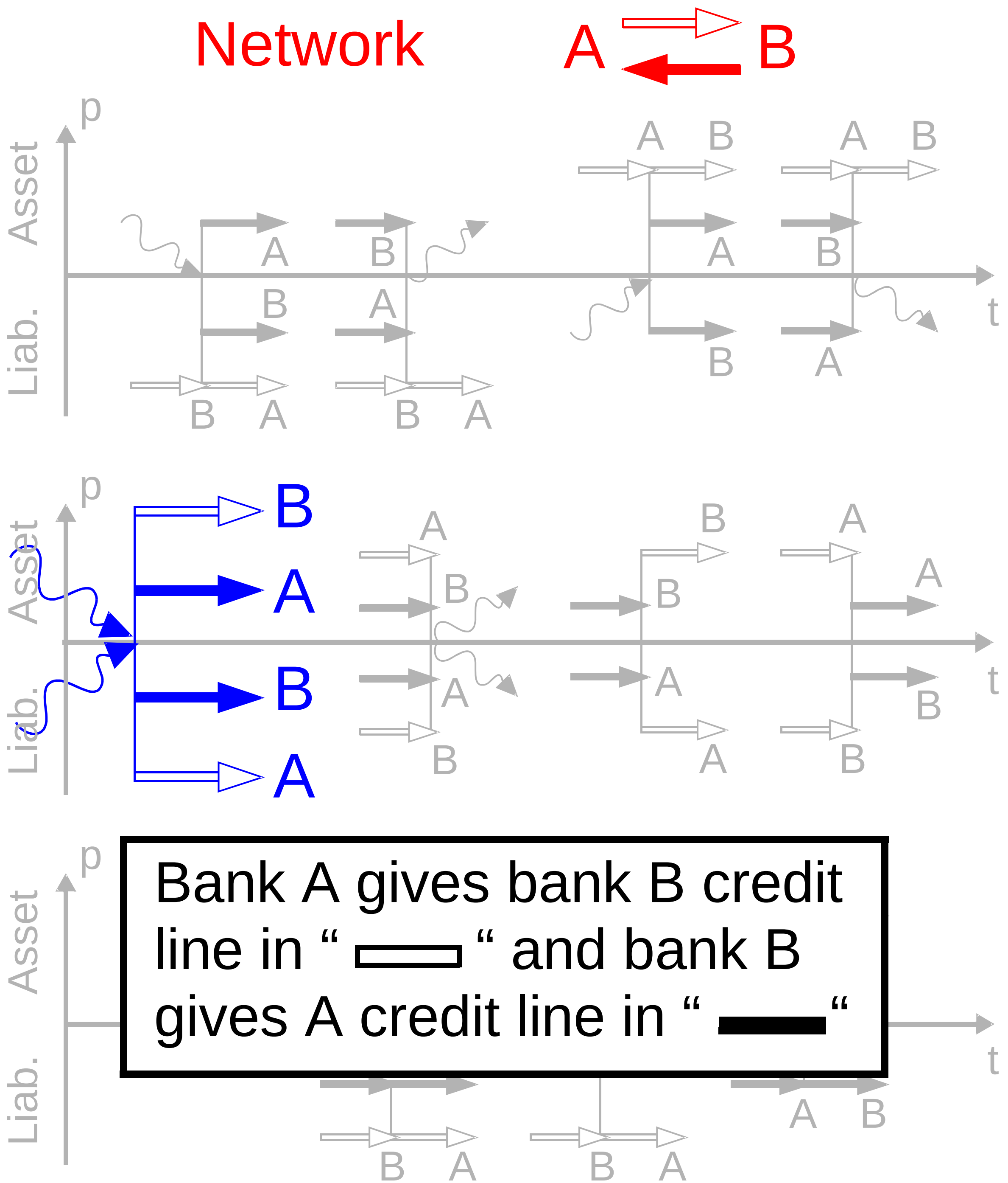
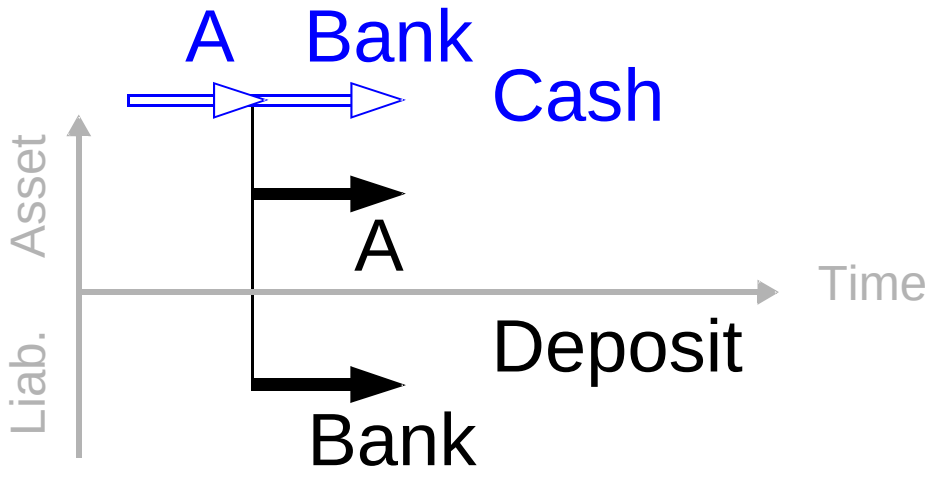


Debt dynamics

Piggy Bank

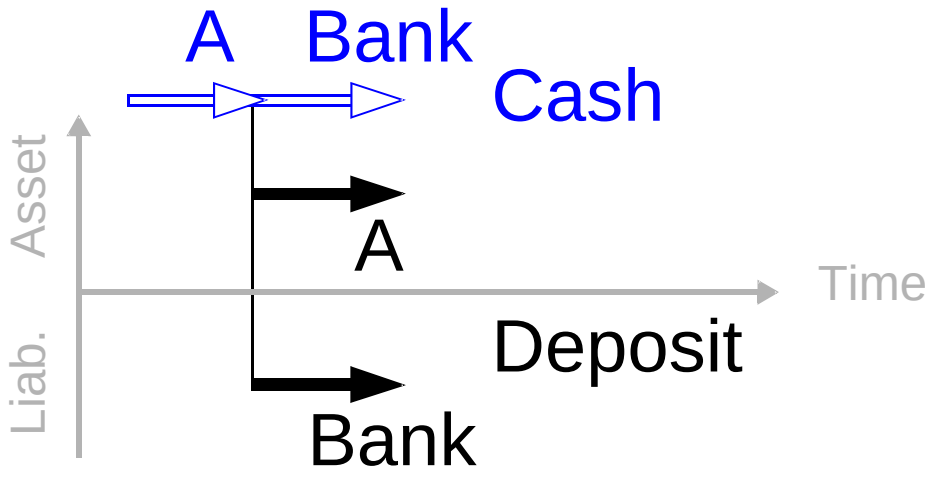
Debt dynamics

Piggy Bank

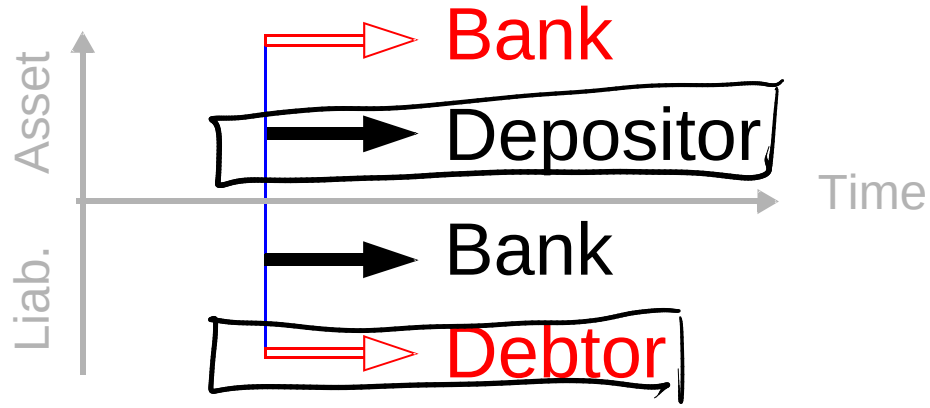


Debt dynamics

Piggy Bank



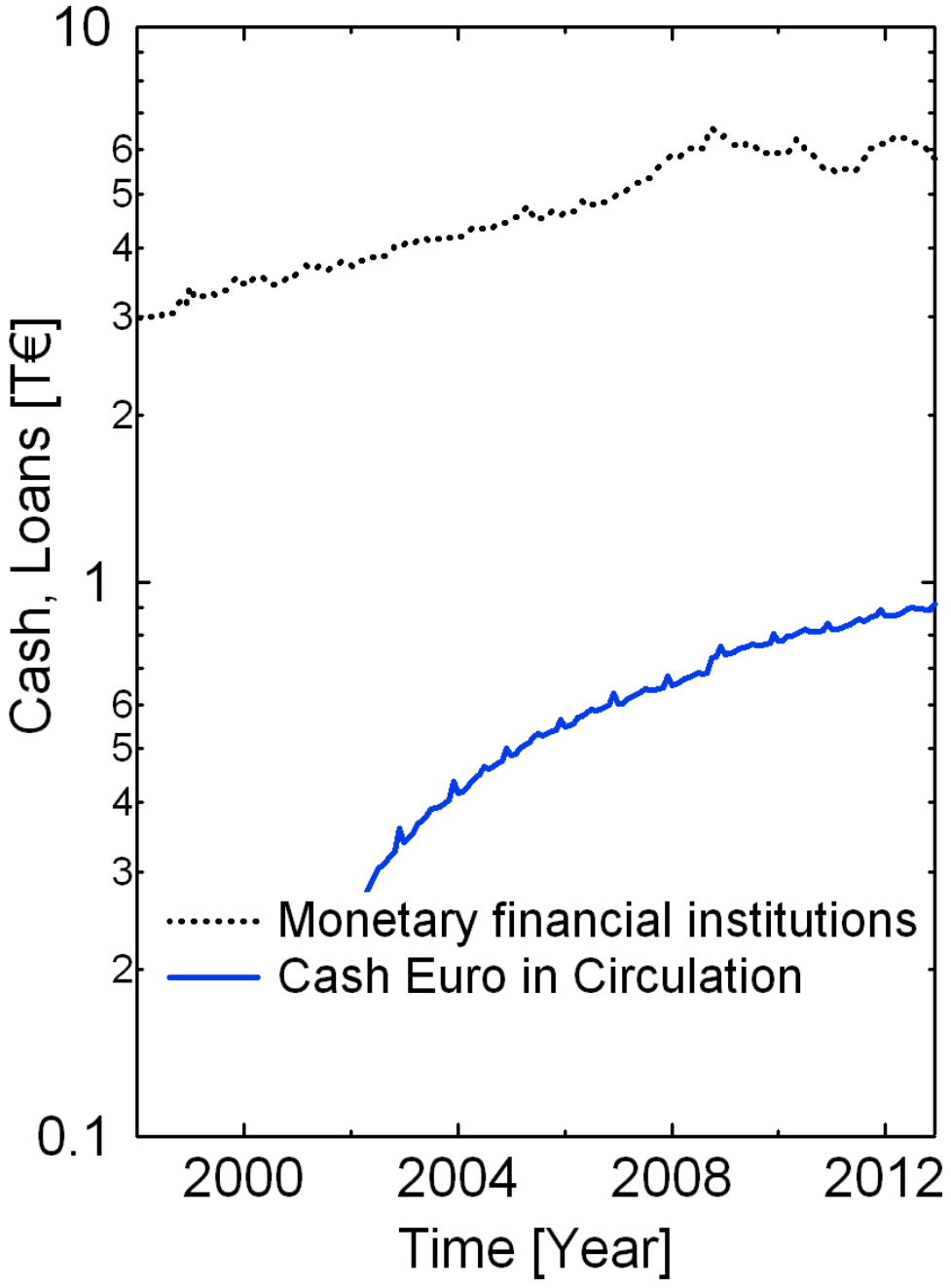
Payment with Credit

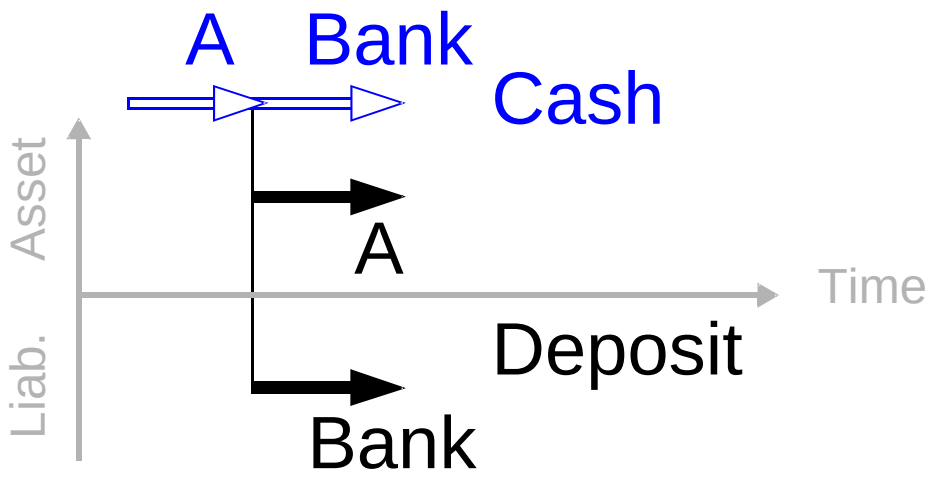


Deposit Units

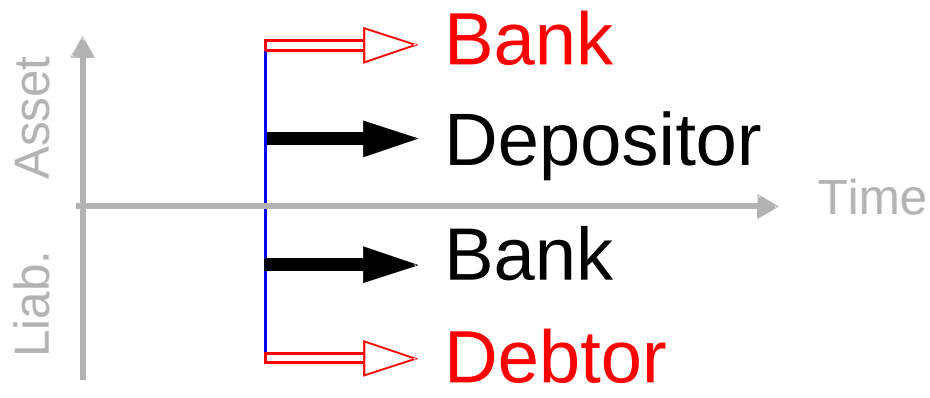
Credit Units

Debt dynamics





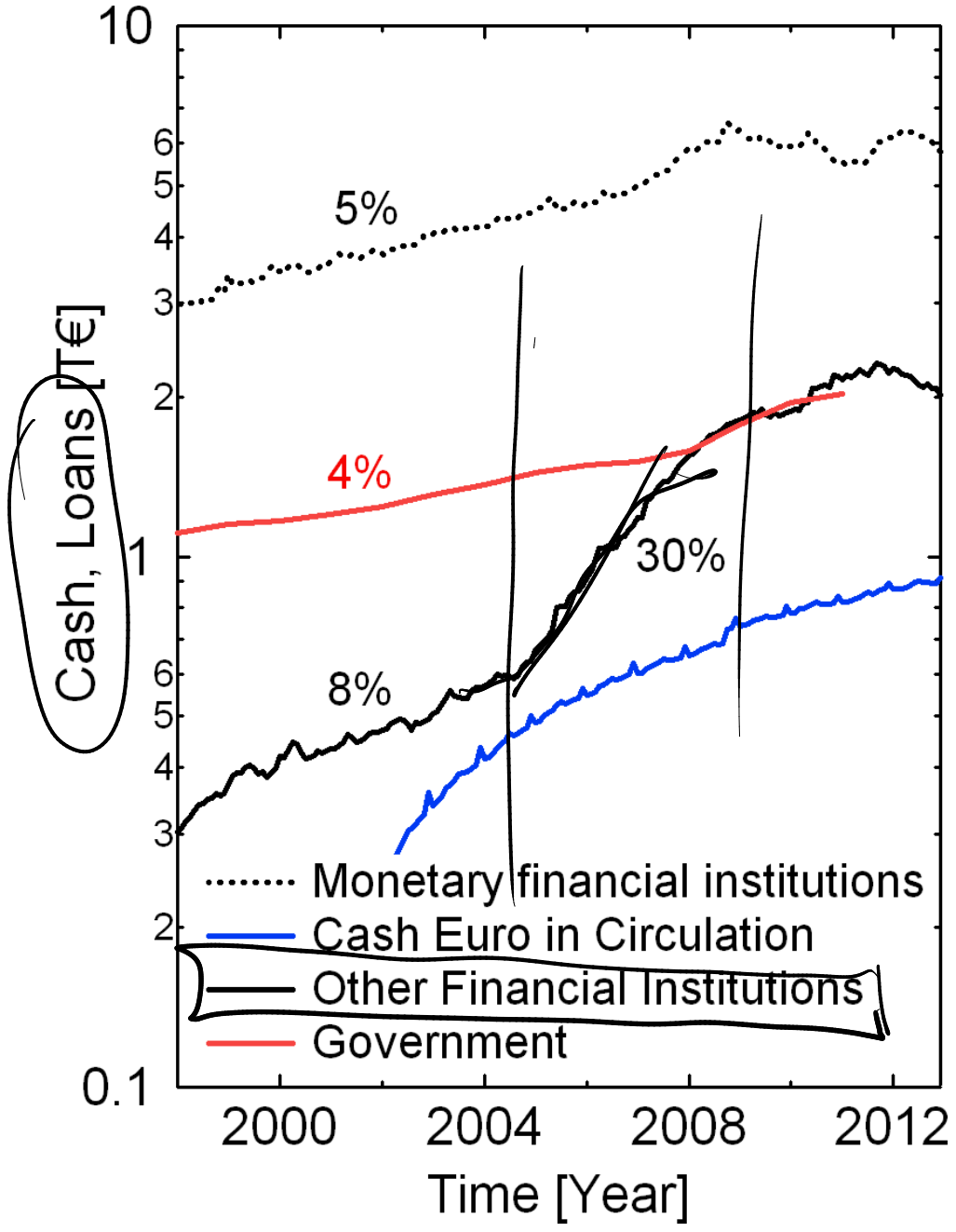
Payment with Credit

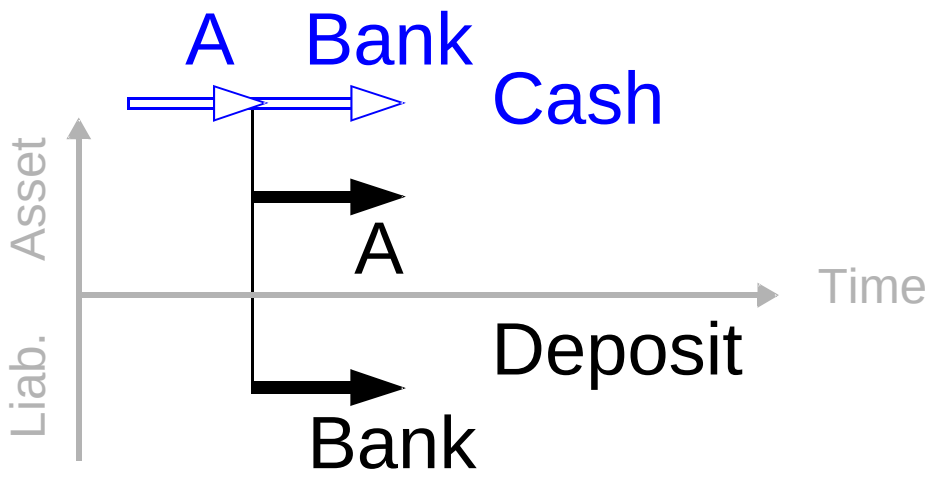


Deposit Units

Credit Units

Debt dynamics





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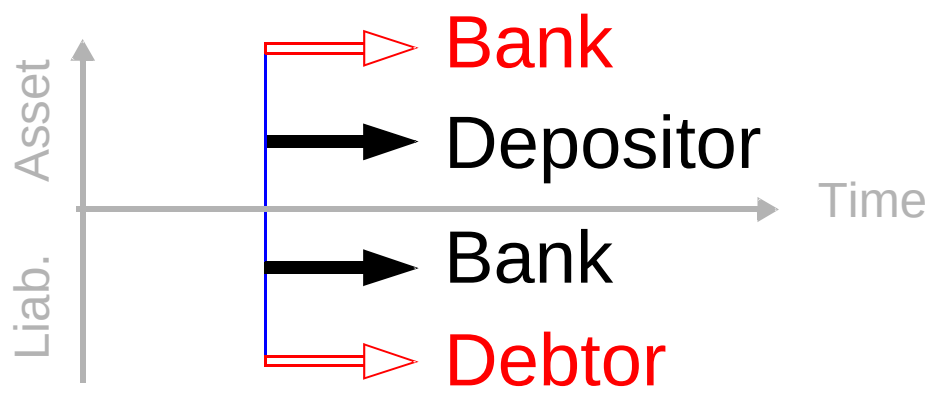
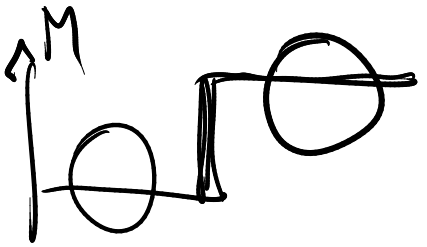


Deposit Units

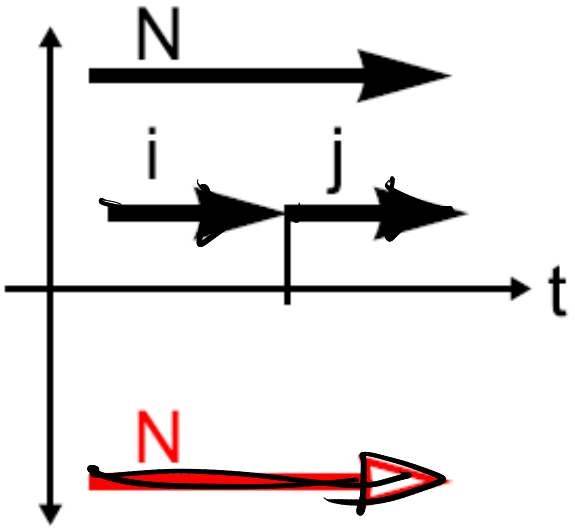
Credit Units

Nonlocal Effects of Credit Creation

Cantillon Effect: Nonlocal Wealth Change

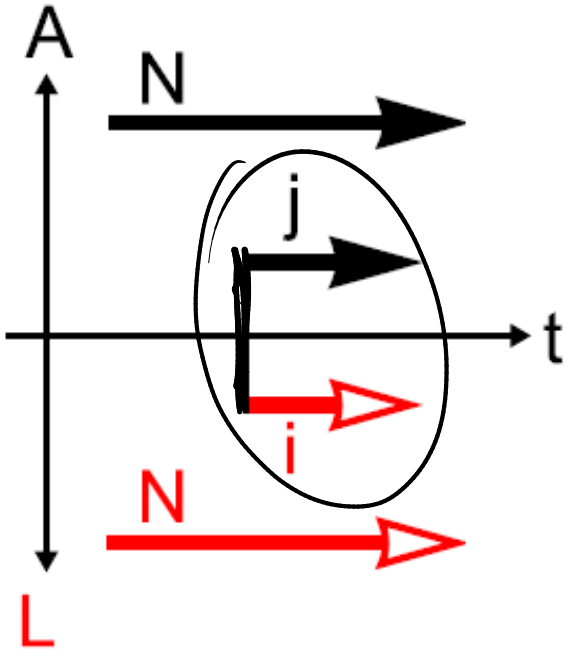


Assets



Liabilities

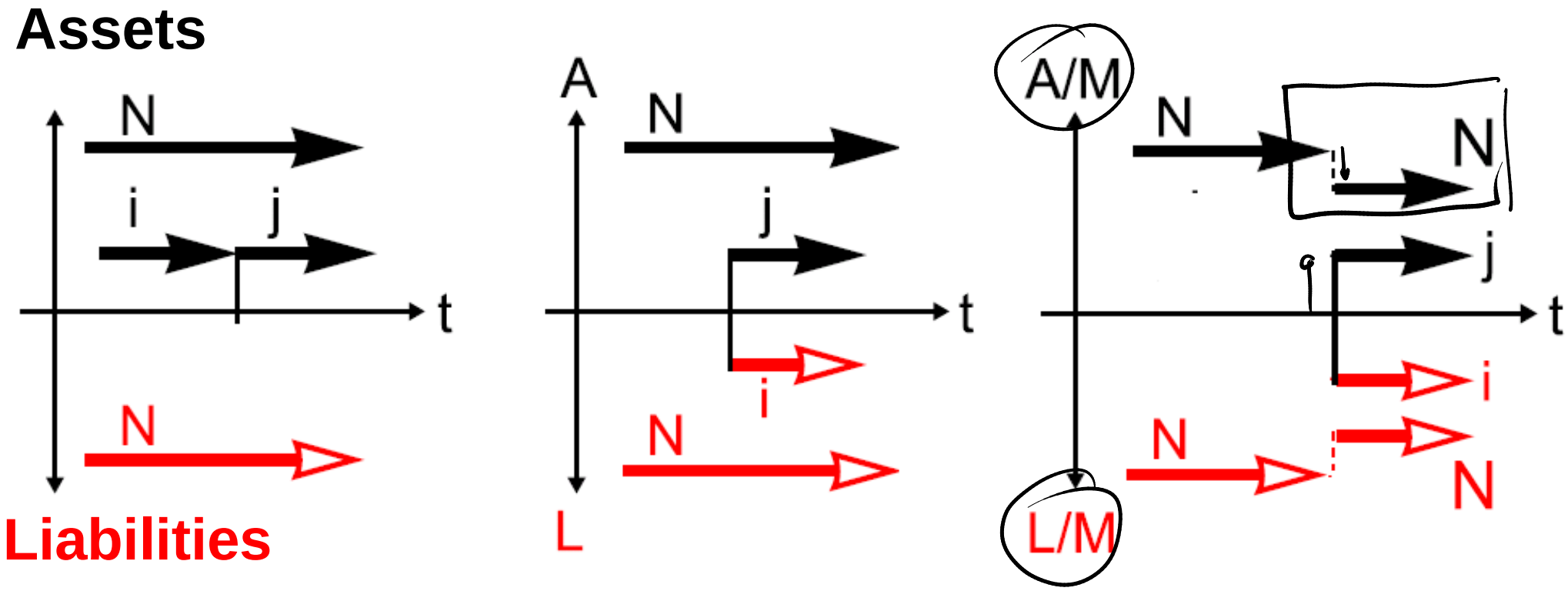
Direct Transfer



$\rho \sim M$

Credit Creation

Cantillon Effect: Nonlocal Wealth Change

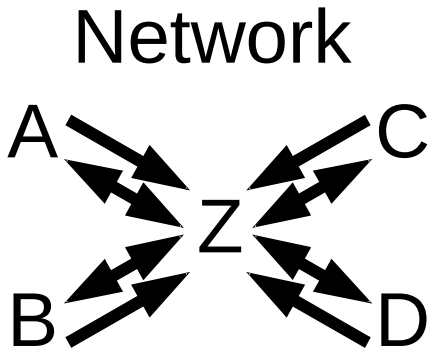


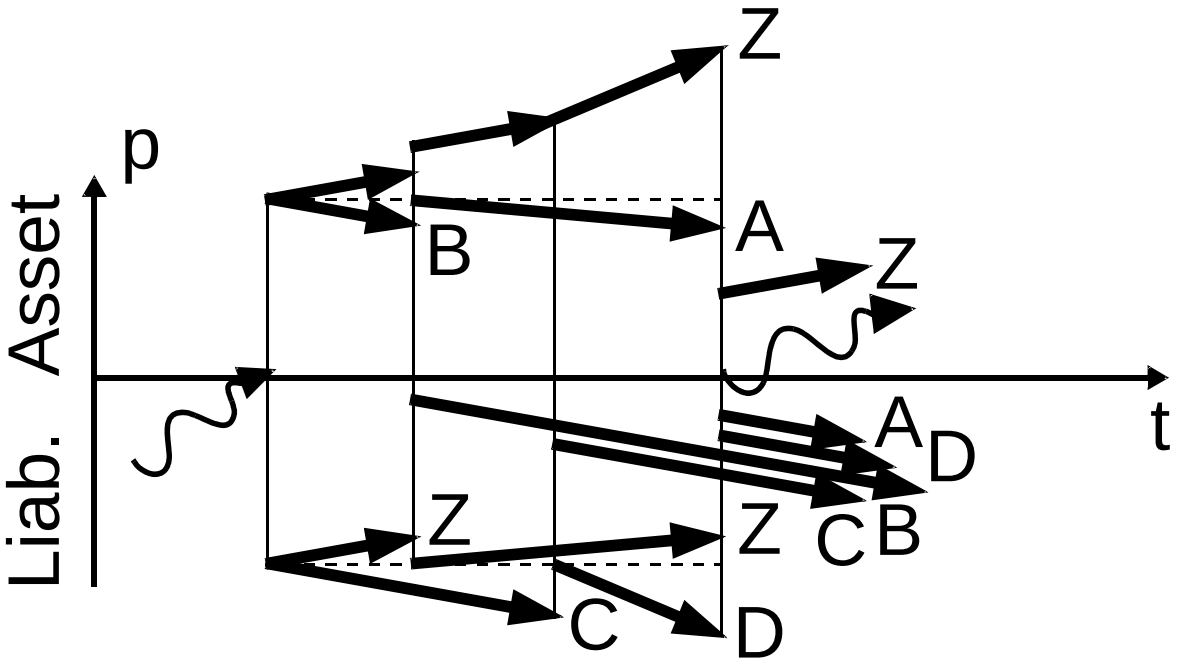
Direct Transfer

Credit Creation

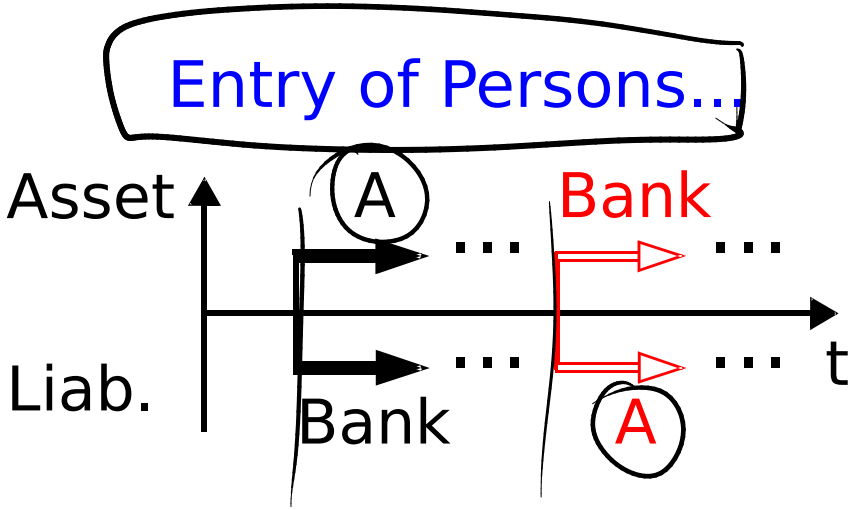
Circular transfer with interest

Through
Bank
with interest





Traditional Banking ... ‘renormalized’

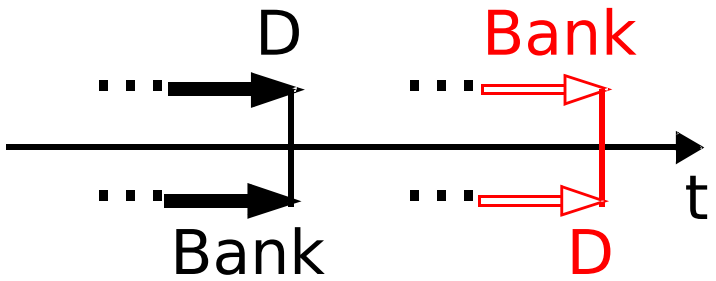


Money Quantity M

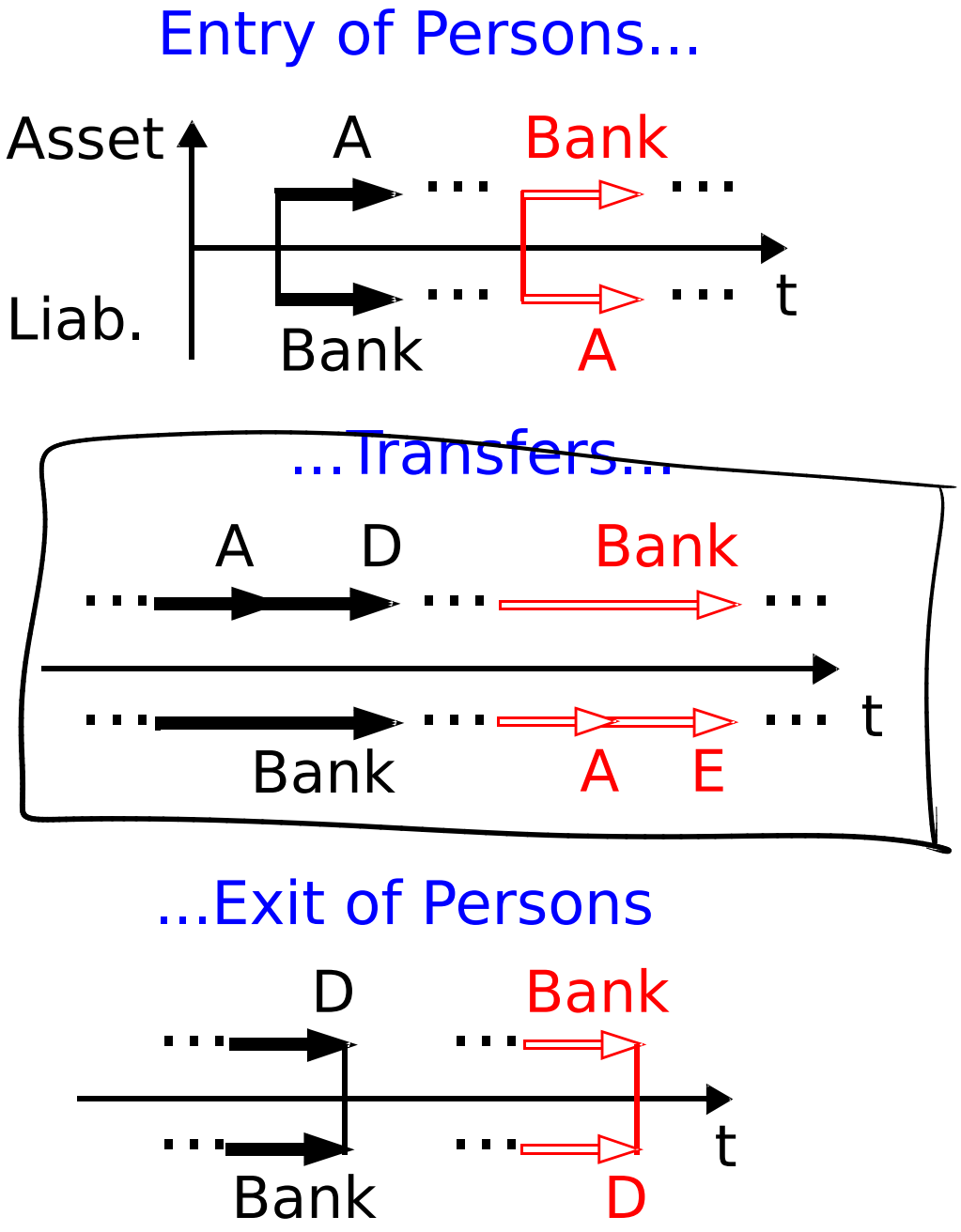
$\propto$

Number of Persons

...Exit of Persons

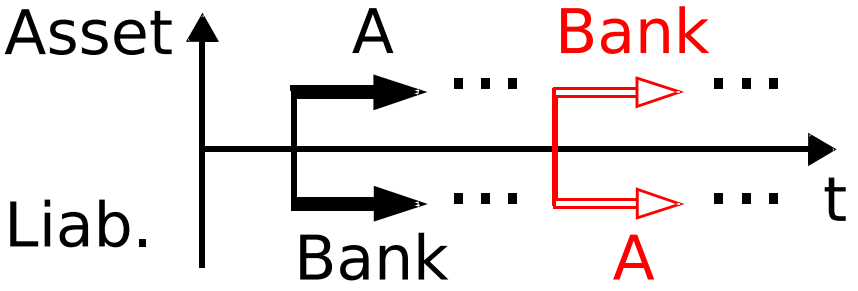


Traditional Banking ... ‘renormalized’

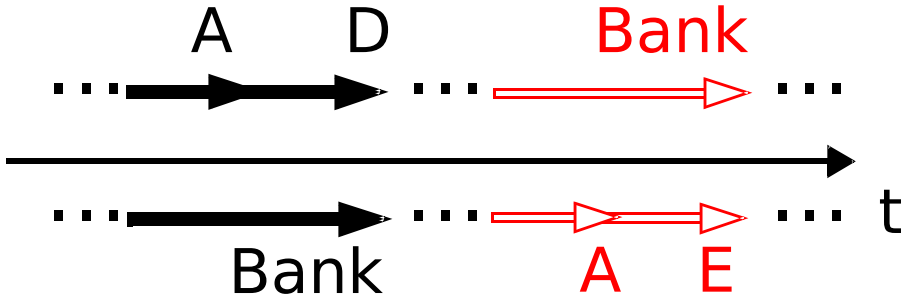


Traditional Banking ... ‘renormalized’

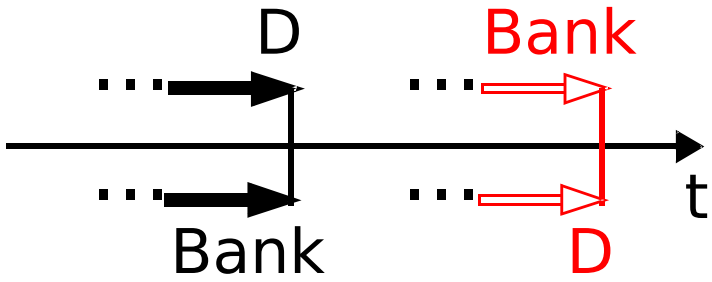
Entry of Persons...

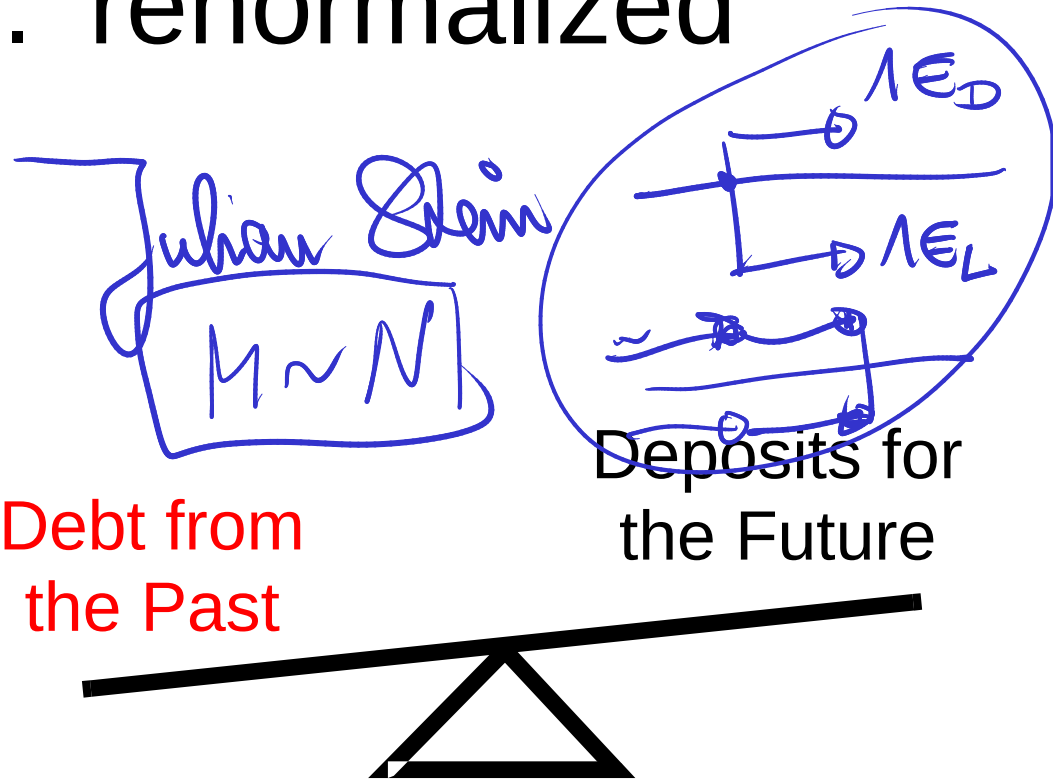


...Transfers...



...Exit of Persons





Deposits for the Future

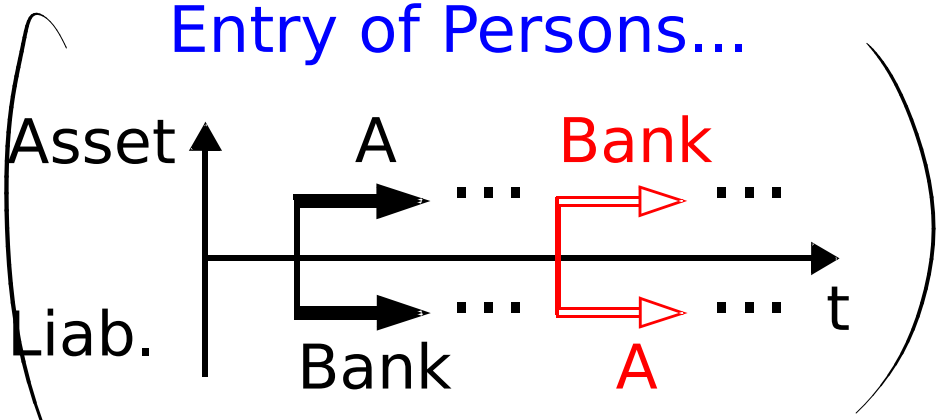
Debt from the Past

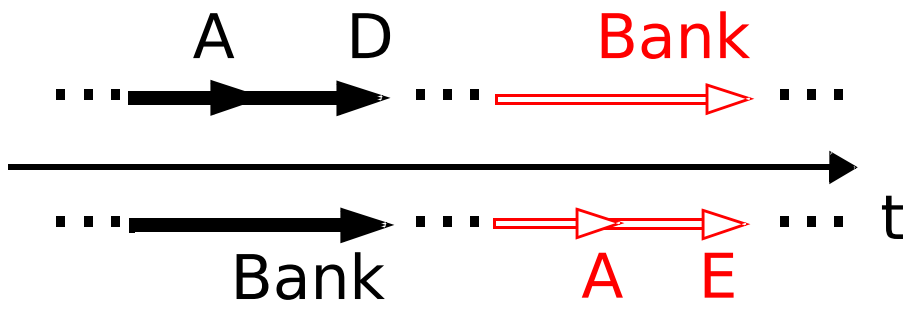
Exchange Rate between Debts and Deposits

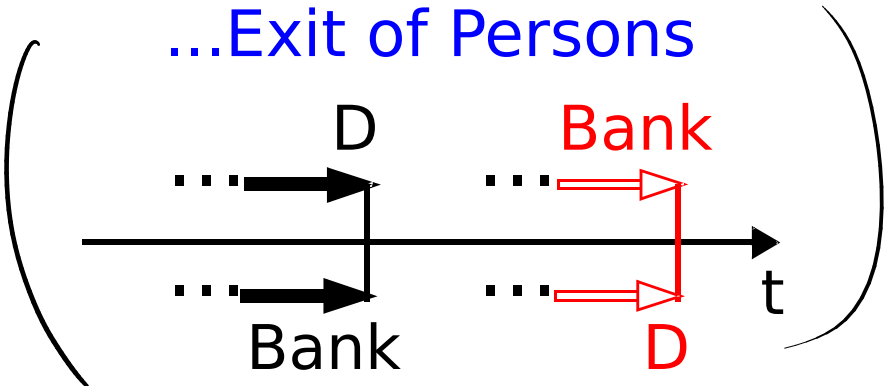
Judgement in real-time by all market participants

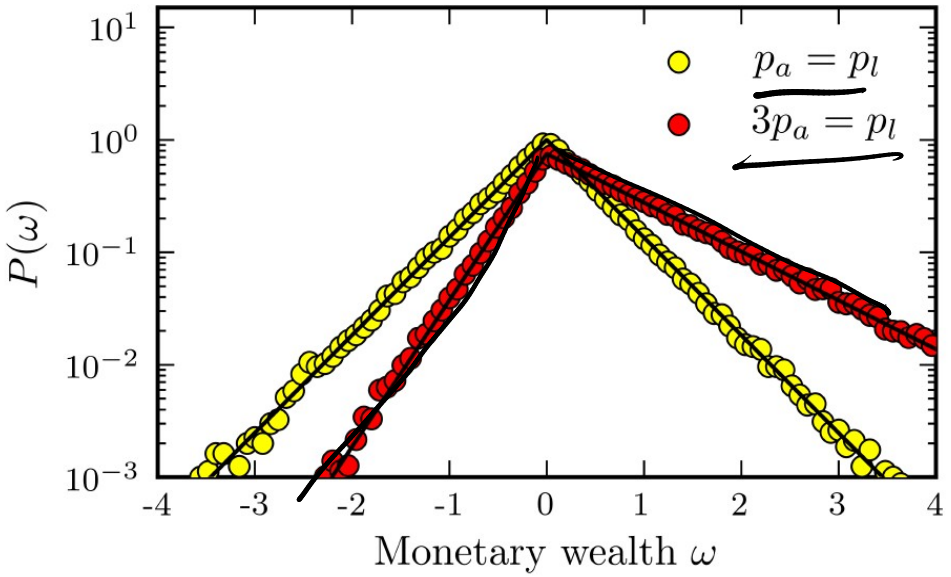
No Nonlocal Cantillon Effect

Under a Random Economy







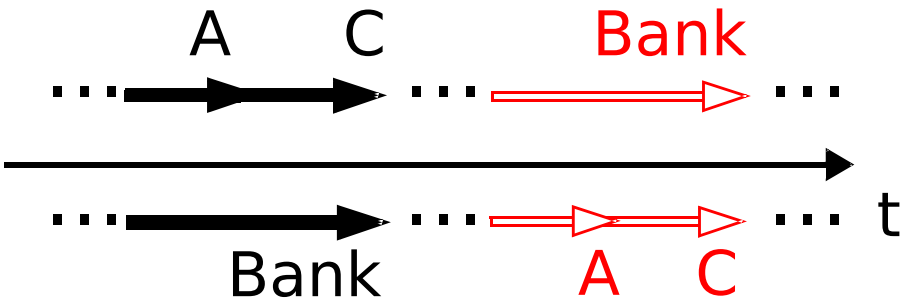


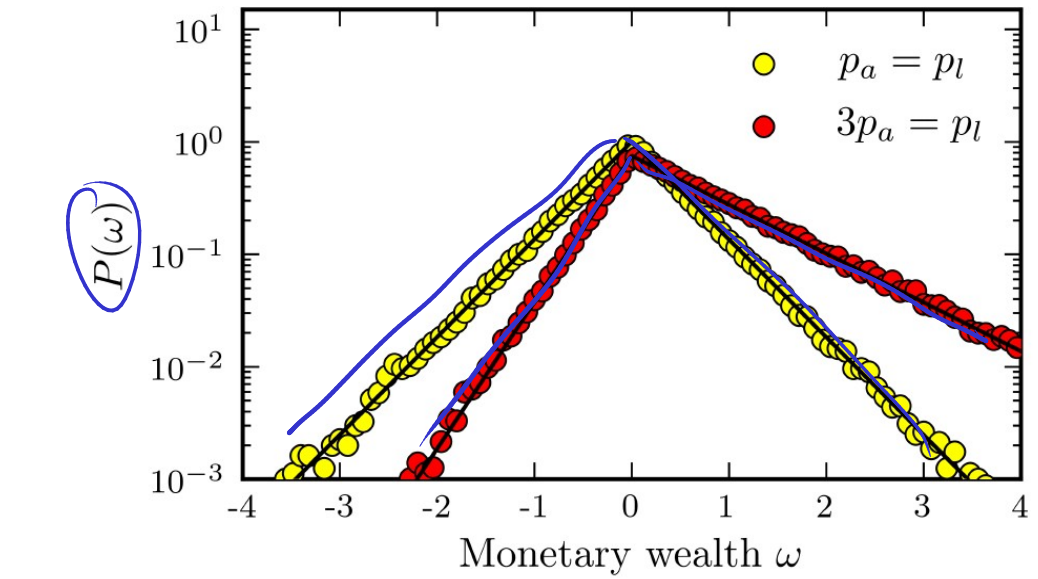
Quantity per Person $T_i = \frac{M_i}{N}$

$$P(\omega) = \frac{p_a p_l}{T_l p_a + T_a p_l} \cdot \exp\left(-\frac{\omega p_a}{T_a}\right)$$

Under a Random Economy

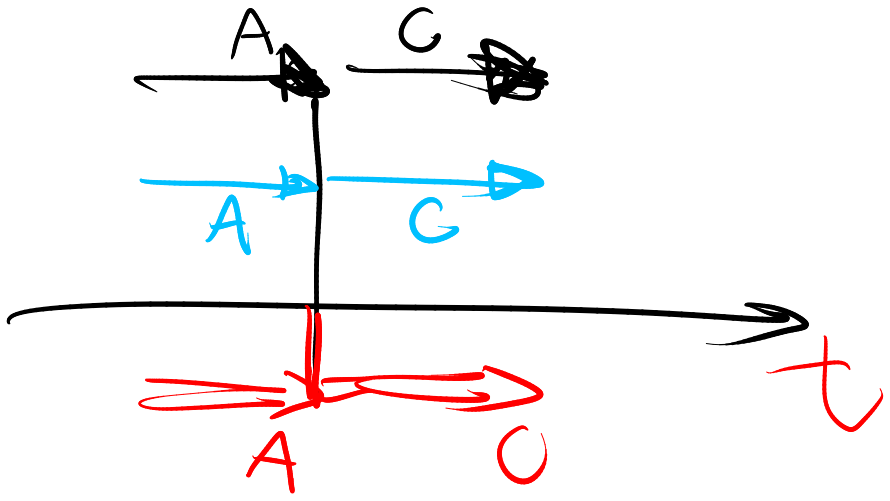
Instead of Credit Creation:
Liquidity transfer from A to C





Quantity per Person $T_i = \frac{M_i}{N}$

$$P(\omega) = \frac{p_a p_l}{T_l p_a + T_a p_l} \cdot \exp\left(-\frac{\omega p_a}{T_a}\right)$$



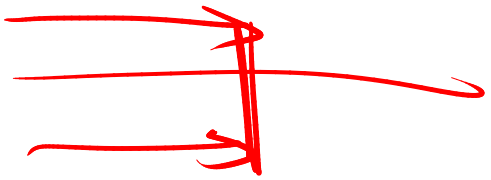
Volgold initiative

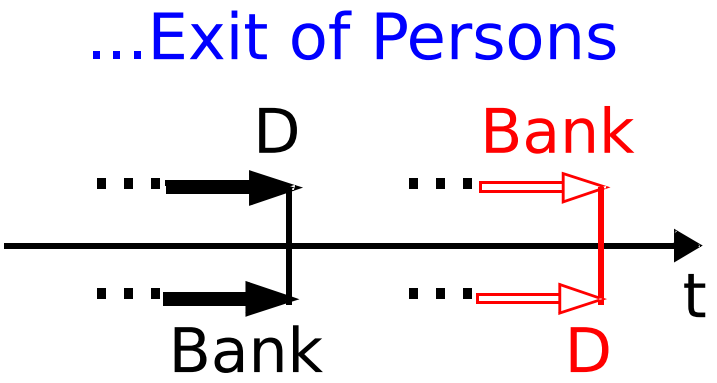
Stability of Monetary Systems

Traditional Banking

‘Renormalized’ Banking

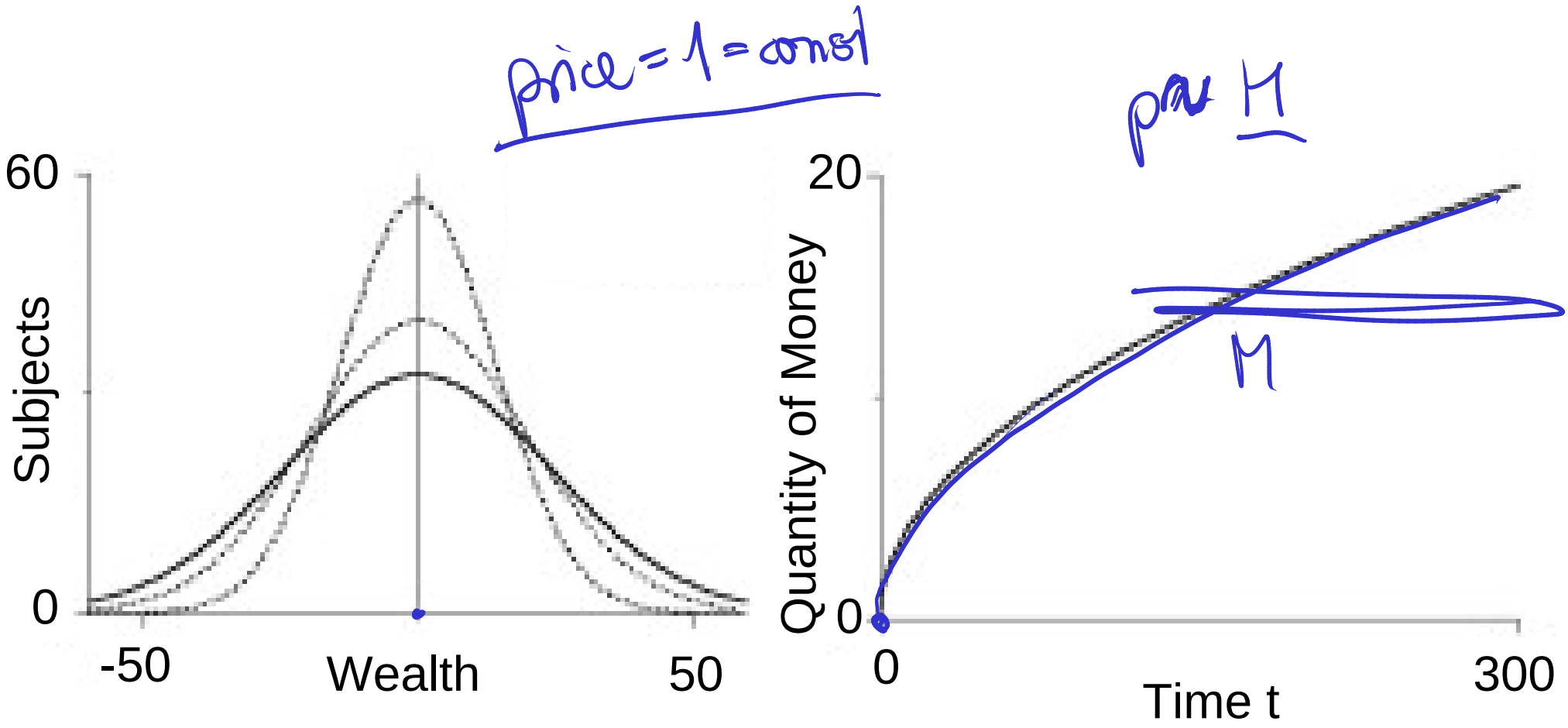
Credit Default





Network → Money Deposits only local transfers!

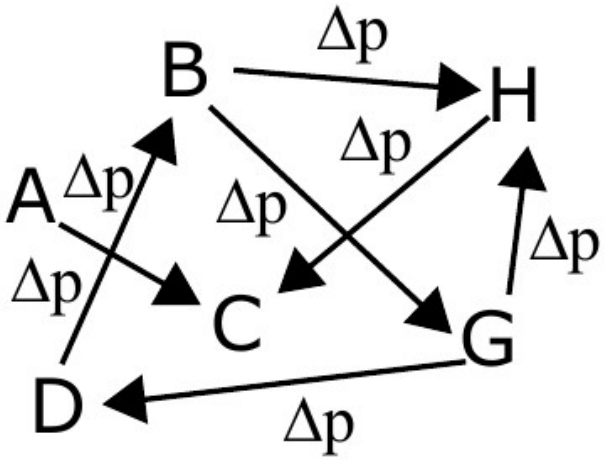
Traditional Banking ... diverges under Random Transfers



A first stress test for monetary systems?

Random Economy

Random Graph

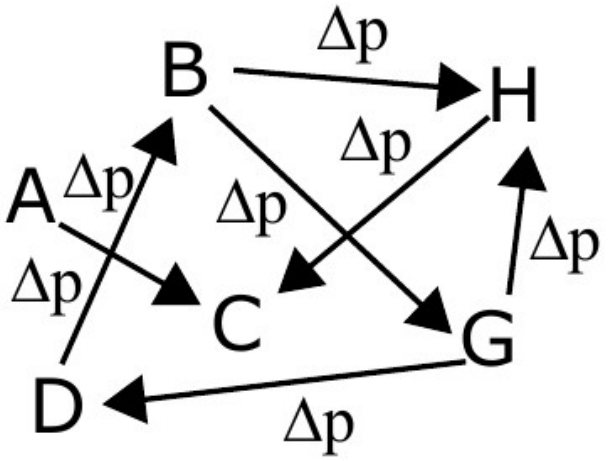


$$D = \frac{\Delta p^2}{\Delta t}$$

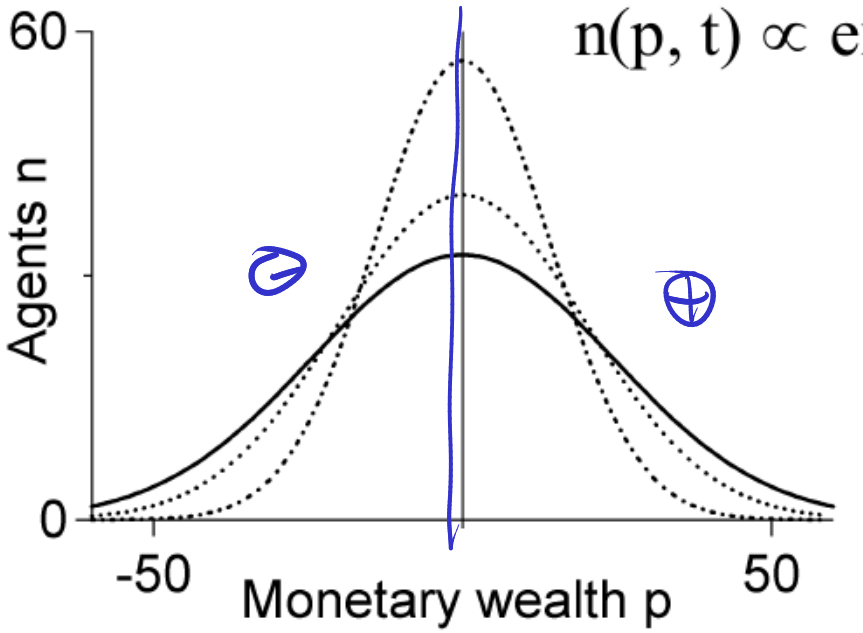
Physica A 321:605-618 (2003)

Random Economy

Random Graph



$$D = \frac{\Delta p^2}{\Delta t}$$

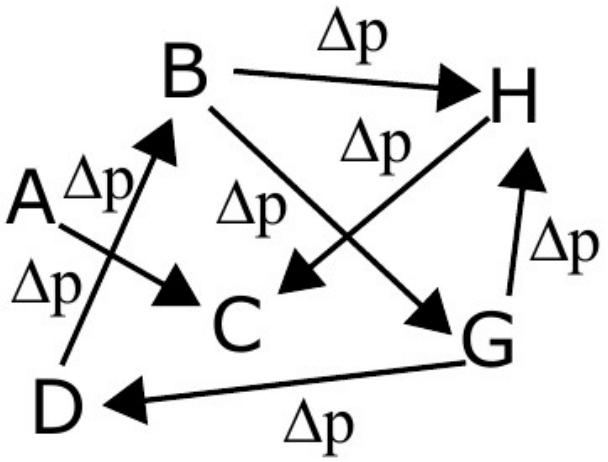


$$n(p, t) \propto \exp -\frac{p^2}{4Dt}$$

Physica A 321:605-618 (2003)

Random Economy

Random Graph

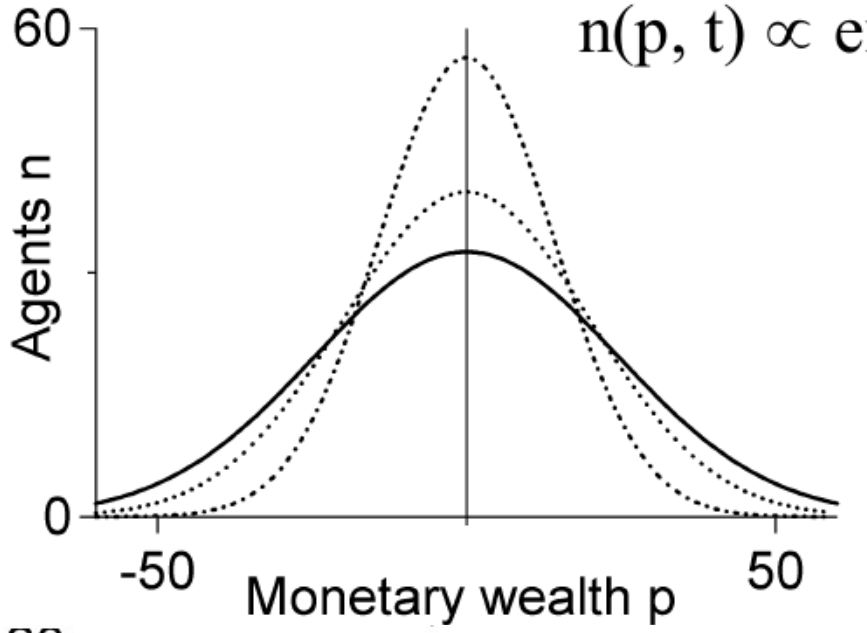


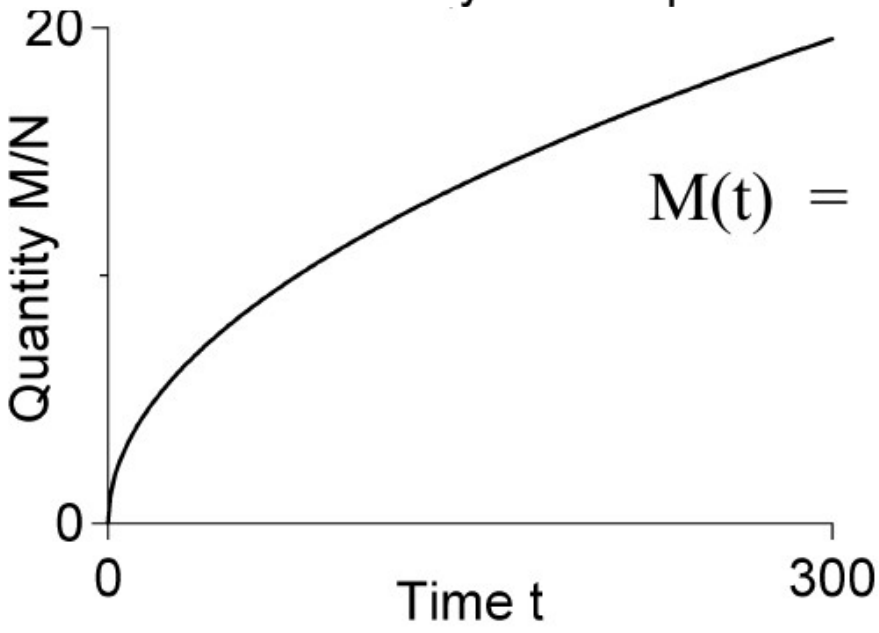
$$D = \frac{\Delta p^2}{\Delta t}$$

Inflational
Information
Overflow

(like wavepacket in QM)

$$n(p, t) \propto \exp -\frac{p^2}{4Dt}$$





$$M(t) = 4N\sqrt{\frac{Dt}{\pi}}$$

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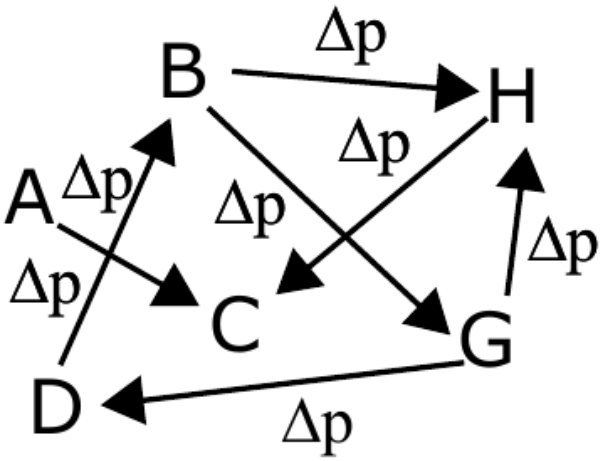
Random Economy

Random Graph

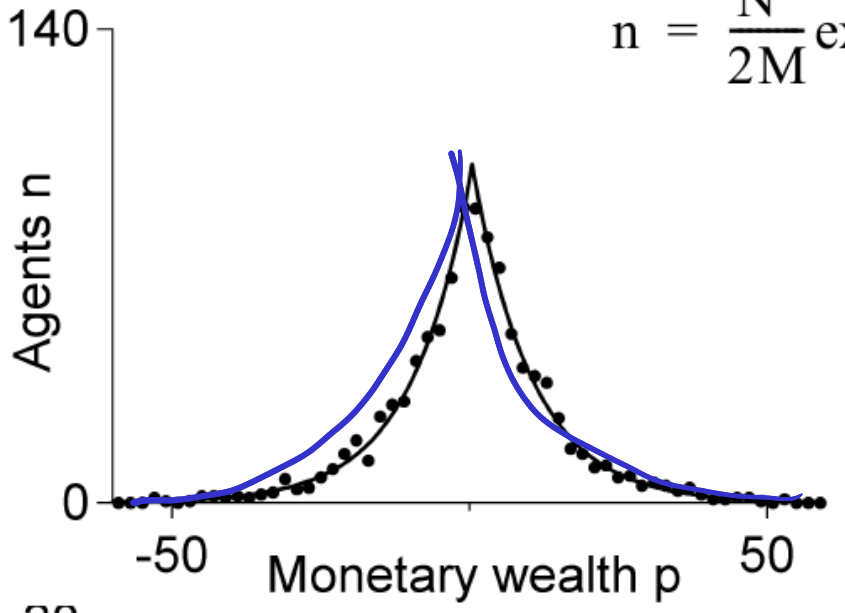


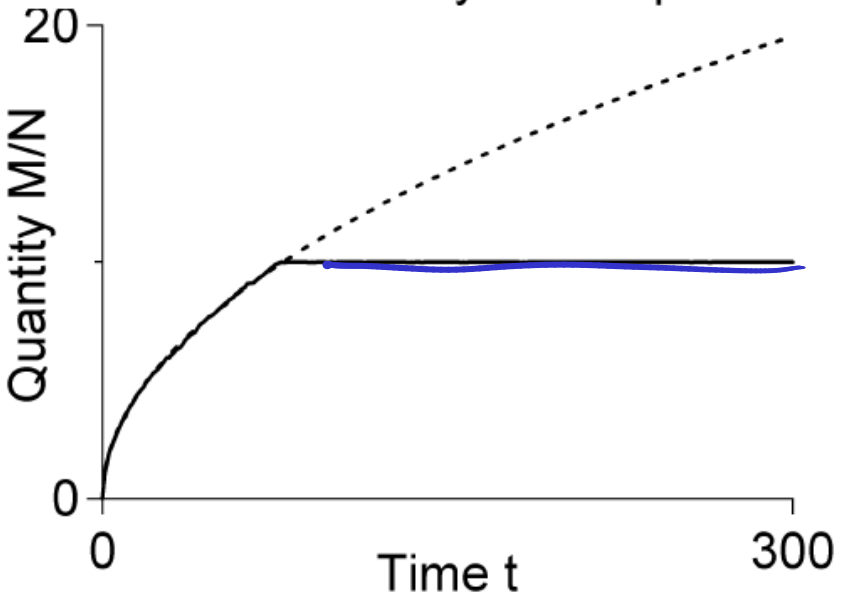
$$D = \frac{\Delta p^2}{\Delta t}$$

Quantity limit

No transactions which exceed the quantity of money limit M.

$$n = \frac{N^2}{2M} \exp\left(-\frac{N|p|}{M}\right)$$

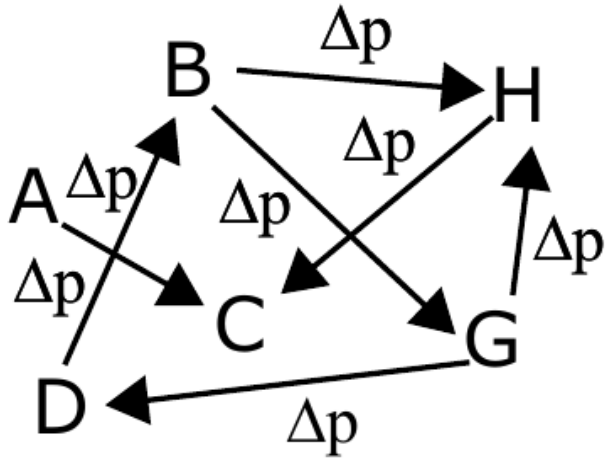




Physica A 321:605-618 (2003)

Random Economy

Random Graph

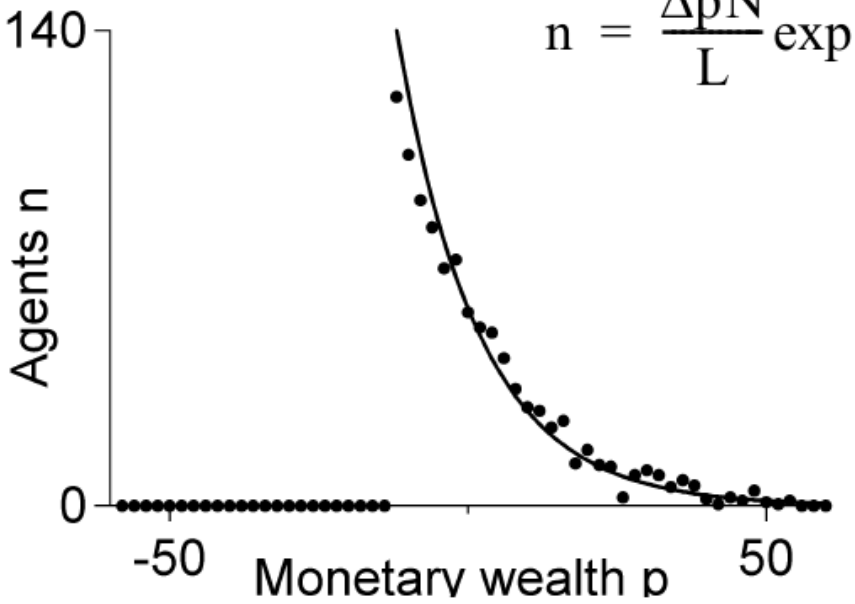


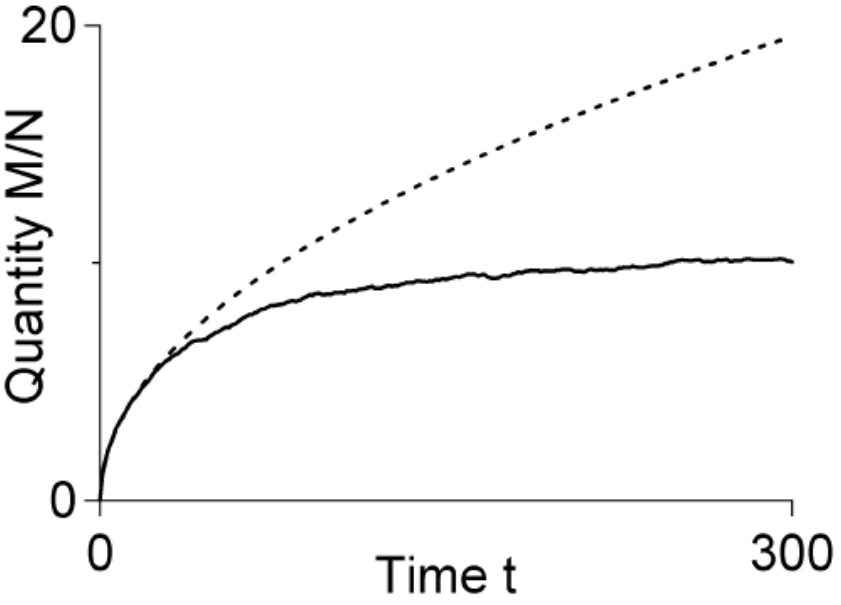
$$D = \frac{\Delta p^2}{\Delta t}$$

Liability limit

Debts are limited to L.

$$n = \frac{\Delta p N}{L} \exp -\frac{p + L}{L}$$

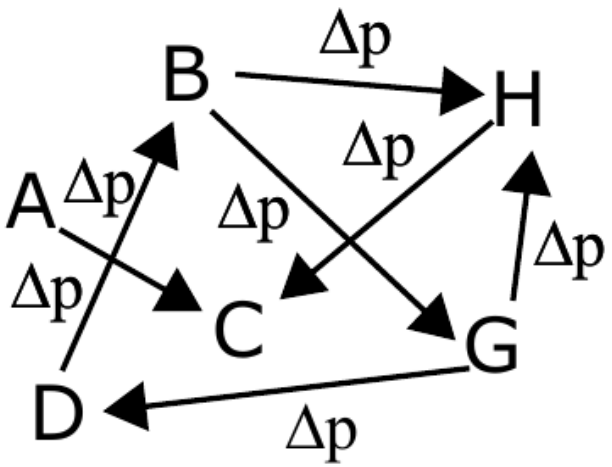




Physica A 321:605-618 (2003)

Random Economy

Random Graph

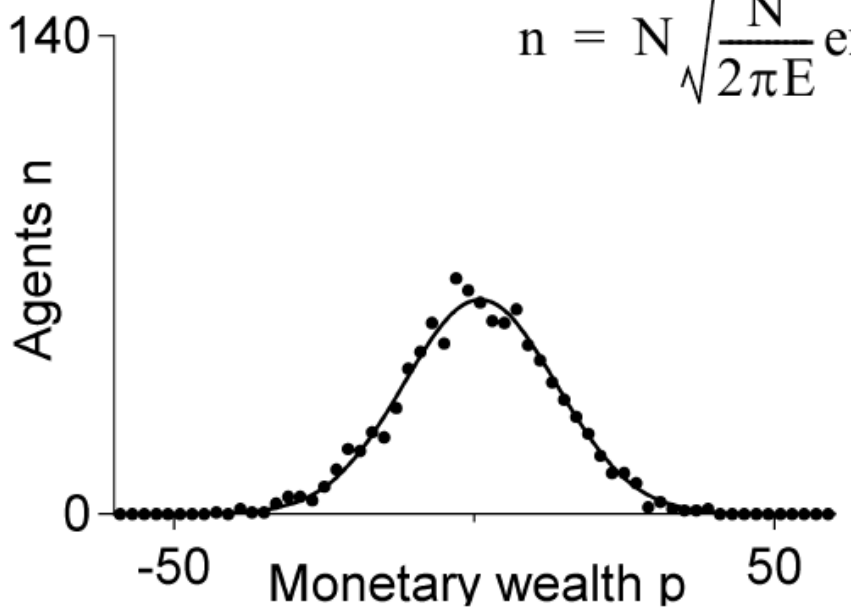


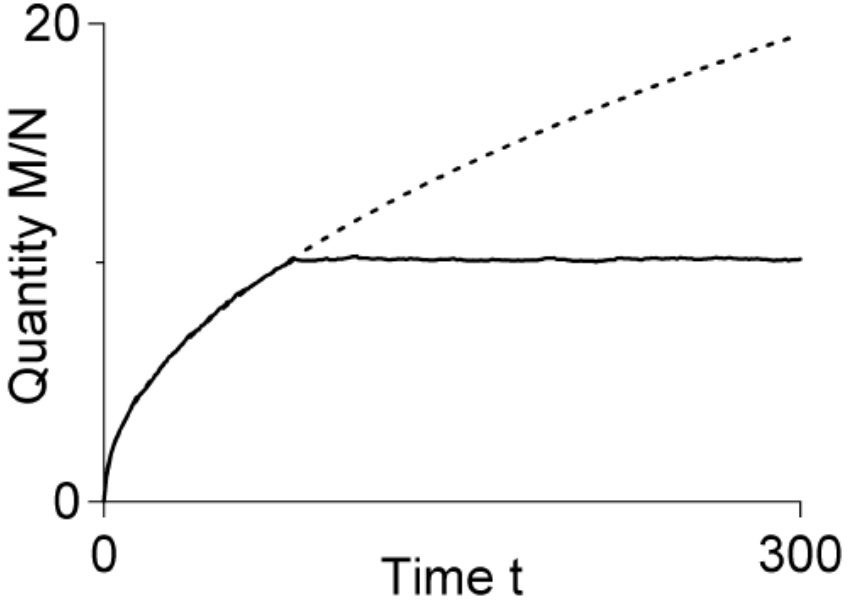
$$D = \frac{\Delta p^2}{\Delta t}$$

Energy limit

No transactions which exceed a quadratic Energy measure of money.

$$n = N\sqrt{\frac{N}{2\pi E}}\exp -\frac{Np^2}{2E}$$



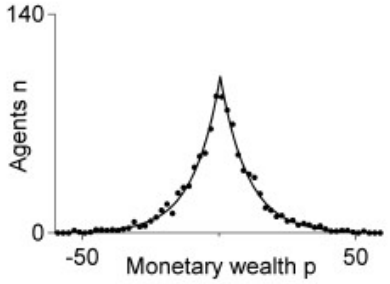


Physica A 321:605-618 (2003)

Random Economy under Central Limit

Quantity limit

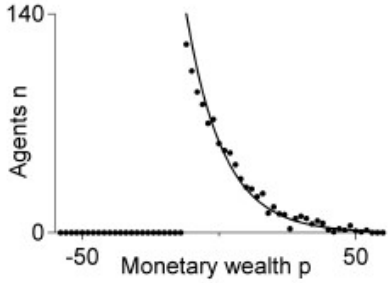
No transactions which exceed the quantity of money limit M.



$$n = \frac{N^2}{2M} \exp - \frac{N|p|}{M}$$

Liability limit

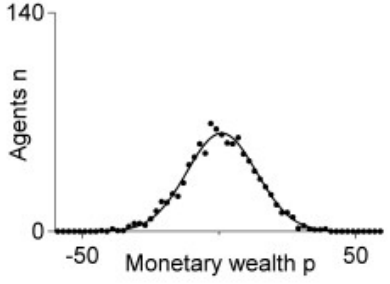
Debts are limited to L.



$$n = \frac{\Delta p N}{L} \exp - \frac{p + L}{L}$$

Energy limit

No transactions which exceed a quadratic Energy measure of money.



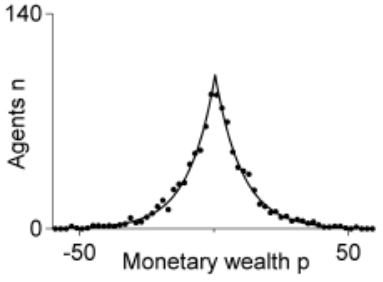
$$n = N \sqrt{\frac{N}{2\pi E}} \exp - \frac{Np^2}{2E}$$

Physica A 321:605-618 (2003)

Random Economy under Central Limit

Quantity limit

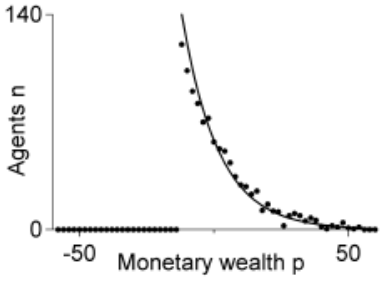
No transactions which exceed the quantity of money limit M.



$$n = \frac{N^2}{2M} \exp -\frac{N|p|}{M}$$

Liability limit

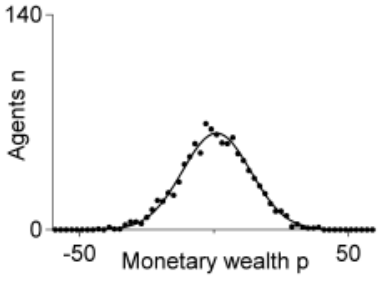
Debts are limited to L.



$$n = \frac{\Delta p N}{L} \exp -\frac{p + L}{L}$$

Energy limit

No transactions which exceed a quadratic Energy measure of money.



$$n = N\sqrt{\frac{N}{2\pi E}} \exp -\frac{Np^2}{2E}$$

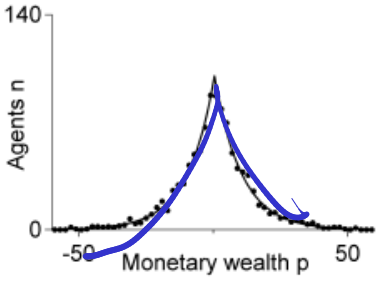
Wealth Distribution by "Economic Boltzmann" $n(p) \propto \exp\left(-\frac{\text{Limit}(p)}{D}\right)$

Physica A 321:605-618 (2003)

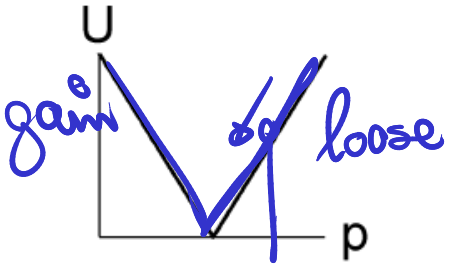
Random Economy + Transfer Potential

Quantity limit

No transactions which exceed the quantity of money limit M.

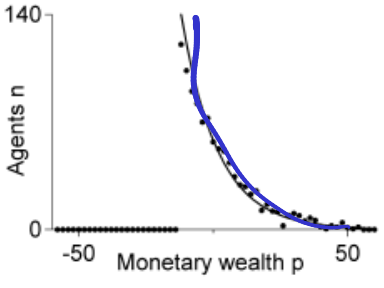


Abs.lin. Potential



Liability limit

Debts are limited to L.



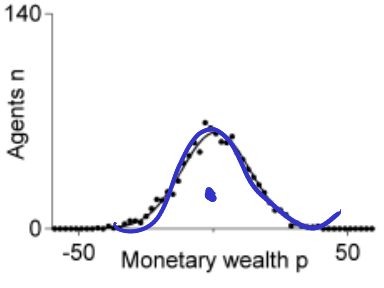
Crop.lin. Potential

Interpret Limit as Transfer Potential U

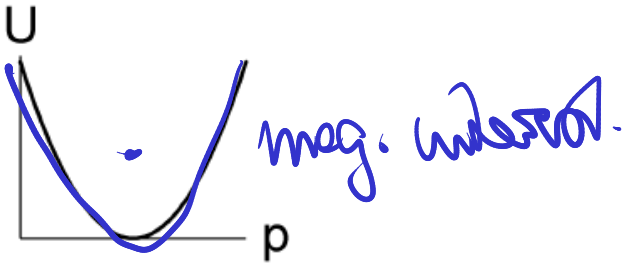
$$\frac{\Delta p}{\Delta t} = -\nabla \mathrm{Limit}(p)$$

Energy limit

No transactions which exceed a quadratic Energy measure of money.



Parabolic Potential



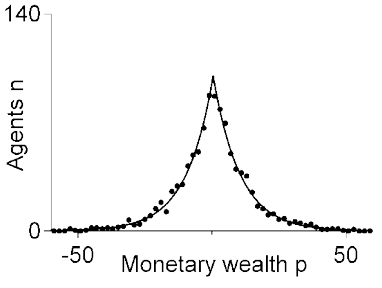
Wealth Distribution by "Economic Boltzmann"

$$n(p) \propto \exp\left(-\frac{U(p)}{D}\right)$$

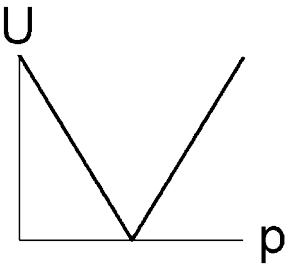
Physica A 321:605-618 (2003)

Random Economy + Transfer Potential

Quantity limit
No transactions which exceed the quantity of money limit M.

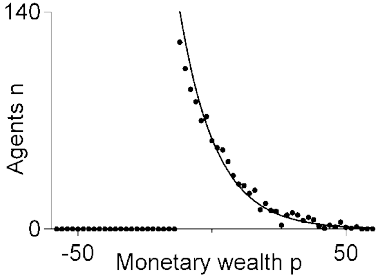


Abs.lin. Potential

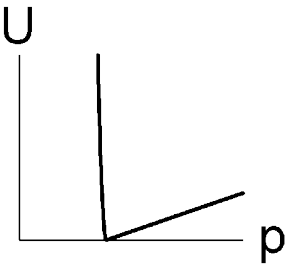


Symmetric Head Tax
State imposes a head tax which it distributes to liability holders.

Liability limit
Debts are limited to L.

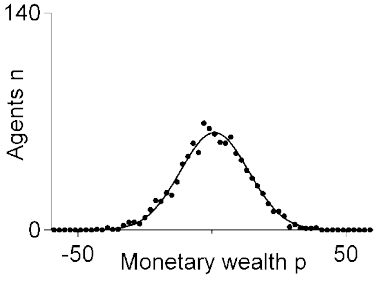


Crop.lin. Potential

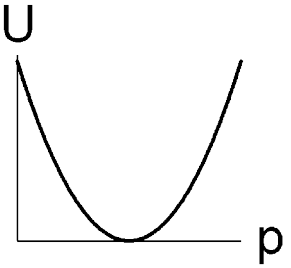


Cropped Head Tax
Head tax together with highly non-linear social security benefits for liability holders.

Energy limit
No transactions which exceed a quadratic Energy measure of money.



Parabolic Potential



Negative interest
Negative interest rate imposed as money tax. Results in transfer from rich to poor.

Wealth Distribution by “Economic Boltzmann”

$$n(p) \propto \exp\left(-\frac{U(p)}{D}\right)$$

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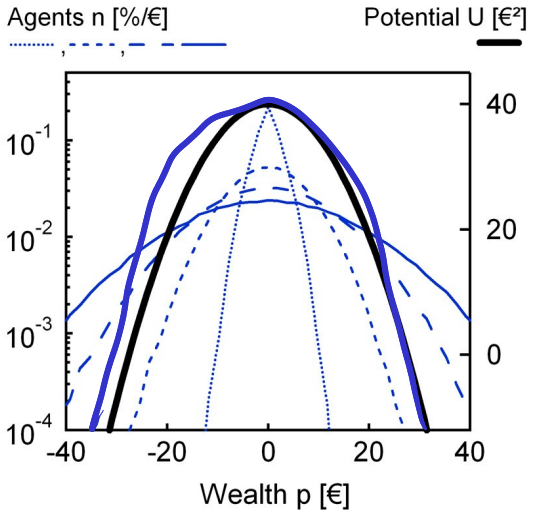
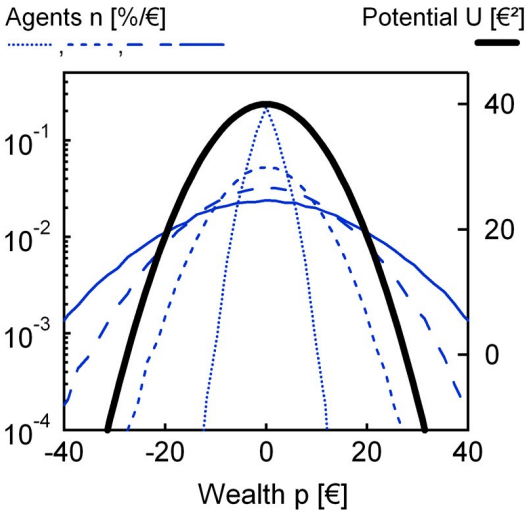
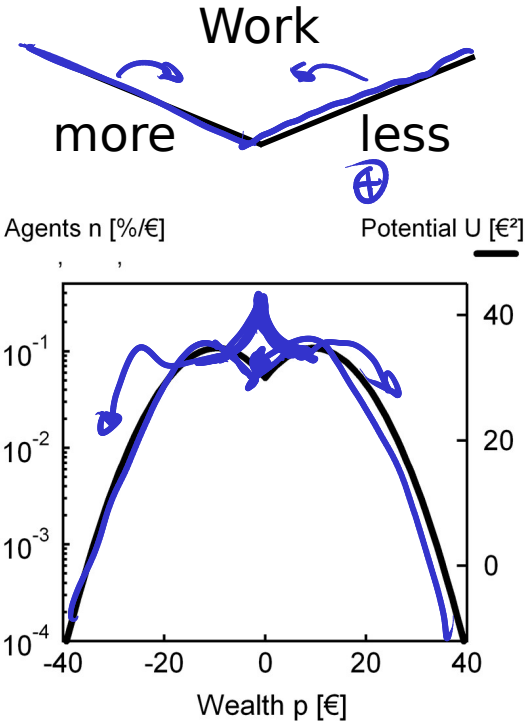
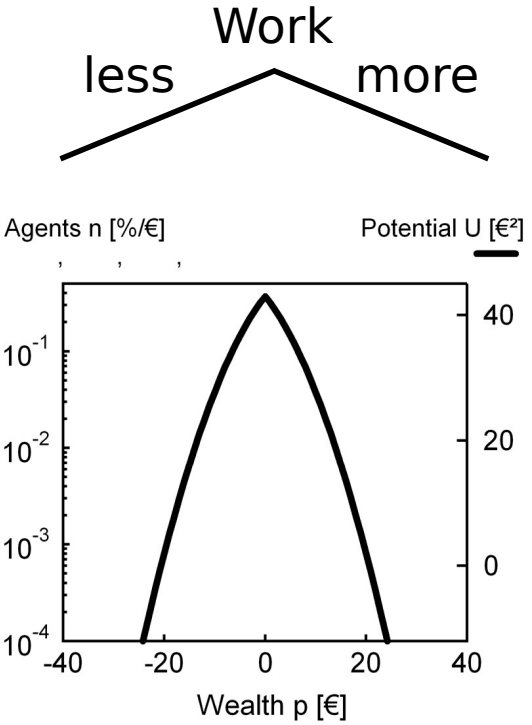
Random Economy + positive Interest



Random Economy + positive Interest







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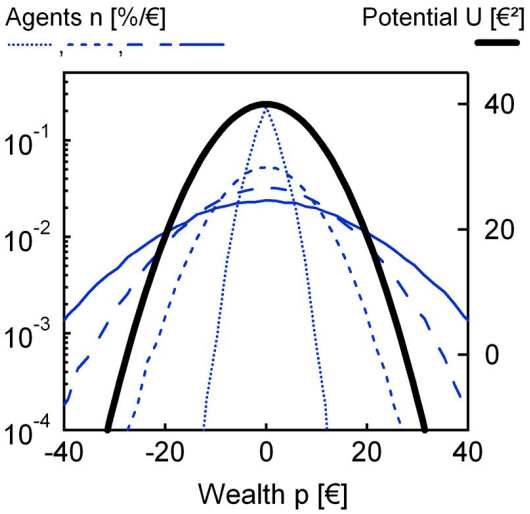

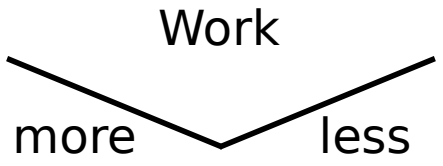

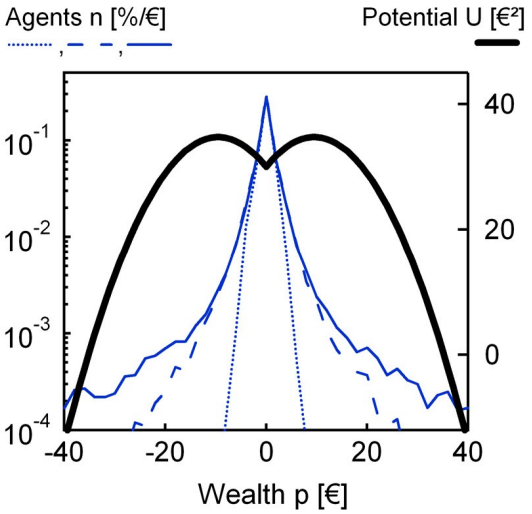

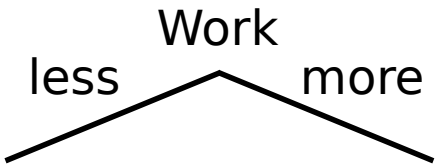

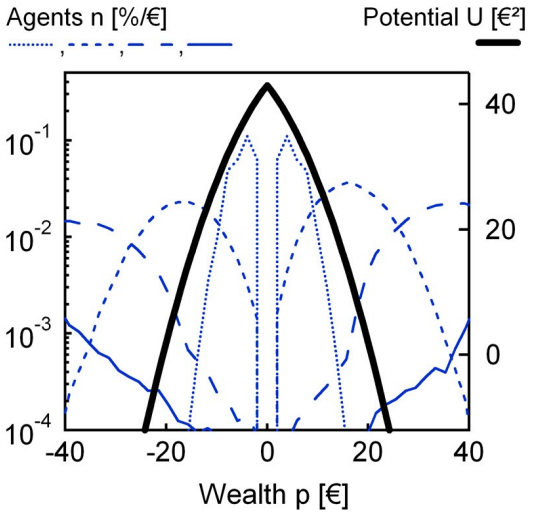

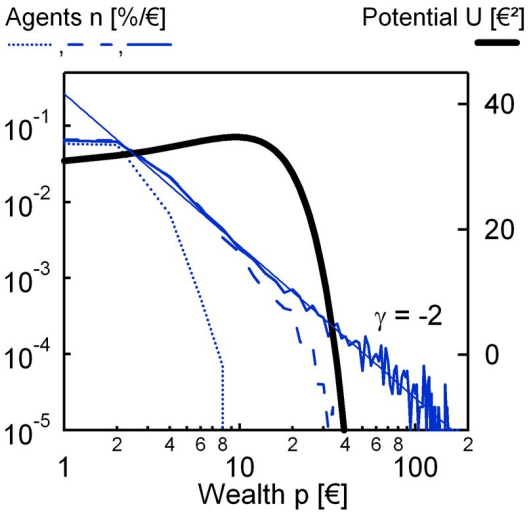

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