



Macro and Money Models: Blockchains, Tokens, and Inside Money

Markus K. Brunnermeier
Princeton University



Overview

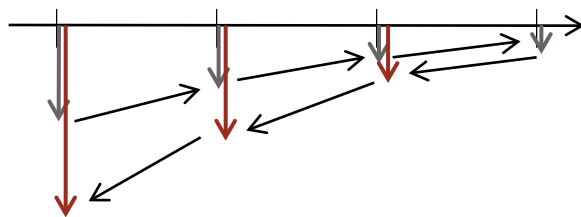
- Macro Model
 - From Impulse Response Function to Risk Dynamics/Resilience

- Models of Money
 - In the digital age: Blockchain, Crypto, and Digital CB Money
 - Currency competition
 - “Fork competition”

Abadi & Brunnermeier 2018

Traditional Macro: Impulse Response

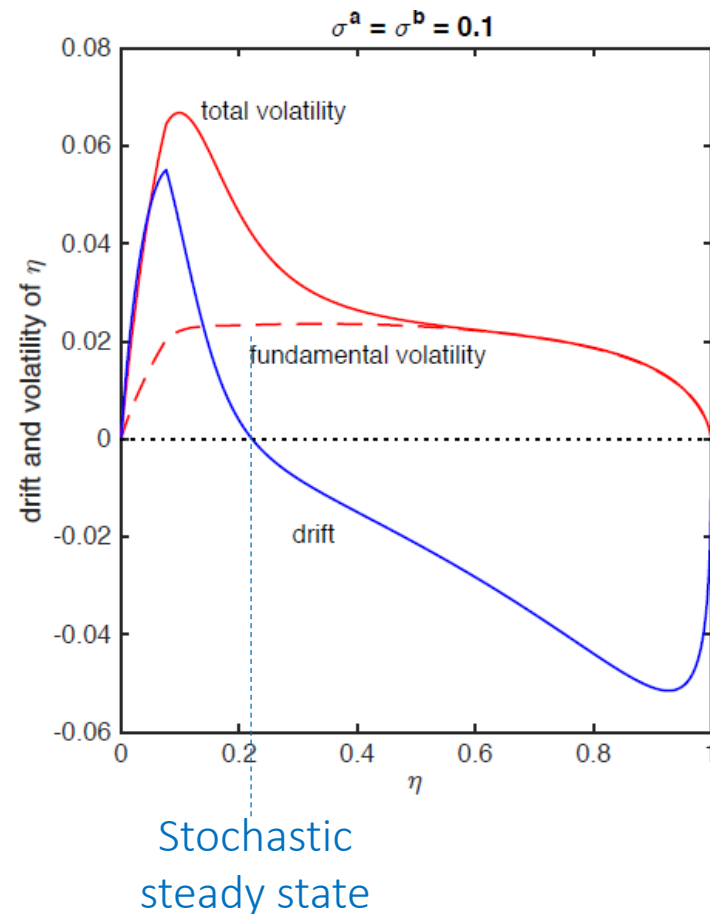
- Study of deviation from steady state after shock
 - One shock-one-deterministic return to steady state



- Persistence
- Amplification (BGG, KM, ...)
 - Deterministic path back to steady state

Risk-focused Macro

- Nonlinearities
 - Skewness, fat tails, ...
- Endogenous Volatility Dynamics
 - Time-varying volatility



||| Risk-focused Macro

- **Nonlinearities**
 - Skewness, fat tails, ...
- Endogenous **Volatility Dynamics**
 - Time-varying volatility
 - **Volatility Paradox** “low measured volatility is most risky”

||| Risk-focused Macro

- **Nonlinearities**
 - Skewness, fat tails, ...
- Endogenous **Volatility Dynamics**
 - Time-varying volatility
 - **Volatility Paradox** “low measured volatility is most risky”
 - **Paradox of Prudence** “micro-prudent is macro **im**prudent”

Risk-focused Macro

■ Nonlinearities

- Skewness, fat tails, ...

■ Endogenous Volatility Dynamics

- Time-varying volatility

- Volatility Paradox

- Paradox of Prudence

■ Focus on time-varying risk-premia

$$\bullet p_t = E_t \left[\sum_{\tau=1}^{T-t} M_{t,t+\tau} y_{t+\tau} \right] + E_t \left[M_{t,T} p_T \right]$$

SDF news

Cash-flow news

Empirical Failure of

- Expectation hypothesis
- Uncovered interest rate parity

Models of Money

■ Outside Money as a bubble

- OLG Model enables trading across generations
 - Samuelson 58
- Money as **Store of Value** & Safe Asset partial insurance
 - Bewley only money idio. endowmt.-risk
 - I Theory of Money money & capital coexist capital w/ **idio. risk**
- Money as **Medium of Exchange**
 - Money has lower transaction costs

■ Inside Money

- Created by intermediary sector
 - Banks as risk diversifiers BrunSan
- Is better medium of exchange (liquidity) than outside money
 - Brunnermeier & Niepelt (2018)

Yap stone \Rightarrow 2-tier system w/ inside money

- Island Yap

- Fixed supply

- Hard to create/forge

- Unit of account

- Medium of exchanges

- Difficult to transport
- Derive “claims”/tokens (inside money)



Gold \Rightarrow 2-tier system w/ inside money

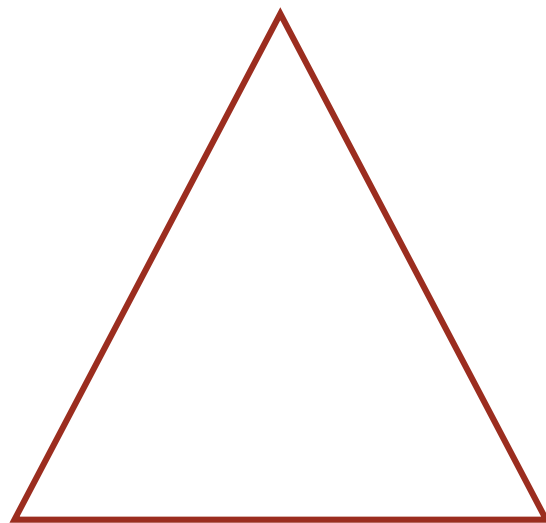


- Bad store of value (historically)
 - high volatility due to new gold discoveries
- Bad medium of exchange
 - “The big problem of small change”

Tom Sargent & Francois Velde

Outside vs. Inside Money

- 2-tier financial system (fractional reserve banking)



Anchor: e.g. Gold/Yap Stone *Unit of account*

Currency - no claim

Deposits - private debt

} *Medium of Exchange*
(easy to swap, carry,...)

Credit

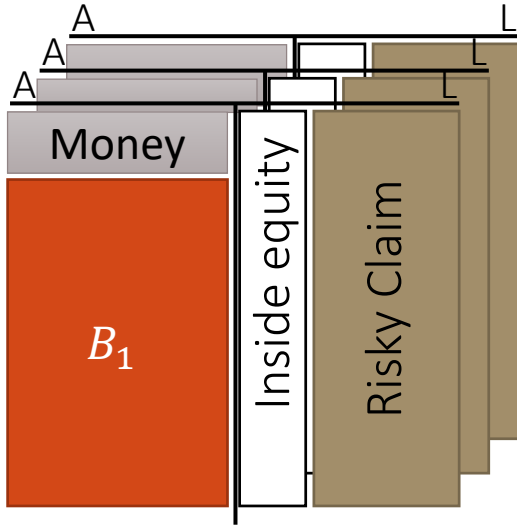
Store of Value

- Backing with
 - Commodity (e.g. gold)
 - Less liquid risky claims/credit
 - Data

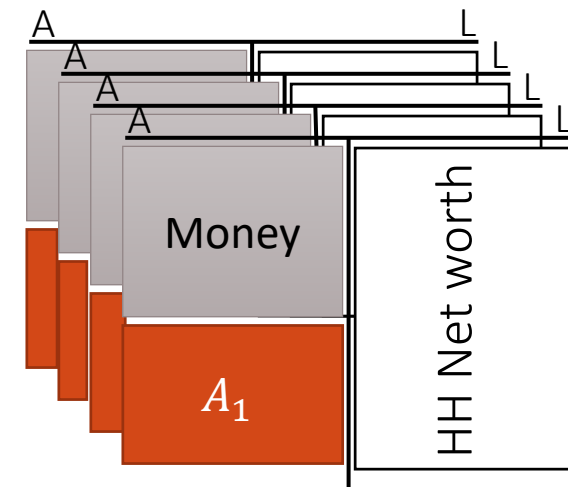
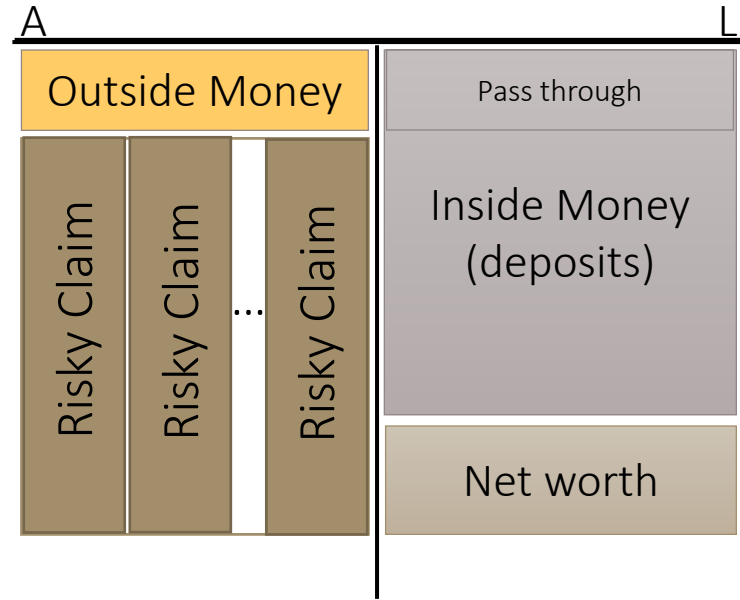
2 Tier Financial System

Outside Money

Technologies b



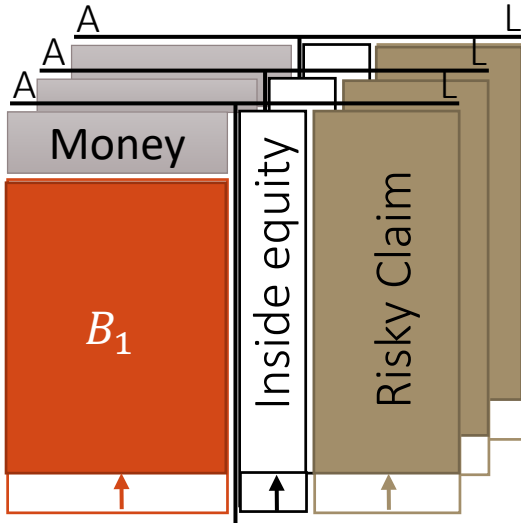
Technologies a



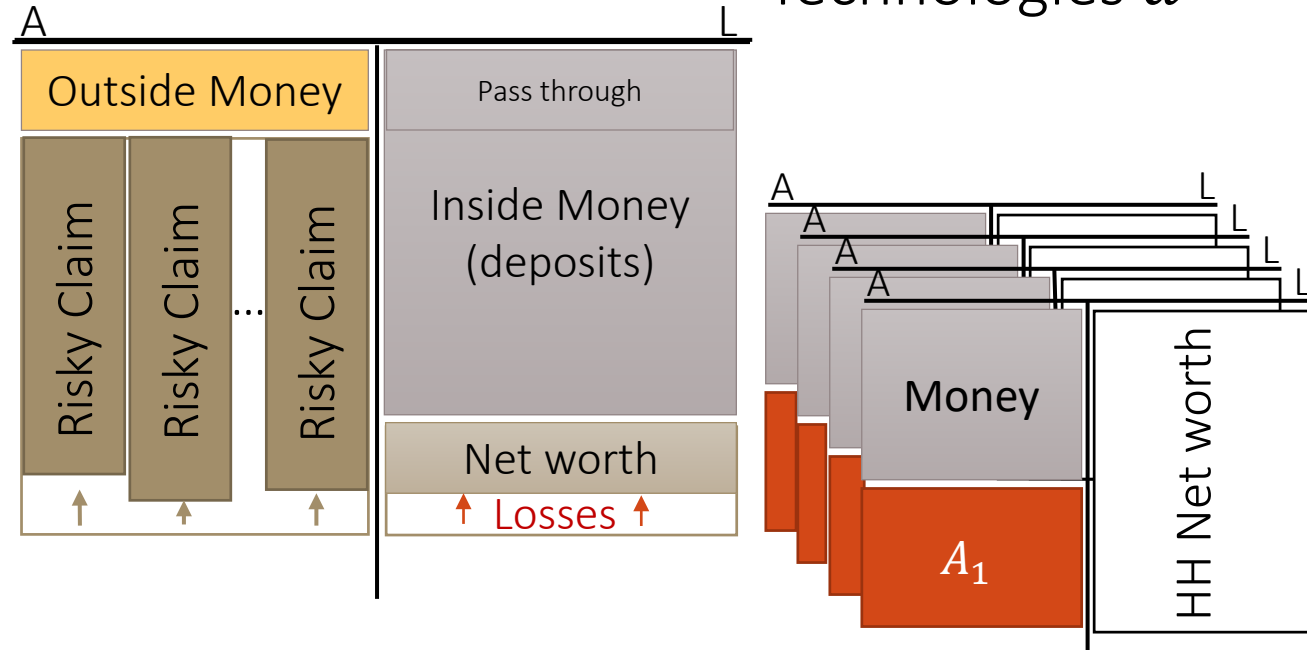
“The I Theory of Money”
with Yuliy Sannikov

Shock impairs assets: 1st of 4 steps

Technologies b

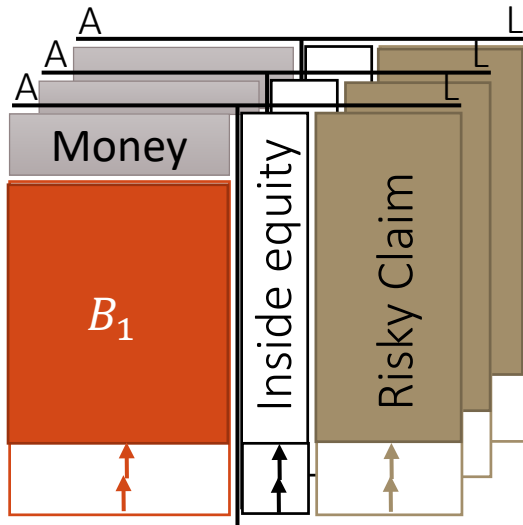


Technologies a

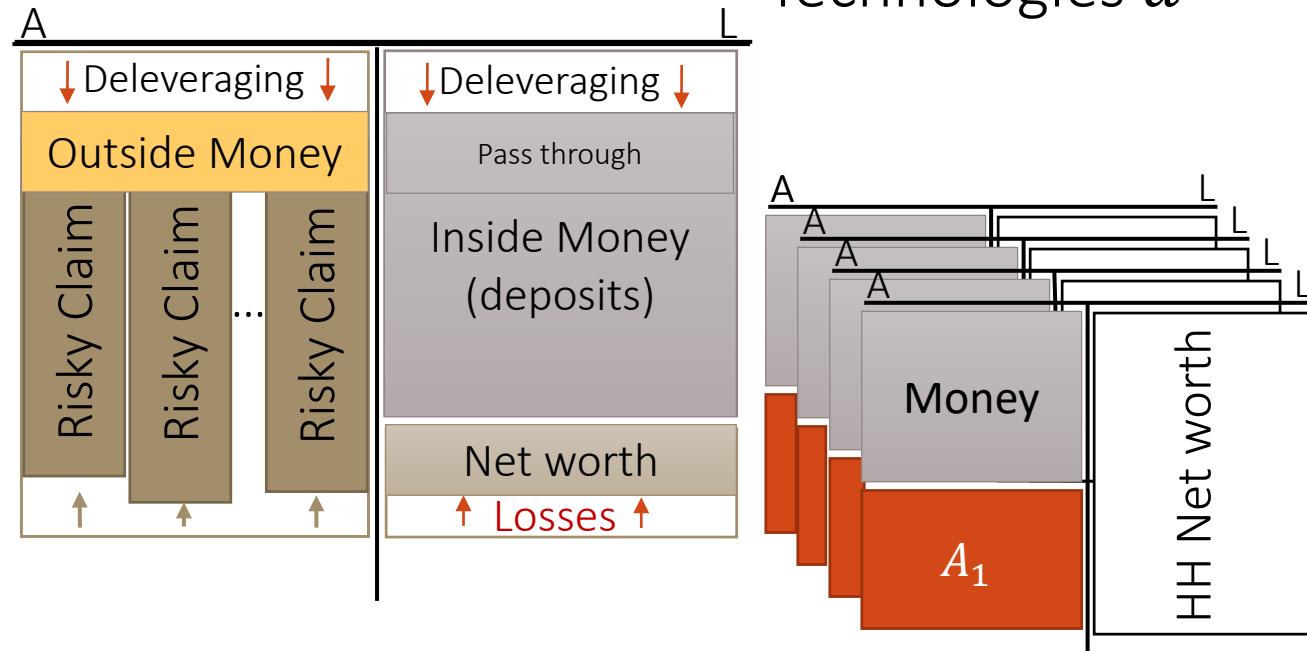


Shrink balance sheet: 2nd of 4 steps

Technologies b



Technologies a

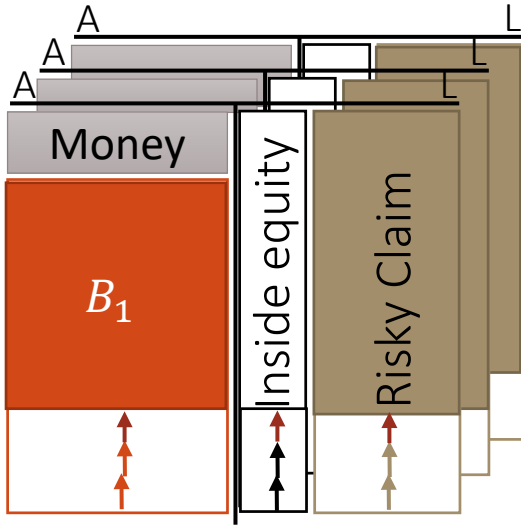


“Paradox of Prudence”

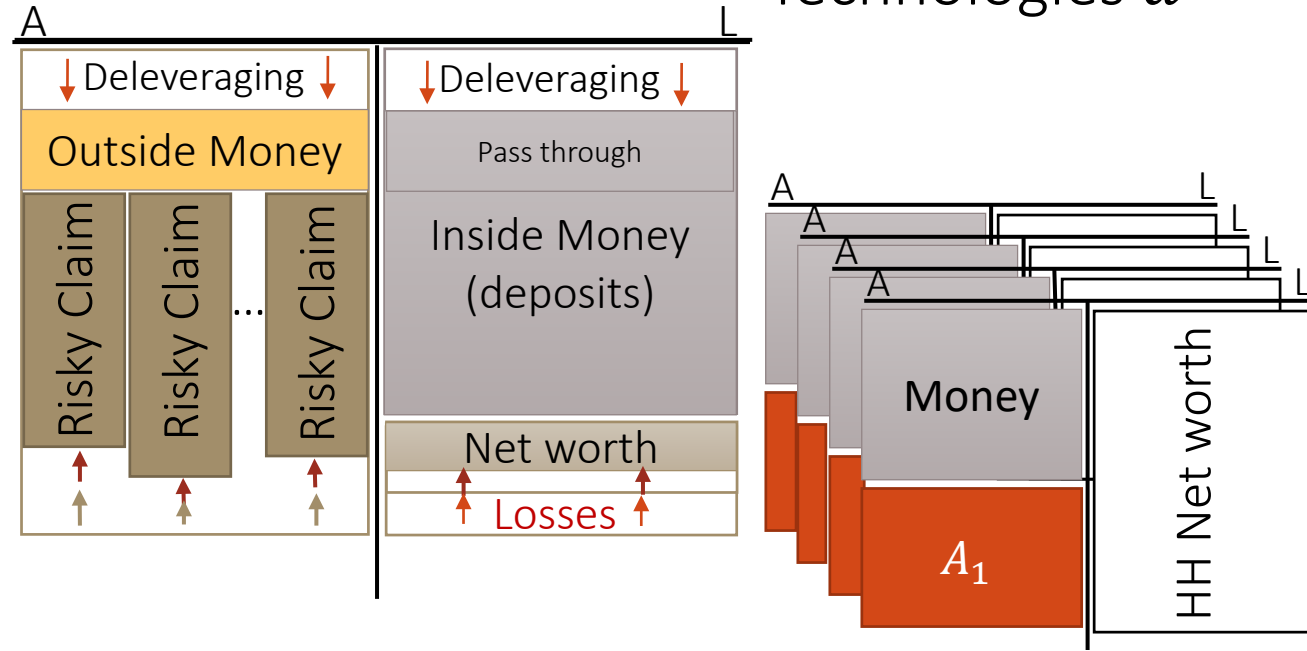
Like Keynes’ Paradox of Thrift but not in savings levels but in risk space
(see Euro book p. 179)

Liquidity spiral: asset price drop: 3rd of 4

Technologies b

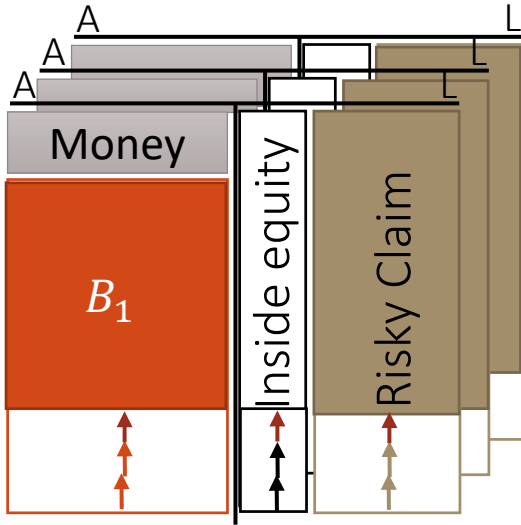


Technologies a

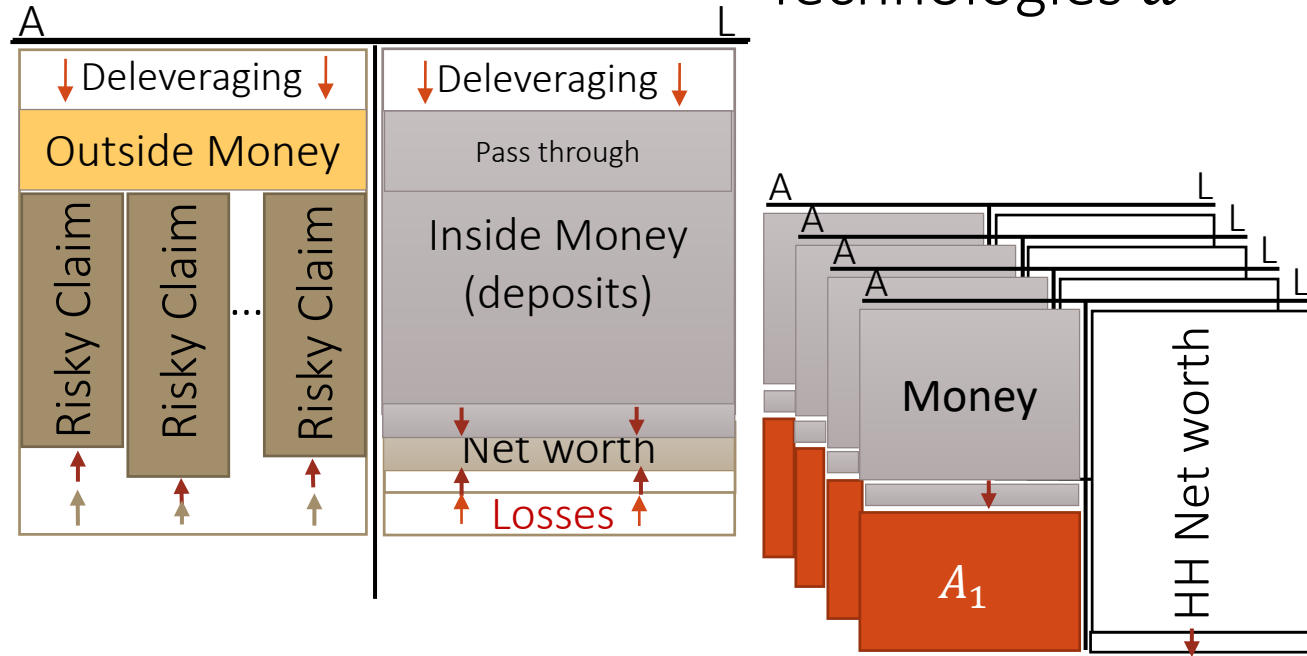


Disinflationary spiral: 4th of 4 steps

Technologies *b*



Technologies *a*

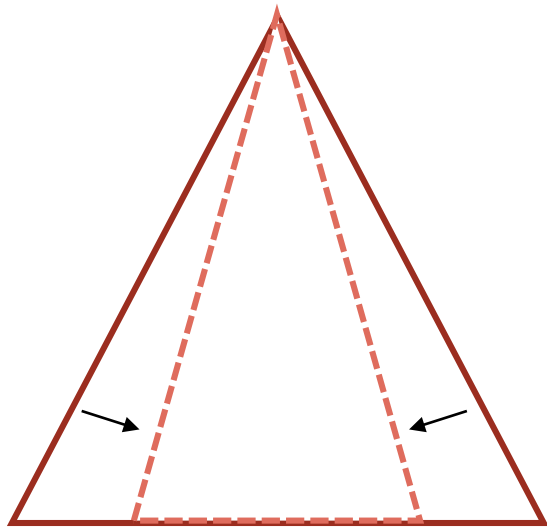


- Inside money supply ↓
- Money demand (since more idio risk) ↑

Same holds for tokens

Outside vs. Inside Money

- 2-tier financial system (fractional reserve banking)



Anchor: e.g. Gold/Yap Stone *Unit of account*

Currency - no claim

Deposits - private debt

} *Medium of Exchange*
(easy to swap, carry,...)

Credit

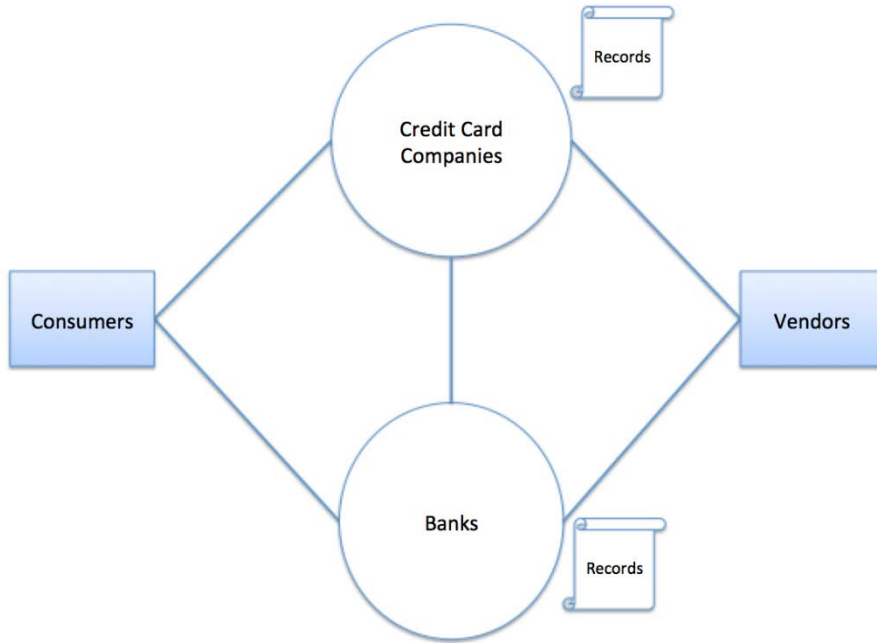
Store of Value

III Digital Economy – Rethinking Money

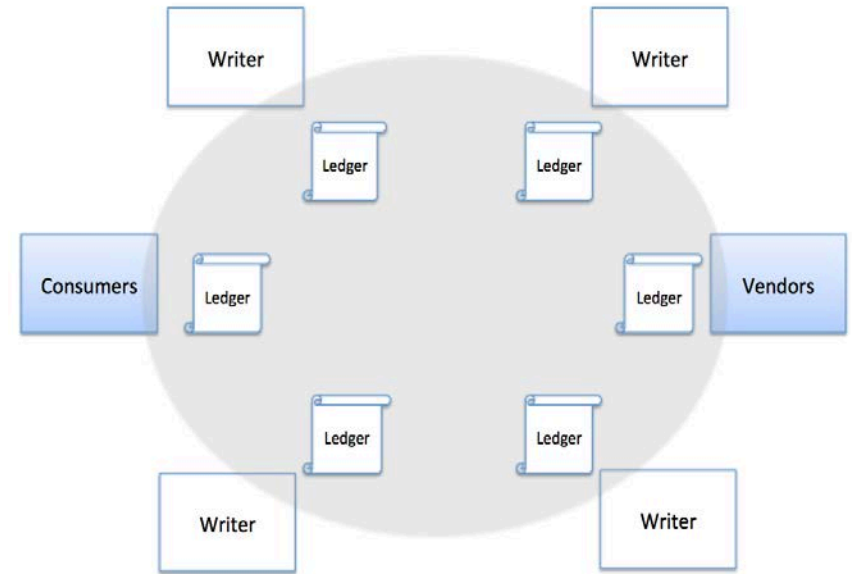
- Role of cash and reserves (outside money)
 - Cash as protector of privacy in an open society
- What new forms of money might emerge?
- Should central banks endorse/fight
 - Digital money? CBDC?
 - Cryptocurrencies?
 - Blockchain technology?
- Competition among currencies
(and other stores of value, means of payments)
in a world with declining transaction costs
- Tokenization

*“Blockchain Economics”
with Joseph Abadi*

When Intermediary? When Blockchain?



Centralized record-keeping



Decentralized record-keeping

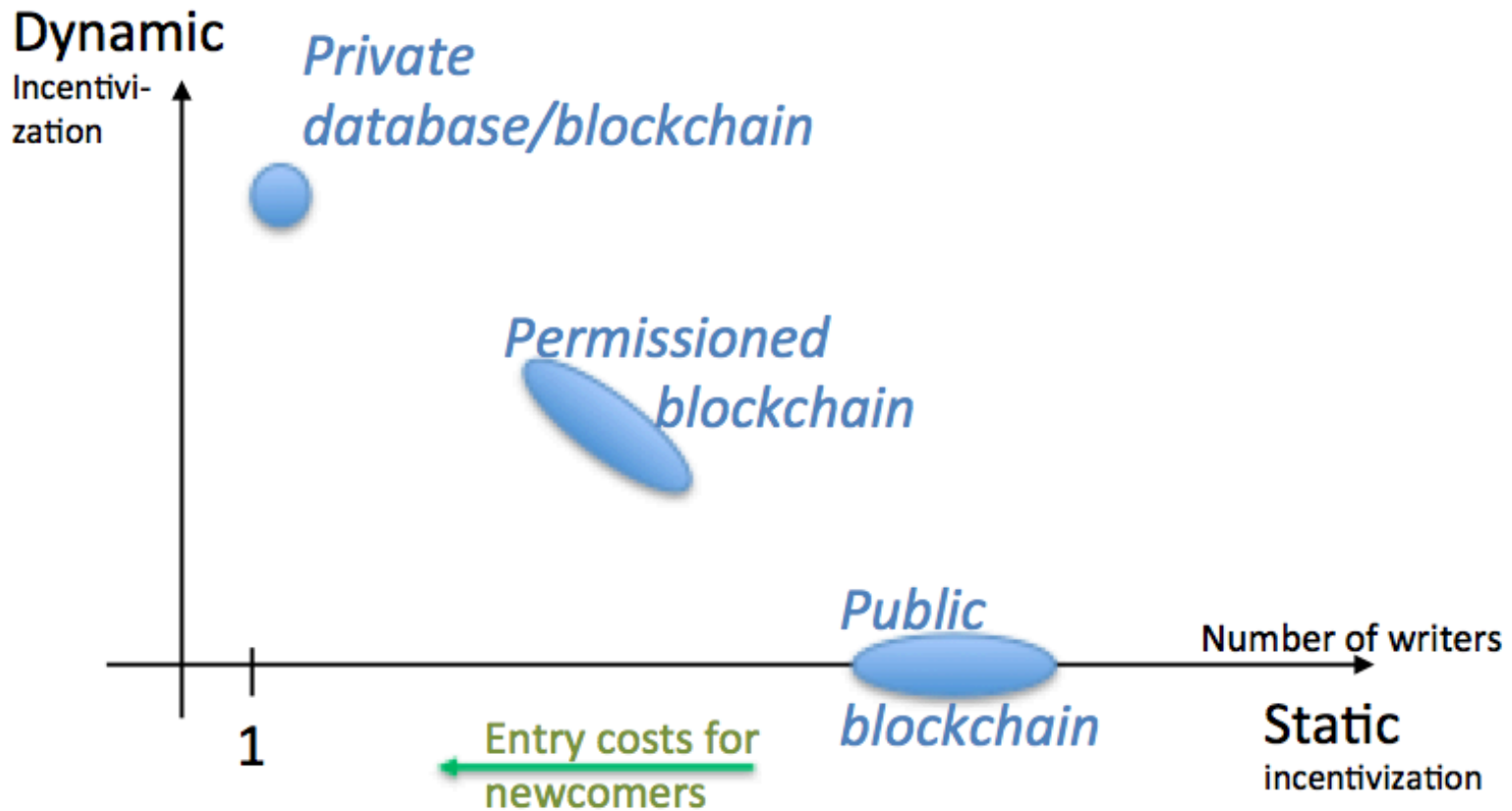
Dynamic vs. Static Incentivization

- Franchise value:
 - Preserve future rents
 - Collusion among writers via dynamic punishment strategies (e.g. Tit-for-Tat)
- Free entry:
 - No continuation value ($V = 0$)
 - No collusion via dynamic punishment strategies
 - Requires identify management (Proof-of-Work)

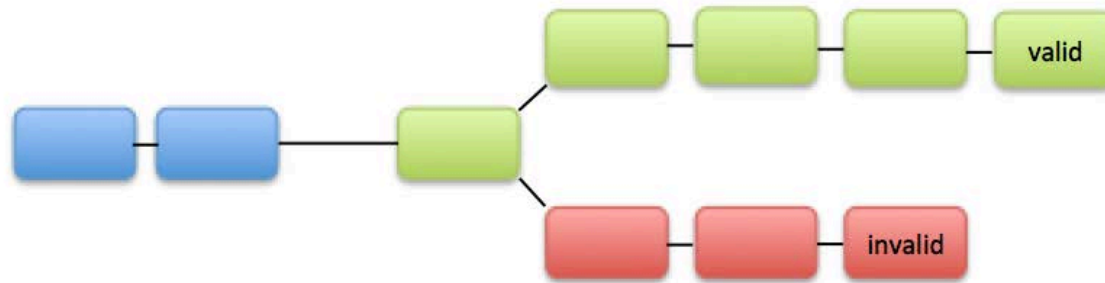
Dynamic vs. Static Incentivization



Dynamic vs. Static Incentivization



What is a Blockchain? What is a fork?



- Hard fork: splits community into two (both continue)
- (Soft fork: backwards compatible with old rules software update)

2 Forms of Competition

- Competition via entry and forking (“platform competition”)

		Ability to FORK	
Ability to ENTER		yes	No
	free entry	Blockchain	
	restricted	Permissioned Blockchain	Monopolistic intermediary

- “Fork competition”: 2 necessary ingredients
 - Replication of info
 - Competition among writers
- Information advantage – limits competition
 - W.r.t. other potential proposer (who don’t know states/bitcoins)
 - W.r.t. readers (who can only detect distortions with probability)

||| Currency Competition

- Currency/cash competition **à la Hayek**
(competition gives incentive for low inflation)
 - Cash as “imaginary ledger” (many wallets in your pockets)
 - Nobody knows distribution
 - *Flash back*: tribal reward system (see David Andolfatto)
 - Proposal: New (private) currency with new (inflation) rule
 - Coordination with other users/“readers”
 - Have to “sell” old for new currency (loss in value)

|| Currency Competition

- Currency/cash competition **à la Hayek**
(competition gives incentive for low inflation)
 - Cash as “imaginary ledger” (many wallets in your pockets)
 - Nobody knows distribution
 - *Flash back*: tribal reward system (see David Andolfatto)
 - Proposal: New (private) currency with new (inflation) rule
 - Coordination with other users/“readers”
 - Have to “sell” old for new currency (loss in value)
- **Crypto** currency competition “Fork competition”
 - Proposer **forks** blockchain
 - Tries to attract writers (to ensure undistorted ledger)
 - Tries to attract readers/users
 - **Key insight/difference**: *All information is transferred to new branch*
 - Enhances competition among currencies/platforms!
 - Analogy to “Free Banking Era” in US (19th century)
 - Community can split – “doubles” money supply

|| Analog: Greek Currency Reform in 1922



Converted in
new banknote
(half value)

Converted in a
bond



||| Cryptocurrency

- Store of value too volatile
 - Low correlation with other assets

- Medium of exchange too slow
 - Bitcoin: very low speed: 70 transactions/minute vs. 200.000 for Visa
 - Ether: 1500 transactions/minute
 - Ripple: permissioned Blockchain

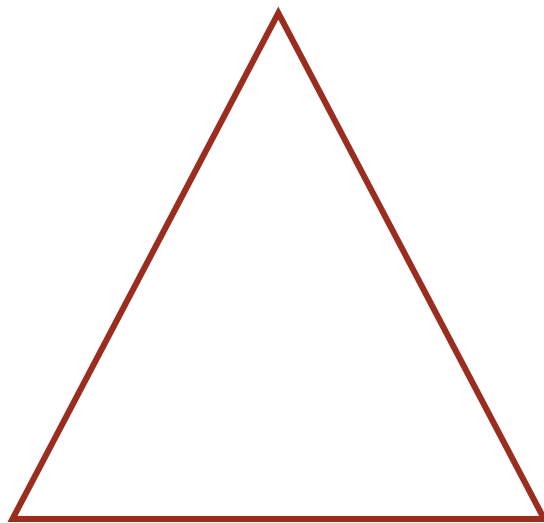
- Historical comparison with Gold
 - High volatility due to new discoveries
 - Small change problem

“Tokenization” as Inside Money

- Tencent, Alibaba, Amazon, Apple, ... will offer tokens
 - “Private money”
- Are tokens money?
- What’s the difference between cryptocurrency and token?
- Cryptocurrency
 - By fiat: no claim
 - Initial coin offering
- Token
 - Claim that can be exchanged for ...

Token as Inside Money

- 2-tier financial system (fractional reserve banking)



Anchor: e.g. Gold/Map Stone *Unit of account*
Currency - no claim
Deposits - private debt

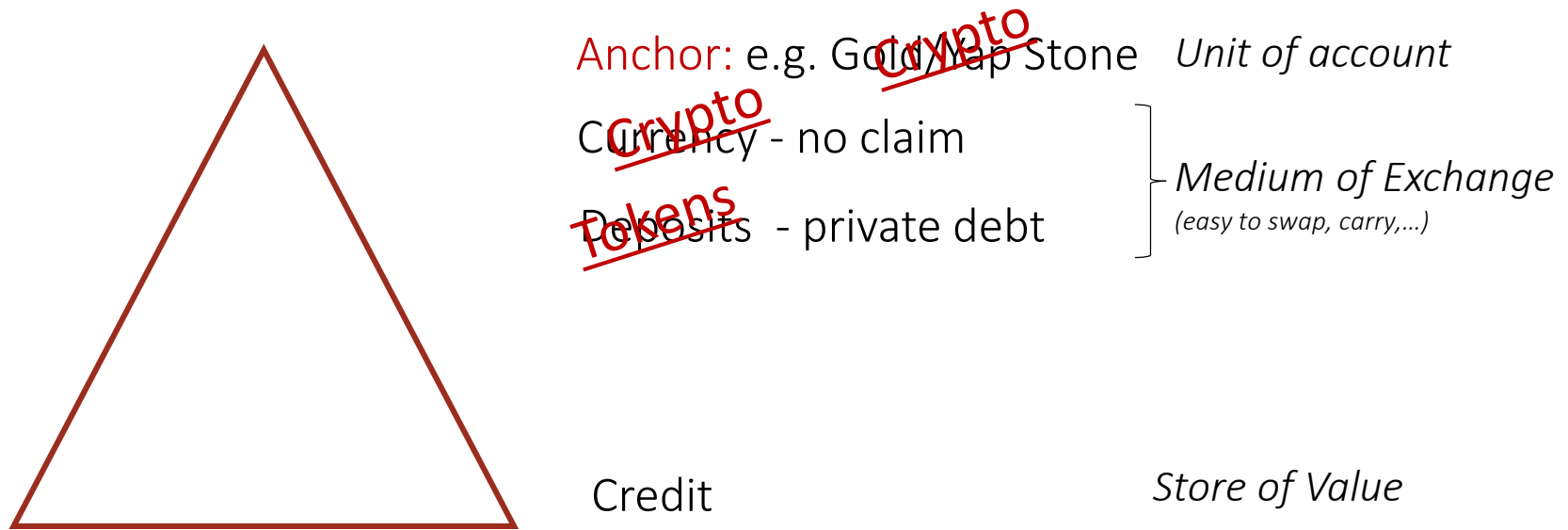
} *Medium of Exchange*
(easy to swap, carry,...)

Credit

Store of Value

Outside vs. Inside Money

- 2-tier financial system (fractional reserve banking)



- Cryptos: outside money interbank market (permissioned blockchain)
- Tokens: inside money (easier to transact with)
high PoW (Bitcoin) transactions costs are not a problem

||| Possession vs. Ownership: Enforcement

- So far: ignored distinction btw **ownership and possession**.
 - Ownership is traded in the secondary market
 - Possession requires enforcer
- Blockchain is good for determining ownership but not possession
 - Centralized intermediary = enforcer (of contracts)
 - Blockchains: Who is the enforcer?
- Currency is the outlier: no enforcer needed

Conclusion

- Macro Model
 - Endogenous volatility dynamics “Paradox of Prudence”
 - Not only impulse response function – back to steady state
- Money Models
 - Financial frictions + idiosyncratic risk \Rightarrow endogenous demand for money
 - The I Theory of Money
- Money in the Digital Age
 - Traditional: centralized monopolistic ledger (franchise value)
 - Blockchain: decentralized ledger (free entry competition)
- “Fork competition”
 - Competition between currencies (more fierce than Hayek’s)
- Tokenization by social media/payment firms
 - Tencent, Alipay, Amazon, Apple, ...
 - Analogy with Free Banking Era
 - Inside Money = Token
 - Outside money = Cryptocurrency
Interbank Market via permission Blockchain
- Macro models with digital agents/machines transferring money

Futuristic