The I Theory of Money

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Updates: http://scholar.princeton.edu/markus/files/i_theory_slides.pdf

	Financial Stability	Price Stability	Debt Sustainability
Financial Regulators	*Liquidity spiral*		
Central Bank		De/inflation	
Fiscal Authority			Fiscal Monetary Dominance

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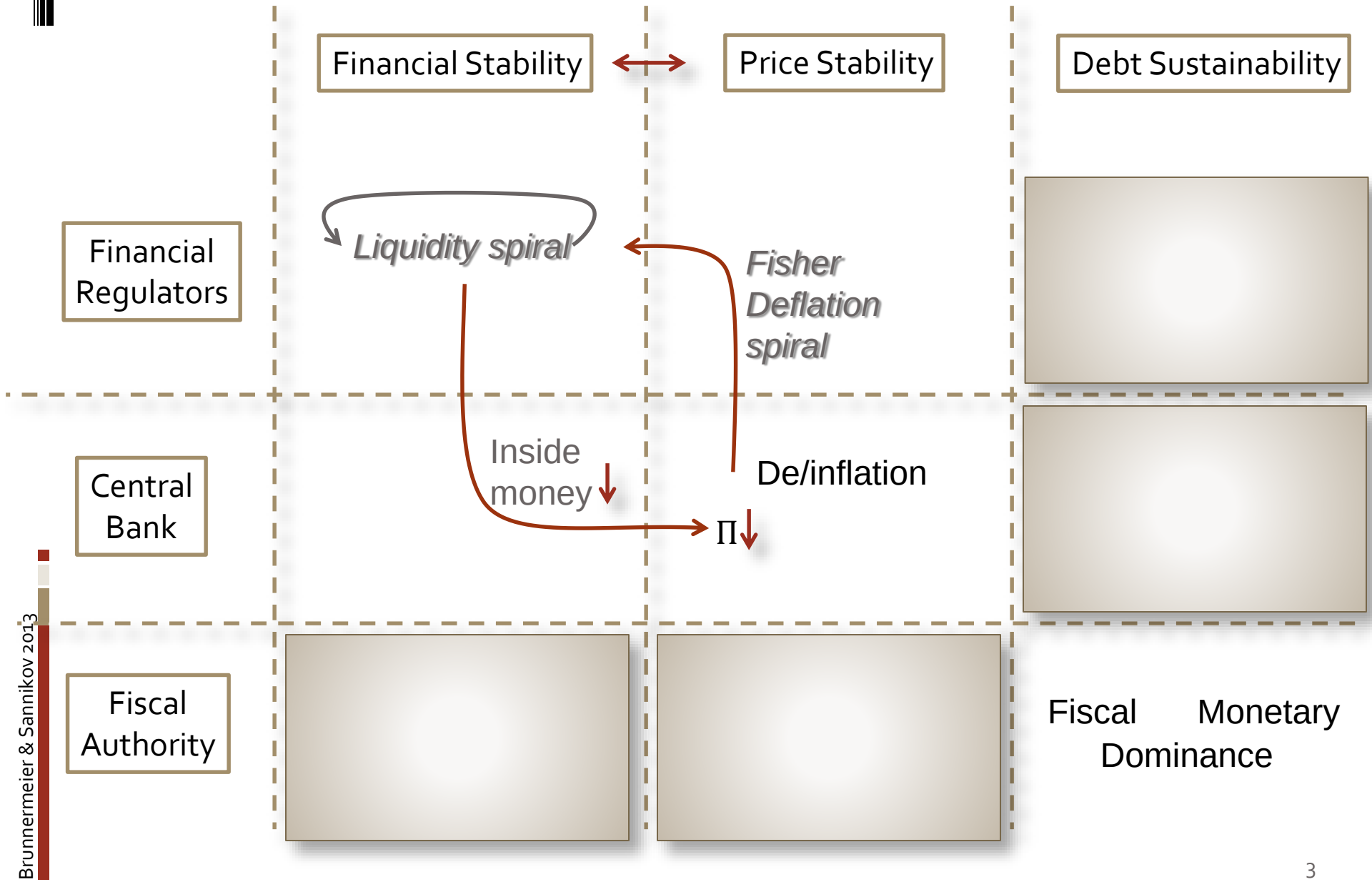

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Motivation

- Unified framework to study financial and price stability
- I: Intermediation (credit) - Inside money
  - Revive "money and banking"
- Value of money endogenous - store of value, liquidity
- In downturns, intermediaries create less inside money
  - Value of **outside** (base) money goes up
  - Fisher (1933) **deflationary spiral** hits borrowers on liability side
  - **Endogenous** money multiplier = f(health of intermediary sector)
- Monetary policy (interest rates, open market operations)
  - Fills in demand for money when money multiplier contracts
  - "Stealth redistribution" from/towards intermediary sector

Finance view vs. Monetary textbook model

- Risk is endogenous
  - Volatility paradox
- Risk premium is time-varying
  - $\Delta\text{price} = f(\Delta E[\text{future cash flows}], \Delta\text{risk premia})$

  - Term spread: expectations hypothesis fails
  - Credit spread: default risk
    risk premium

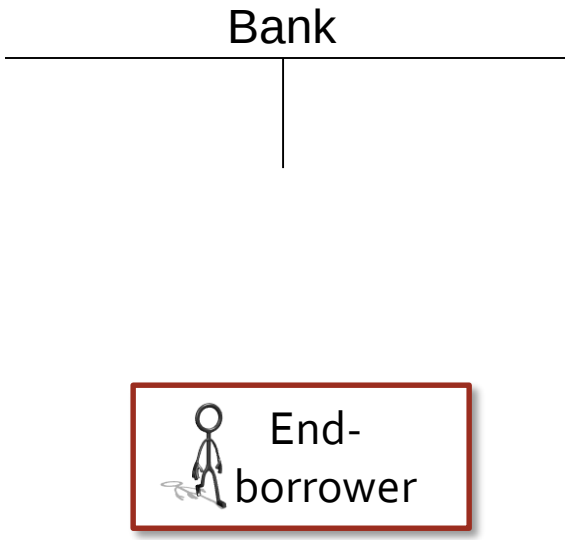
  - MoPo recaps impaired sectors and affects risk and risk premiun
    - Surprise Fed interest rate cut lowers 10 year (real) TIPS yield
      Hanson-Stein (2014)

Main results

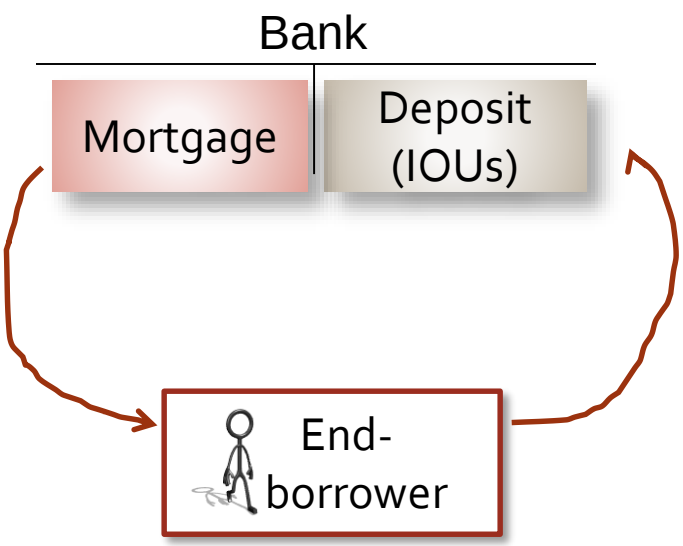
- **Money multiplier** depends on **banks' balance sheets** (rather than reserve requirements)
  - banks well-capitalized or not → level of economic activity
  - Banks create less money in downturns → deflation
- Money as unit of account
  - Nominal deposits: **deflationary spiral** hurts borrowers
- Monetary policy **redistribute wealth** "stealth recapitalization"
  - Interest rate policy, forward guidance, asset purchases, QE

1. limits <u>endogenous</u> (systemic) <u>risk</u>
   - Switch of deflationary spiral — money view
   - Switches of liquidity spiral — credit view
2. reduces <u>risk premia</u> (pure welfare loss)

Setting up the Economy

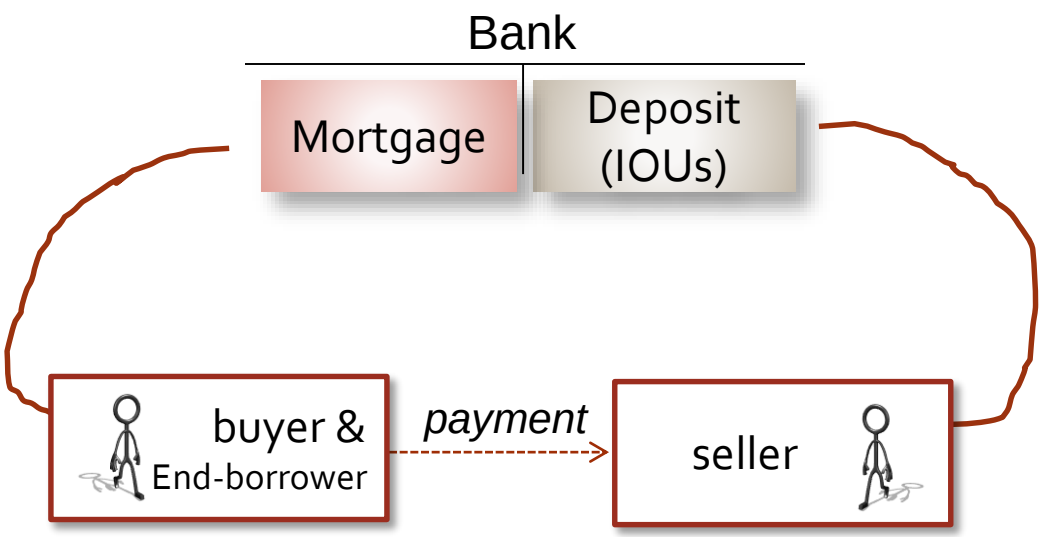


Credit and Money Creation



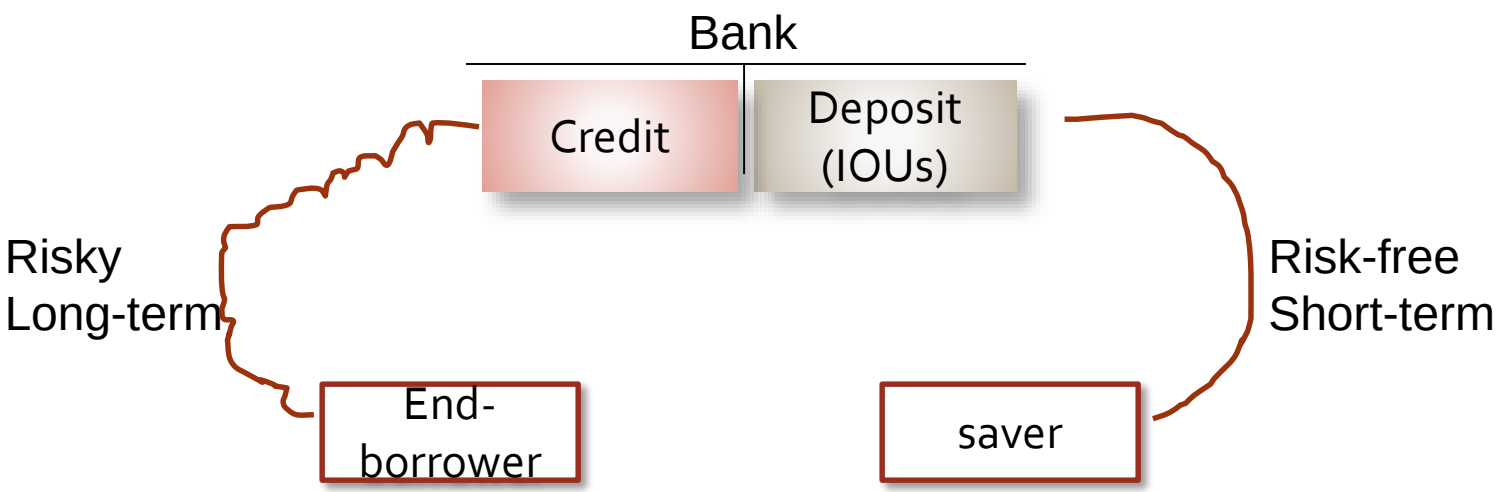
Transferring/accepting Deposits

- End-borrower buys house & transfers deposit to seller of house
- As long as seller holds deposits, he lends through the bank



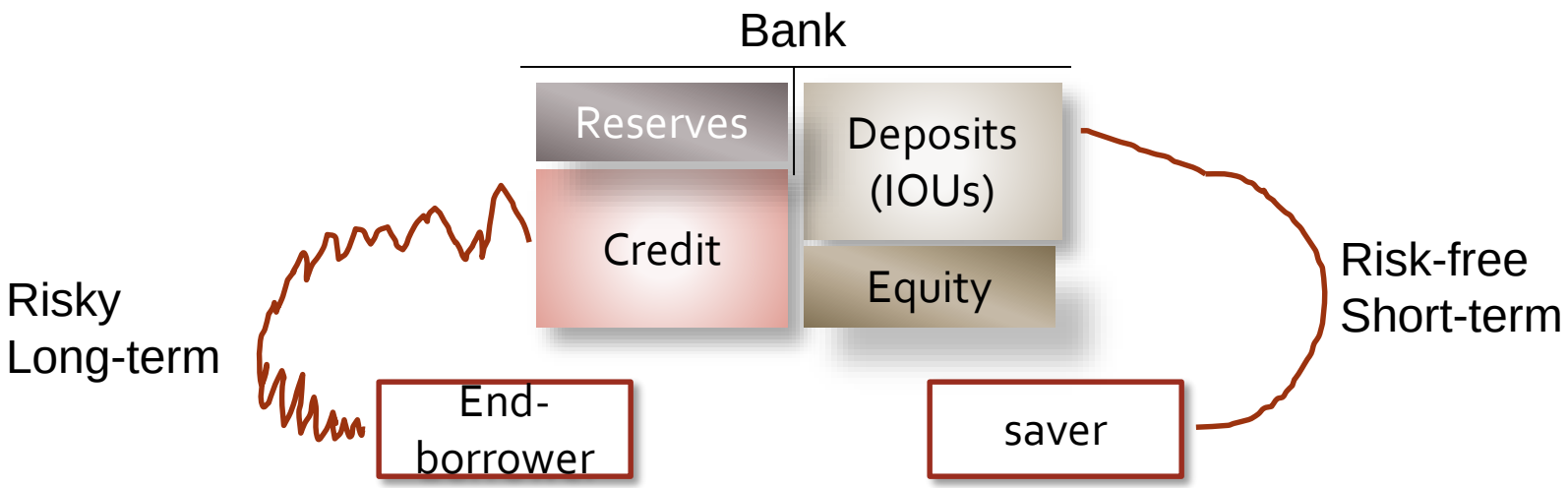
- Money is a "witness" for mortgage/credit
- End-borrower needs money in the future to pay back mortgage

Risky long-term vs. Risk-free short-term

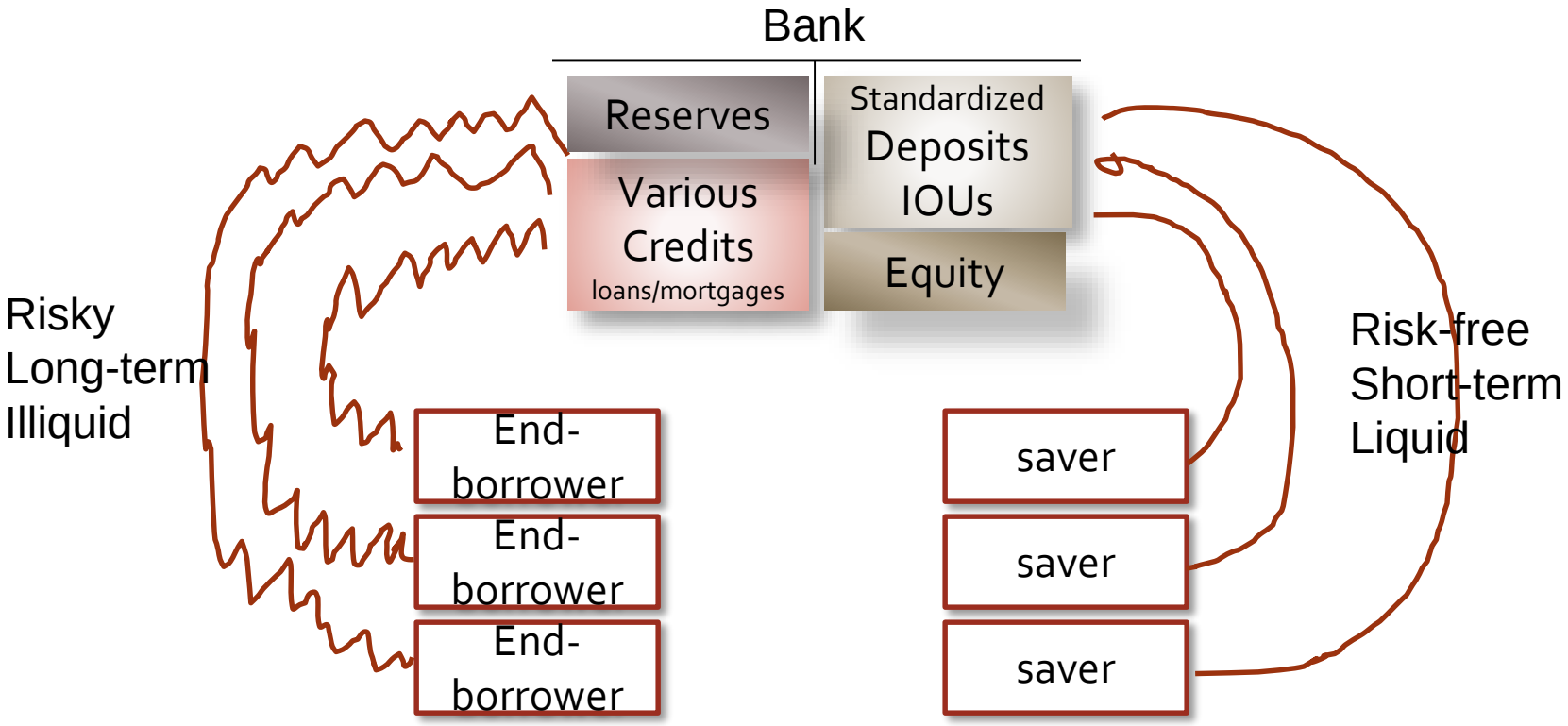


- Two risks:
  - Asset side: Credit/default risk
  - Liability side: Liquidity funding/run risk

Equity cushion to protect against risk



Many forms of credit, standardized IOUs



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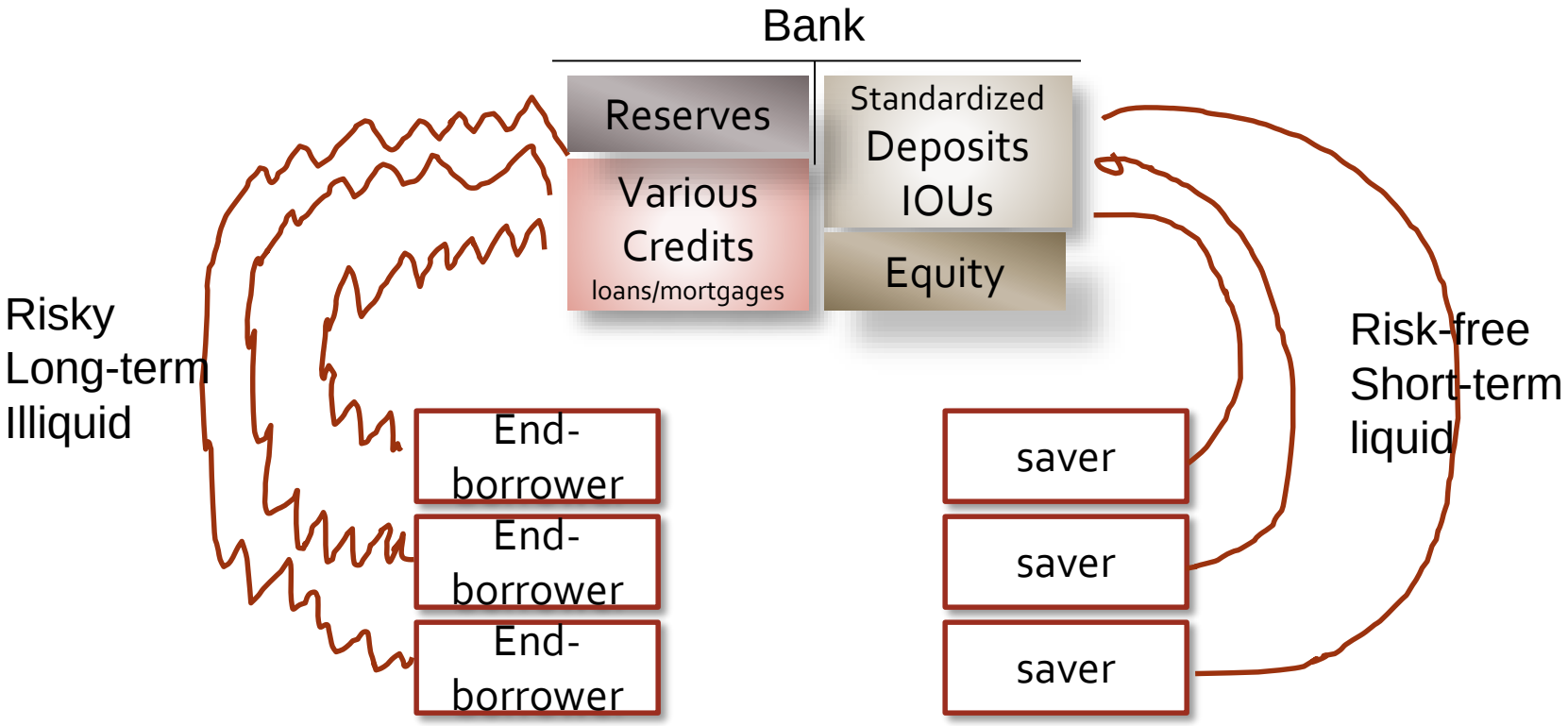
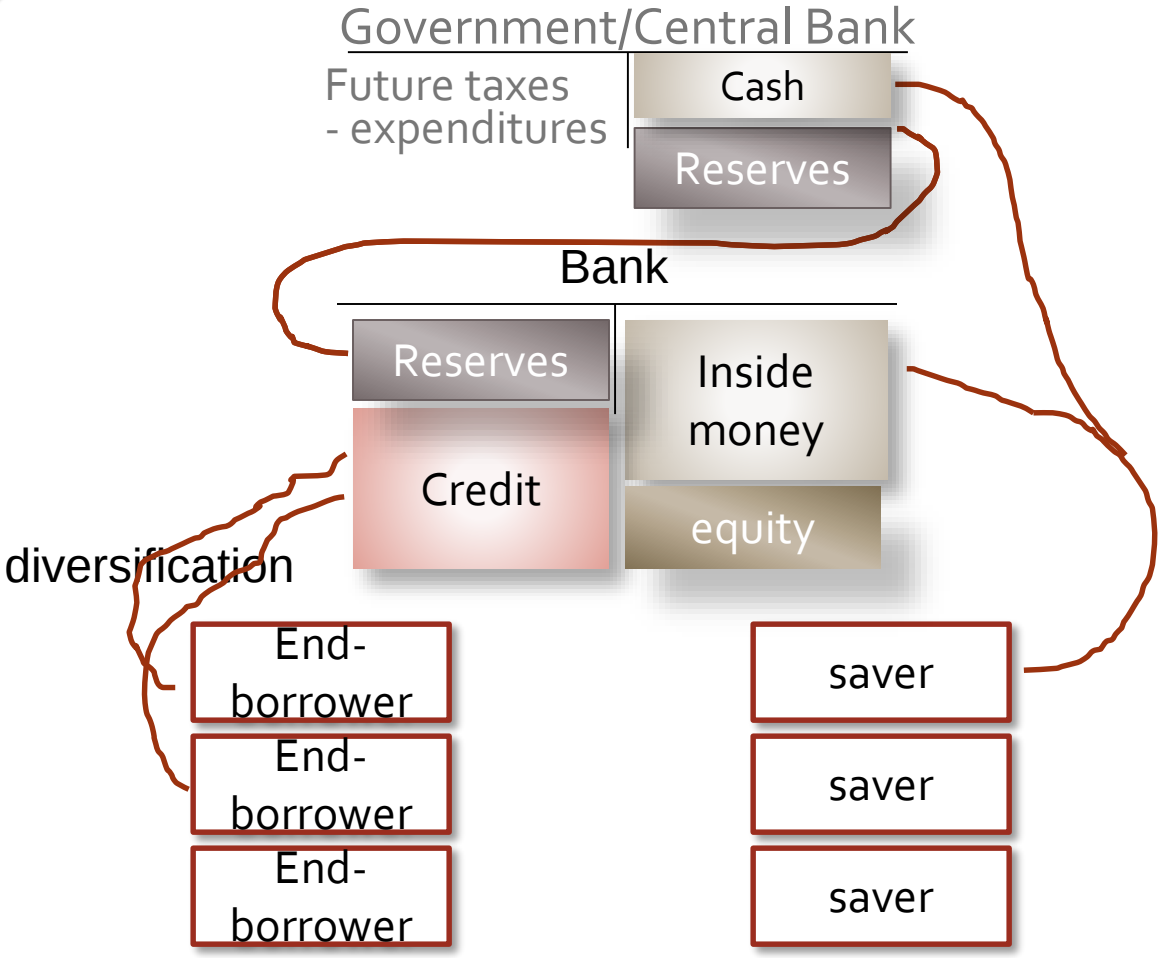
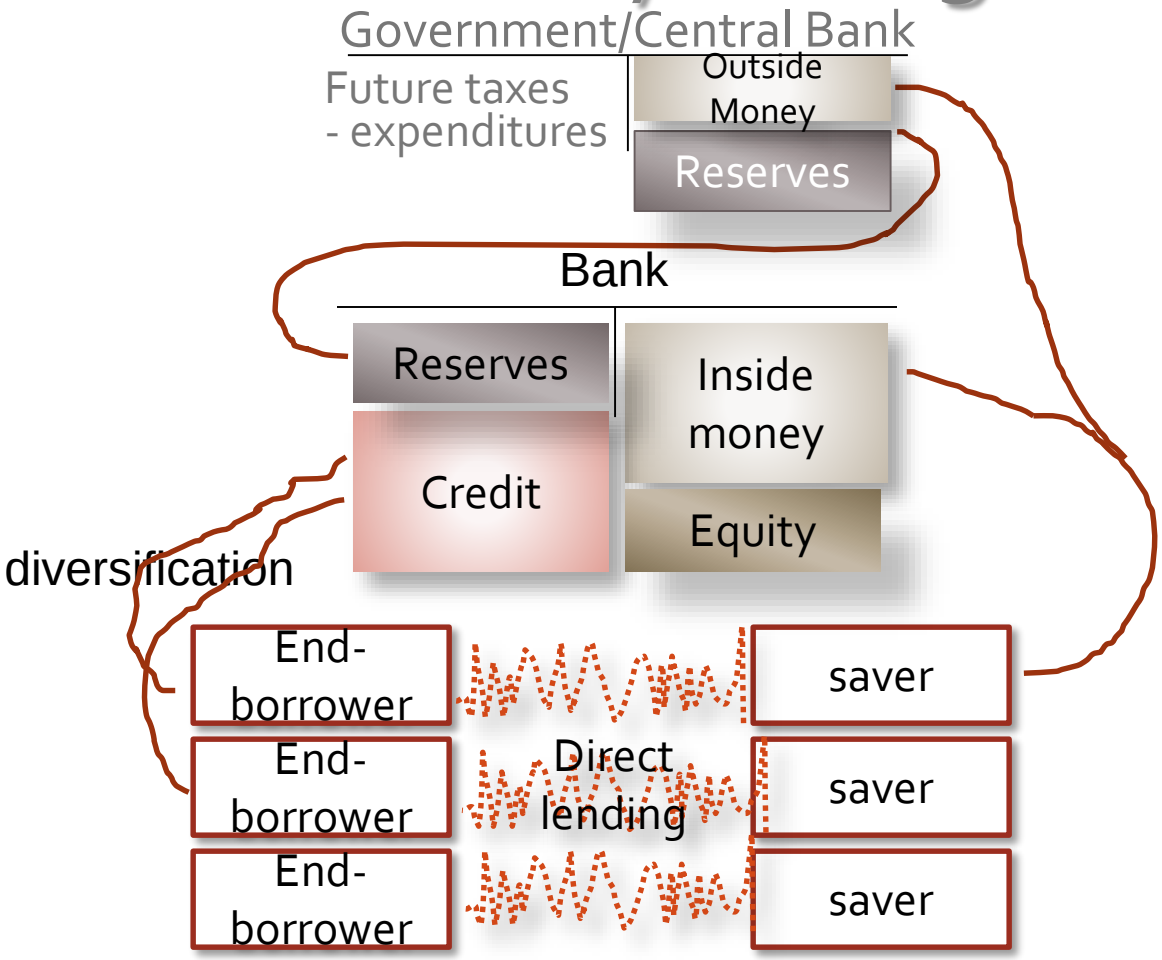


- Inside Money: Standardized IOUs
  - Limited credit risk, no asymmetric information, easy netting!

Add government/Central bank



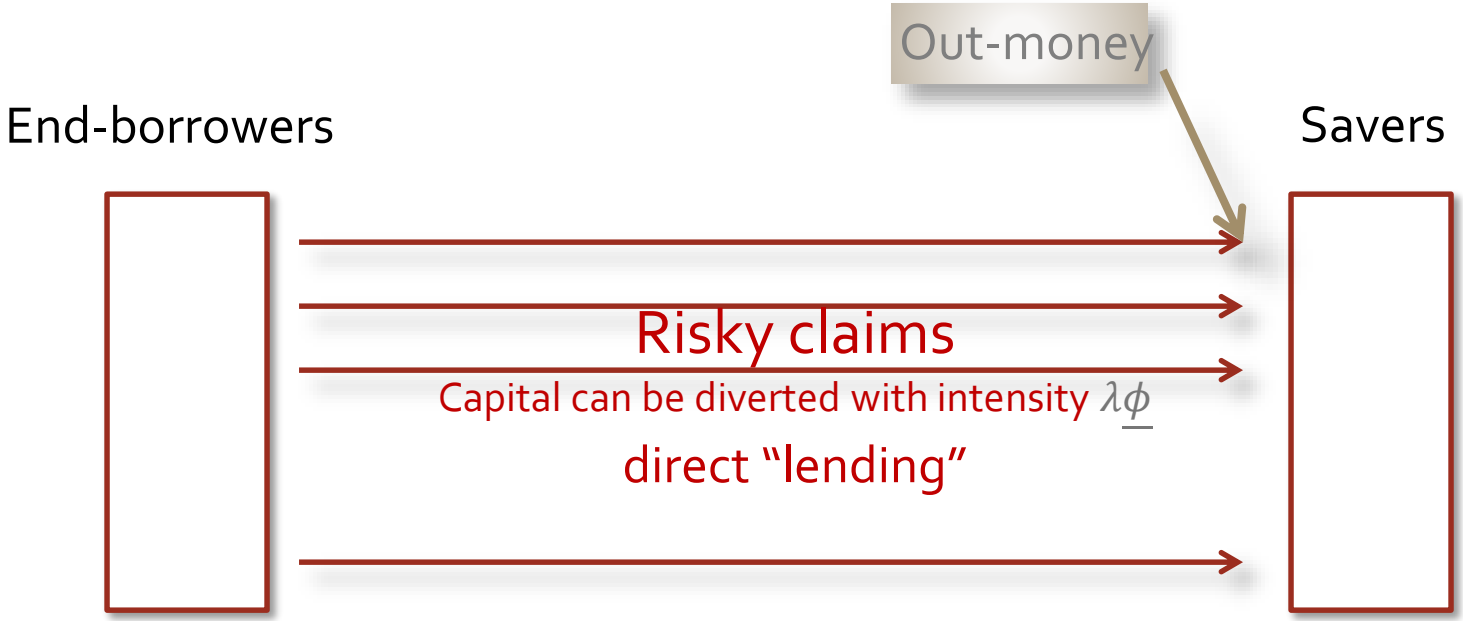
Contrast to direct risky lending



- Direct lending is more risky since
  - No diversification
  - Repayment less enforced

The economy without intermediaries

- Savers have net worth – end borrowers don't
- Friction: direct "lending" is risky
  - end borrowers divert funds with probability $\underline{\phi}$
  - after a shock, which occurs with arrival rate λ



The economy without intermediaries

- Saver HHs rent out capital to end-borrowers (entrepreneurs) with zero wealth, who produce
- Consumption output: $y_t = (a - \iota)k_t$,
- Capital: $dk_t = (\phi(\iota_t) - \delta)\, k_t dt$
- Shocks are purely redistributive
  - λ arrival rate of macro shock
  - $\underline{\phi}$ fraction of end-borrowers divert capital and become HHs
- Consumption:
  - Saver HH $E\left[\int_0^\infty e^{-rt} \log c_t \, dt\right] \Rightarrow$ consume $r *$ wealth
  - End-borrowers consume zero (until they divert and become savers)

Benchmark 1: No intermediaries + Frictions

- Value of aggregate capital $q_t K_t$
- Value of money $p_t K_t$

End-borrowers sell goods for cash with which they pay taxes

Return	Absent shock	shock
On capital r_t^K	$\frac{(1-\tau)(a-\iota)}{q} + \phi(\iota) - \delta$ Dividend yield + capital gain	Loss with prob $\lambda\underline{\phi}$
On money r_t^M	$\frac{\tau(a-\iota)}{p} + \phi(\iota) - \delta$	No loss

Benchmark 1: only direct "lending"

- Optimal portfolio choice for <u>Savers</u>
- $r\underline{V}(n_t) =$
  $\max_{\underline{c},\underline{x}} \log \underline{c} + \underline{V}'(\underline{n}_t)\left[\left(\underline{x}r_t^K + (1-\underline{x})r_t^M\right] + \lambda\underline{\phi}[\underline{V}((1-\underline{x})\underline{n}_t) - \underline{V}(\underline{n}_t)]$
  - where $\underline{V}(\underline{n}_t) = \frac{\log \underline{n}_t}{r} + const$
- FOC, $\underline{c}$: $\quad \underline{c} = r\underline{n}_t$

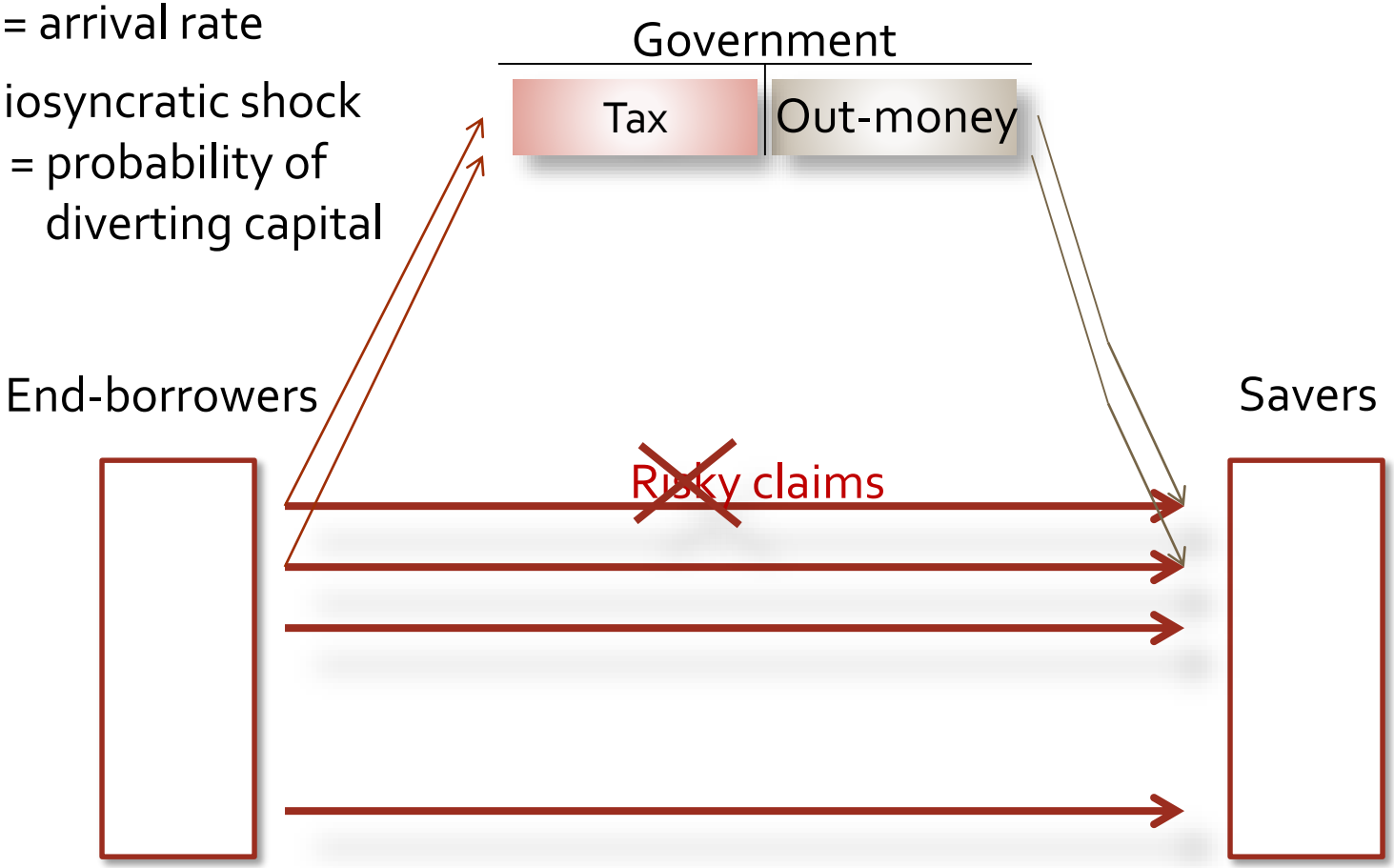
$$\underline{x} : \left(\frac{(1-\tau)a}{q} + \phi(\iota) - \delta\right) - \left(\frac{\tau a}{p} + \phi(\iota) - \delta\right) - \lambda\underline{\phi}\frac{1}{1-\underline{x}} = 0$$

- Market clearing, output: $\quad r(q+p)K = (a-\iota)K$

  capital: $\quad \underline{x} = qK/(qK + pK)$
- Hence, $q = \frac{(1-\tau)(a-\iota)}{r+\lambda\underline{\phi}}$, $p = \frac{(a-\iota)}{r}\frac{\tau r + \lambda\underline{\phi}}{r+\lambda\underline{\phi}}$, $\quad \Phi'(\iota)q = 1-\tau$
- Value of money even if $\tau = 0$ (tax can be even slightly negative)

Benchmark 2: No frictions

- Macro shock
  λ = arrival rate
- Idiosyncratic shock
  $\underline{\phi}$ = probability of diverting capital



Benchmark 2: No frictions

- With frictions:

$$q = \frac{(1-\tau)(a-\iota)}{r+\lambda\underline{\phi}} \text{ and } p = \frac{(a-\iota)}{r}\frac{\tau r+\lambda\underline{\phi}}{r+\lambda\underline{\phi}}$$

- Without frictions, $\lambda = 0$ or $\underline{\phi} = 0$:

$$q = \frac{(1-\tau)(a-\iota)}{r} \quad \text{and} \quad p = \frac{\tau(a-\iota)}{r}$$

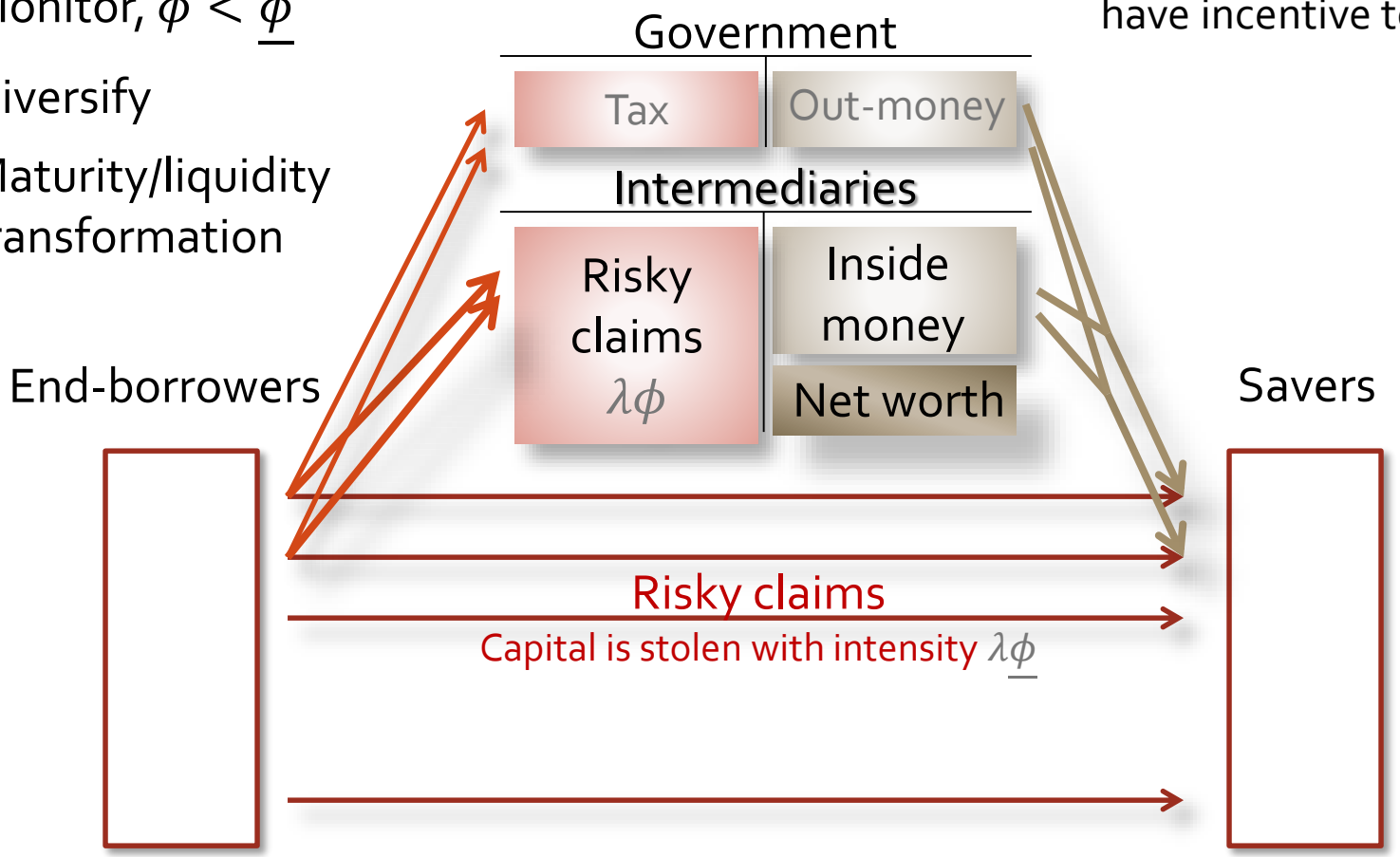
… and $r^M = (1-\tau)(a-\iota)q = r^K = \tau(a-\iota)/p$

  - Value of capital is lower with frictions
  - Value of money is higher with frictions
    - Is zero without frictions if no tax backing

Intermediaries (discount rate $\rho > r$)

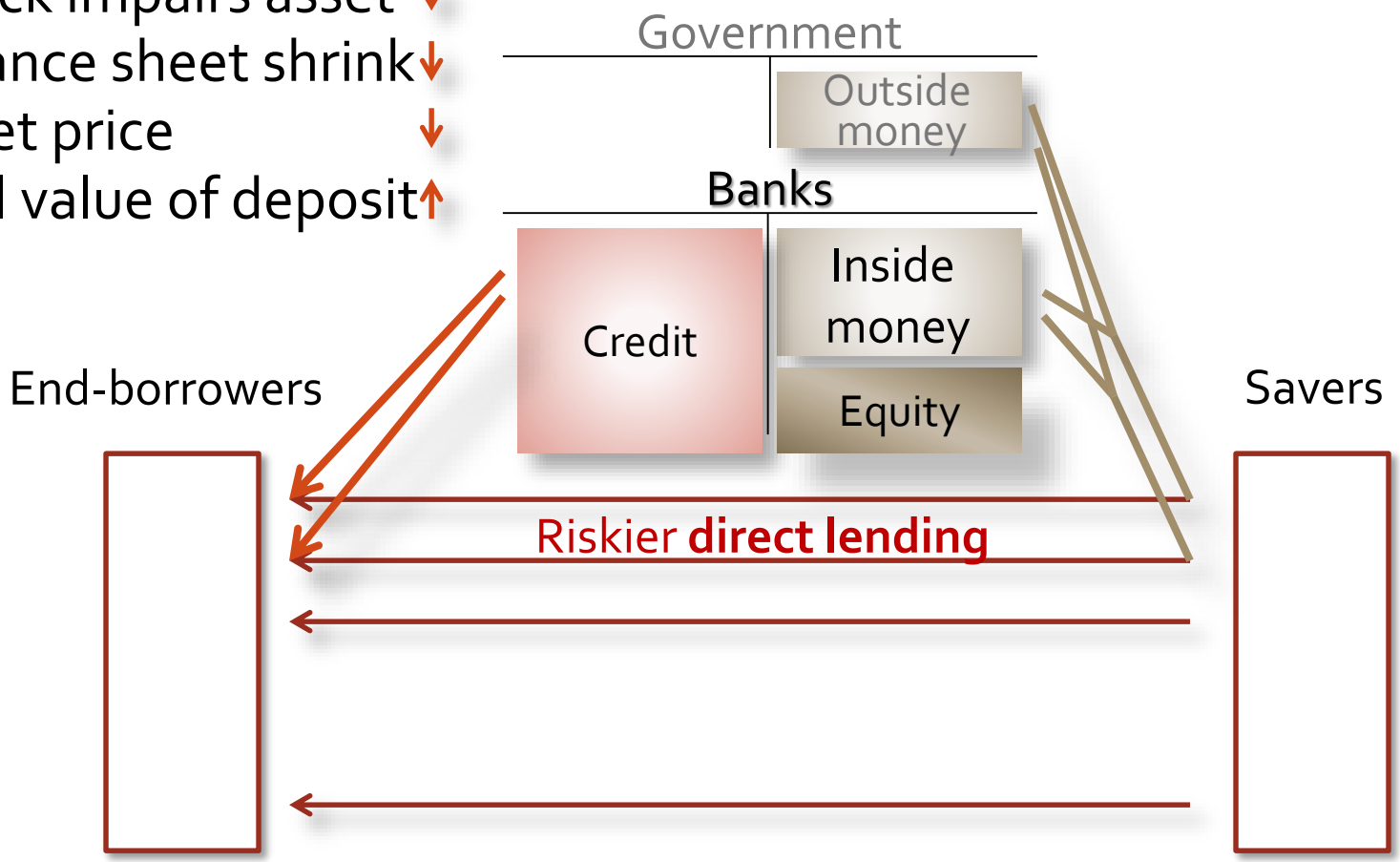
Intermediaries must fully absorb risk of their assets through net worth, e.g. to have incentive to monitor

- Monitor, $\phi < \underline{\phi}$
- Diversify
- Maturity/liquidity transformation



Adverse Shock split into 4 Steps

1. Shock impairs asset ↓
2. Balance sheet shrink ↓
3. Asset price ↓
4. Real value of deposit ↑



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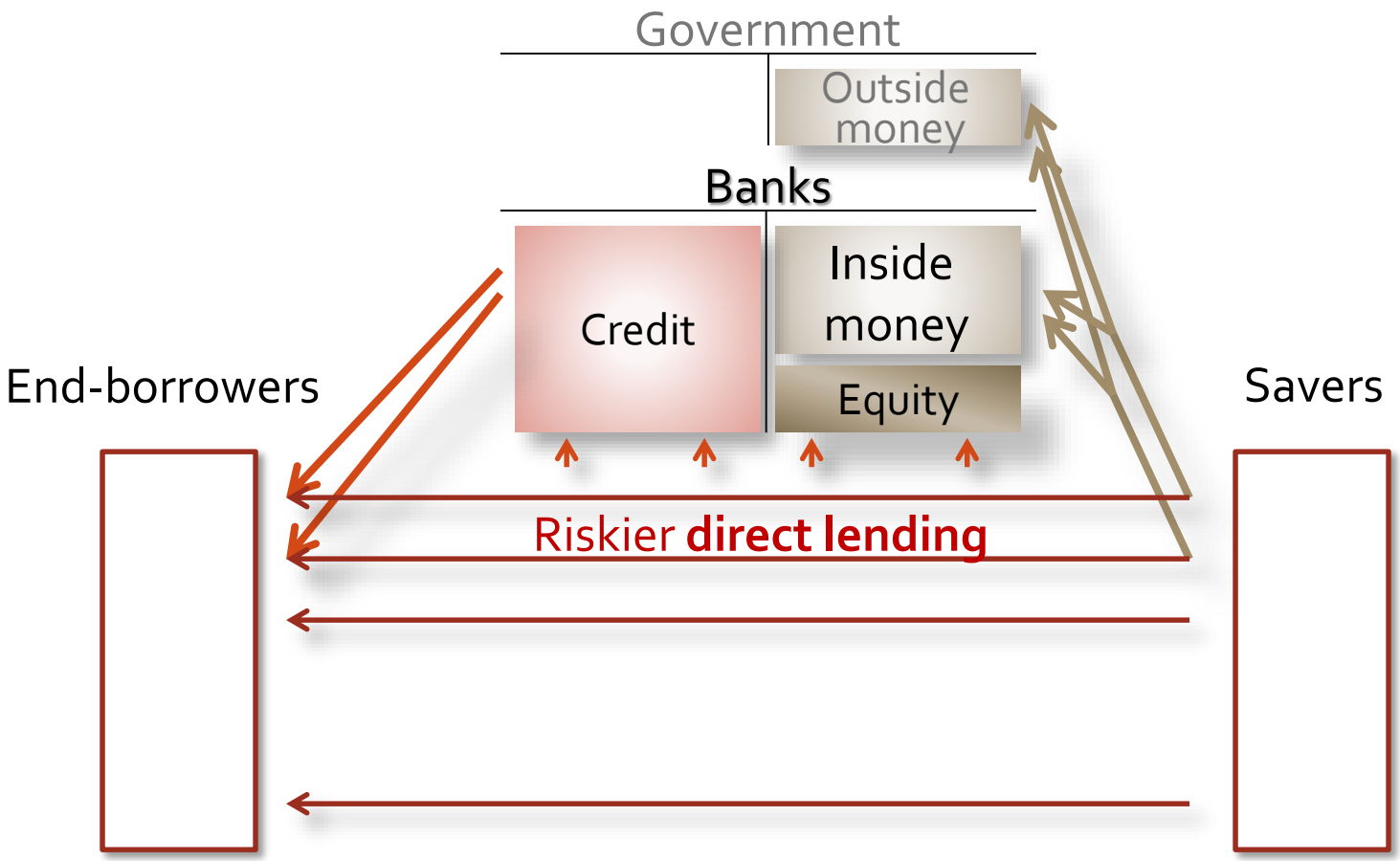
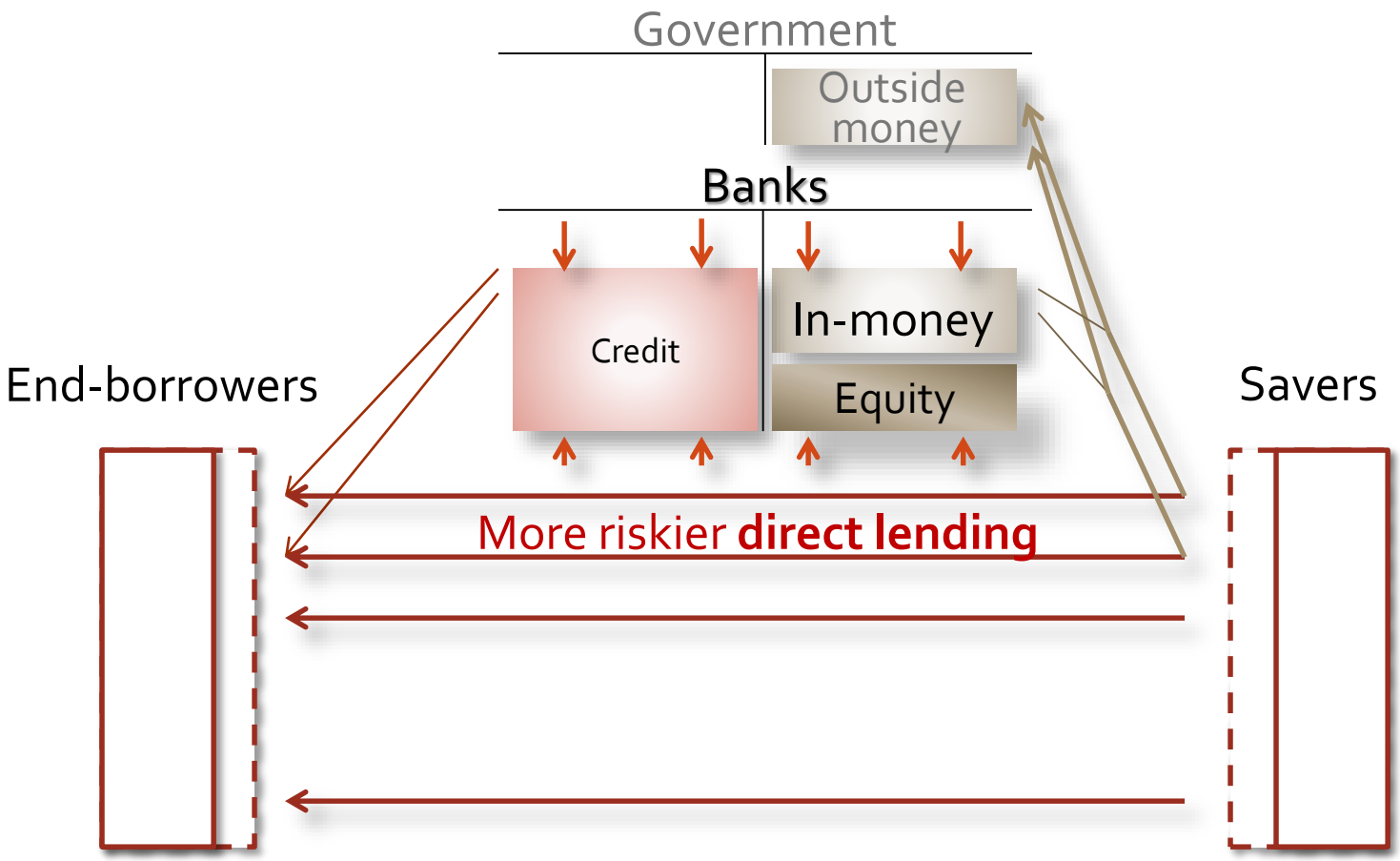
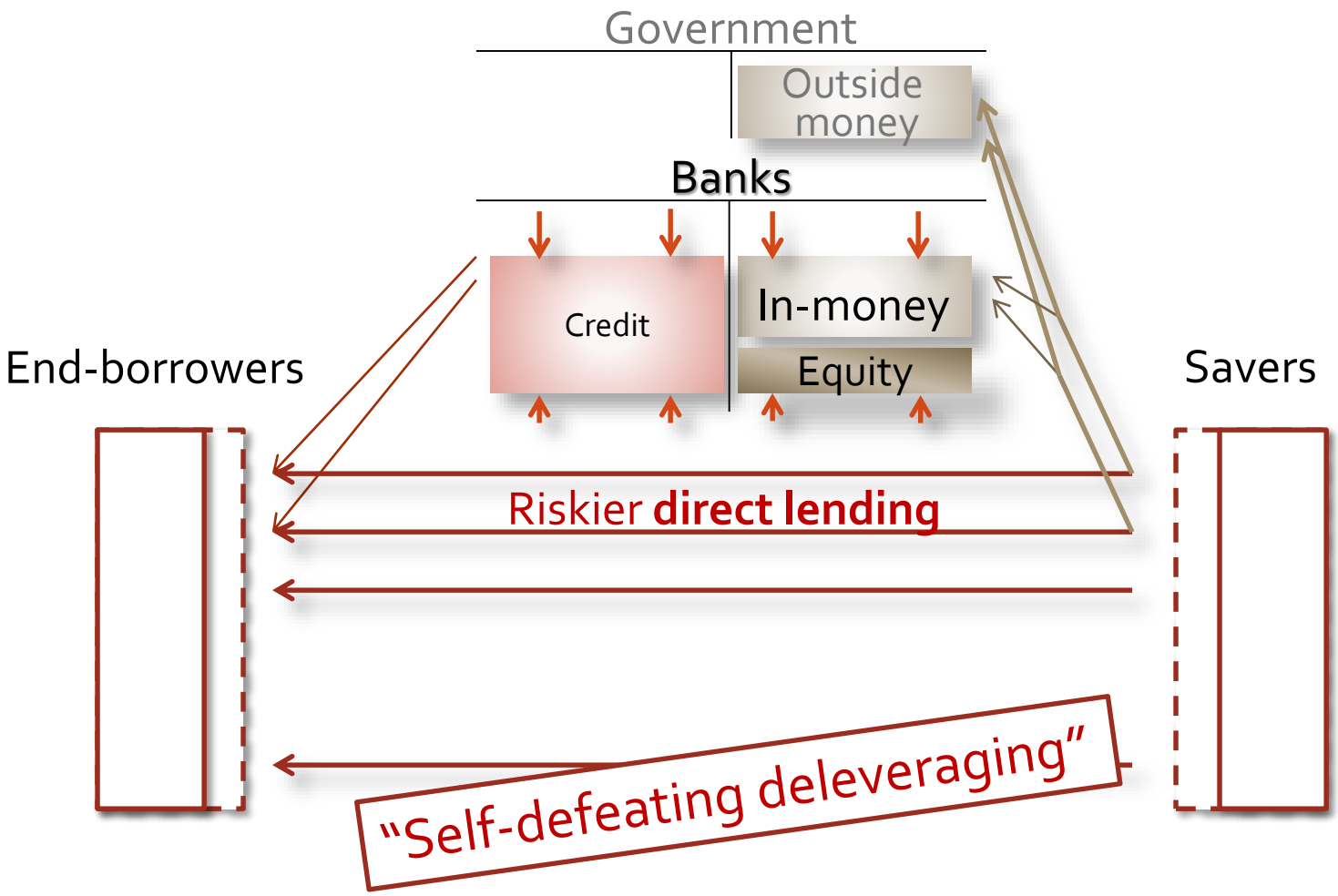
1. Shock Impairs Assets – 1st of 4 Steps



2. Shrink Balance Sheet: Sell off of Assets



3. Liquidity Spiral: Sell off of Assets



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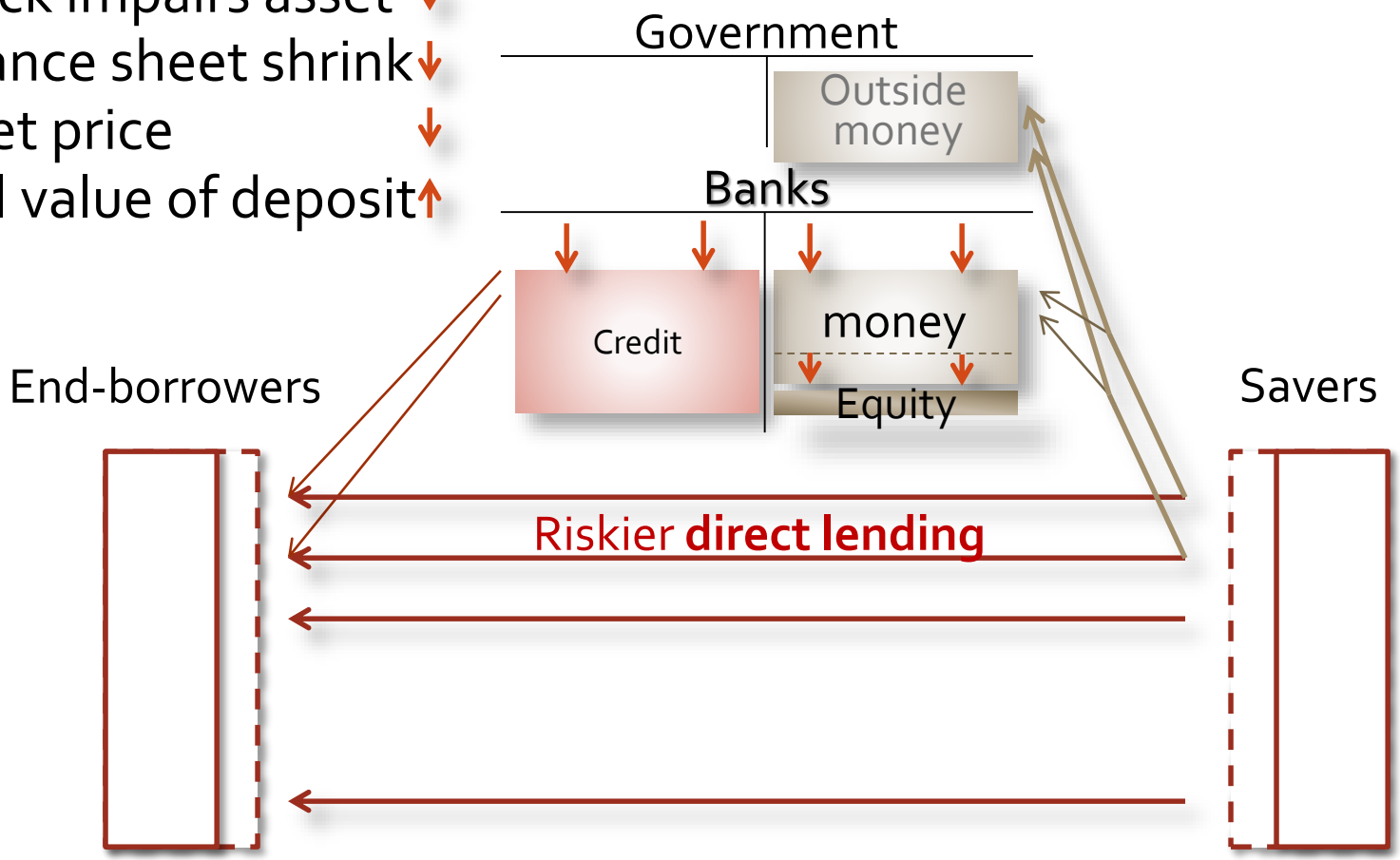
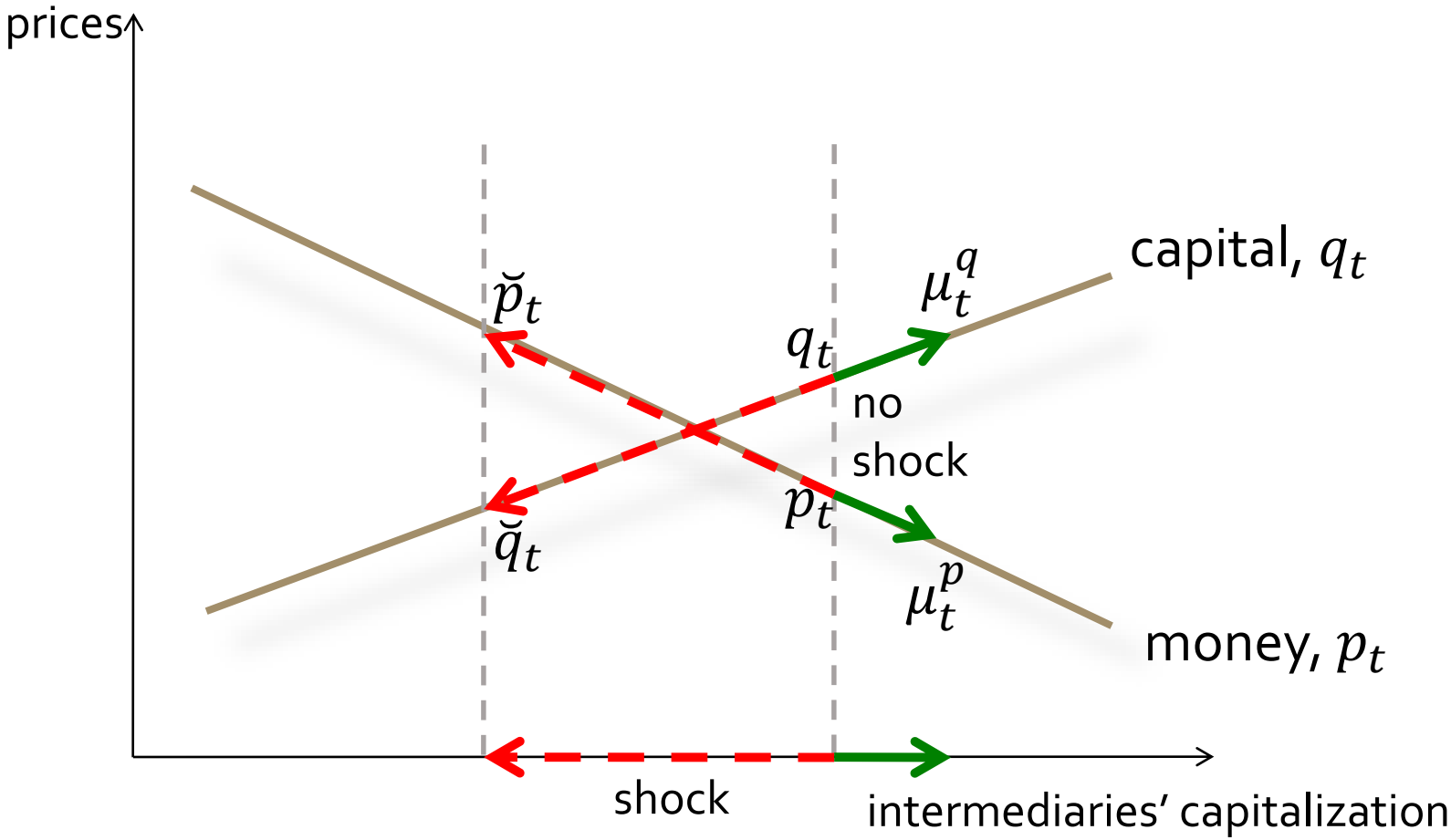
4. Deflation Spiral: Value of Liabilities Expands

1. Shock impairs asset ↓
2. Balance sheet shrink ↓
3. Asset price ↓
4. Real value of deposit ↑



Small shock has large effect and redistributes wealth

Between benchmarks: Price drifts & jumps



Optimal investment ι

- Static problem

$$\max_{\iota_t} \Phi(\iota_t) - \delta - \frac{(1-\tau)\iota_t}{q_t}$$

$$\Rightarrow \Phi'(\iota_t) = \frac{1-\tau}{q_t}$$

- Tobin's q
- Higher q_t , more investment
  - $dK_t = gK_t dt$

Returns and Portfolio choice

Return	Absent shock	Shock	
		Intermediaries	Saving HHs
On capital r_t^K	$\frac{(1-\tau)(a-\iota_t)}{q_t} + \mu_t^q + \phi(\iota) - \delta$	$(1-\phi)\frac{\breve{q}_t}{q_t}$	Loss with prob. $\underline{\phi}$ $\frac{\breve{q}_t}{q_t}$ with prob. $(1-\underline{\phi})$
On money r_t^M	$\frac{\tau(a-\iota_t)}{p_t} + \mu_t^p + \underbrace{\phi(\iota) - \delta}_{=g}$	$\frac{\breve{p}_t}{p_t}$	$\frac{\breve{p}_t}{p_t}$

- Optimal portfolio choice

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Equilibrium

- Maps histories of shocks $\{t_1 < t_2 < \cdots < t_n \leq t\}$ to prices q_t, p_t and allocations $\{x_t, (1 - x_t)\}$, $\{C_t, \underline{C}_t\}$ s.t.
  - Bankers and savers solve their optimal consumption and portfolio choices
    - $C_t = \rho N_t$, $\underline{C}_t = r[(p_t + q_t)K_t - N_t]$ for log utility agents
  - All markets clear
    - Capital: $x_t N_t + \underline{x}_t[(p_t + q_t)K_t - N_t] = q_t K_t$
    - Output: $C_t + \underline{C}_t = (a - \iota)K_t$
  - Budget constraint
    - $\frac{dN_t}{dt} = (x_t r_t^K + (1 - x_t) r_t^M) N_t - C_t$ (absent shock)
    - $\breve{N}_t = \left[x_t (1 - \phi) \frac{\breve{q}_t}{q_t} + (1 - x_t) \frac{\breve{p}_t}{p_t}\right] N_t$ (shock)

Equilibrium characterization

- Equilibrium is a map

Histories of shocks

$\{t_1 < t_2 < \cdots < t_n \leq t\}$

prices, allocations

$q_t, p_t, \{x_t, (1-x_t), \underline{\ldots}\}, \{C_t, \underline{C_t}\}$

wealth distribution

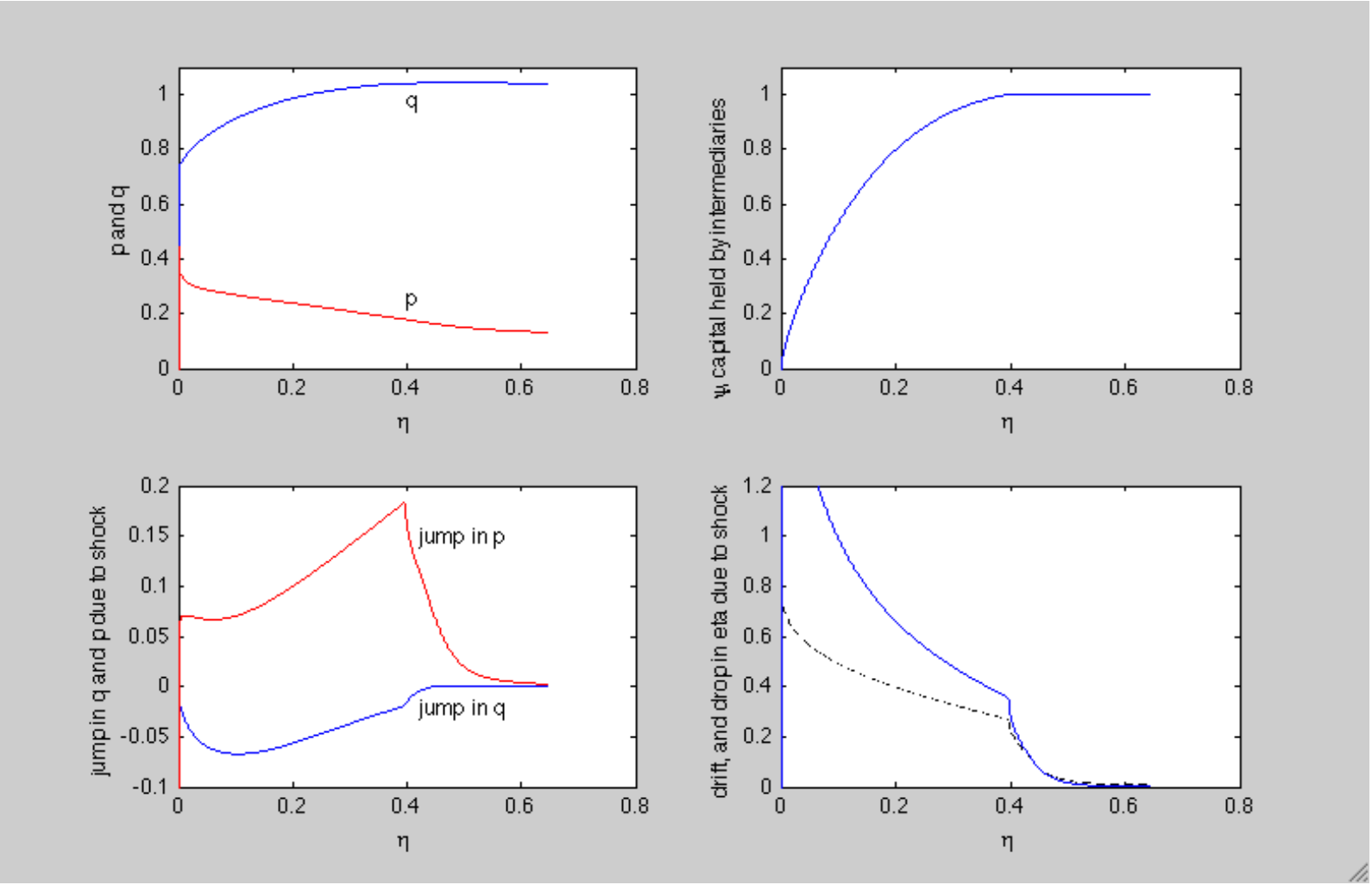
$$\eta_t = \frac{N_t}{(p_t + q_t)K_t} \in (0,1)$$

intermediaries' wealth share

- Growth μ_t^η in η (absent a shock)
- At "steady state" η^* : $\mu_t^\eta = 0$
  - Intermediaries' earnings offset their consumption rate

Example

- Parameters a = 0.1, $\underline{a}$ = 0.02, Φ(ι) has quadratic adj. costs, δ = .04, r = 5%, ρ = 6%, τ = 0.1, λ = 1, φ = .005, $\underline{\varphi}$ = .05, HH can't diversify



After adverse shock

- Intermediary net worth ↓
- **Capital:**
  - fire sales, price q ↓
  - Allocation efficiency ↓

  Liquidity spiral
- **Money:**
  - Lending + deposits ↓
  - value of money p ↑
  - Multiplier ↓

  Deflation spiral
- **Banking**
  - Hit on both sides of balance sheet
  - Externality among banks
  - Competition ↓
- Amplification/persistence → endogenous risk

  → wealth redistribution

Key dynamic properties

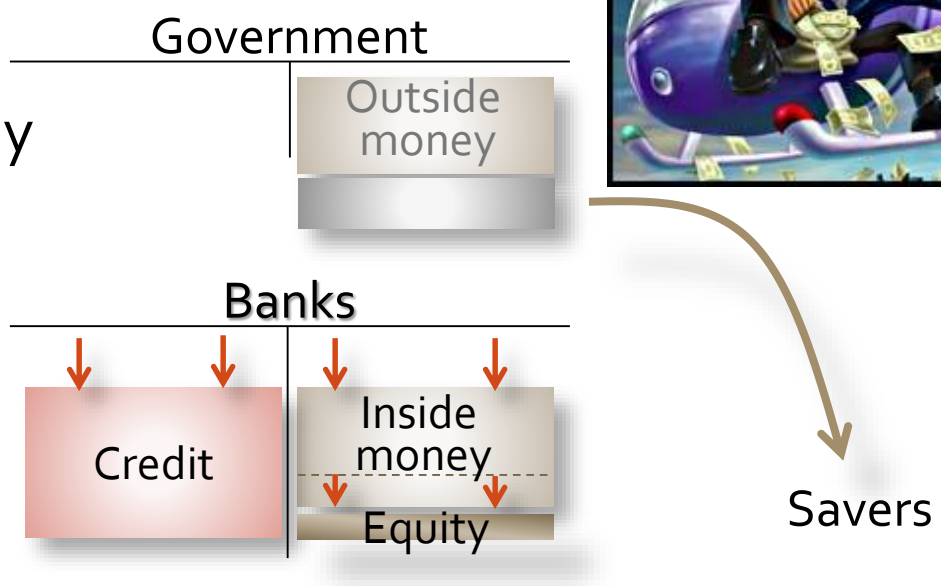
- Nonlinearity
  shocks in normal times (when intermediaries are well capitalized) are amplified much less than in crisis times (when intermediaries fire-sell to HH)
- Volatility paradox
  system is prone to crisis even for low levels of exogenous risk. As ϕ goes down
  - Economy looks more stable in normal times, but
  - Fraction of time spend in crisis is bounded away from 0
  - Endogenous risk in crisis rises

Overview

- No monetary economics
  - Fixed outside money supply
- Monetary economics
  - Money view – stylized
  - Credit view
  - Monetary policy in reality
- Connection to fiscal policy

Money view

- Restore money supply
  - Helicopter drop to savers



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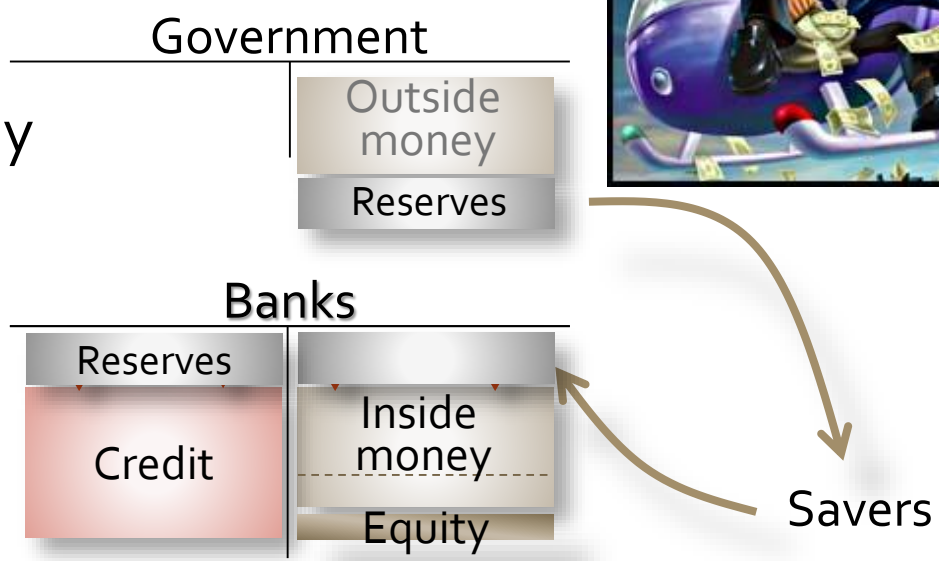
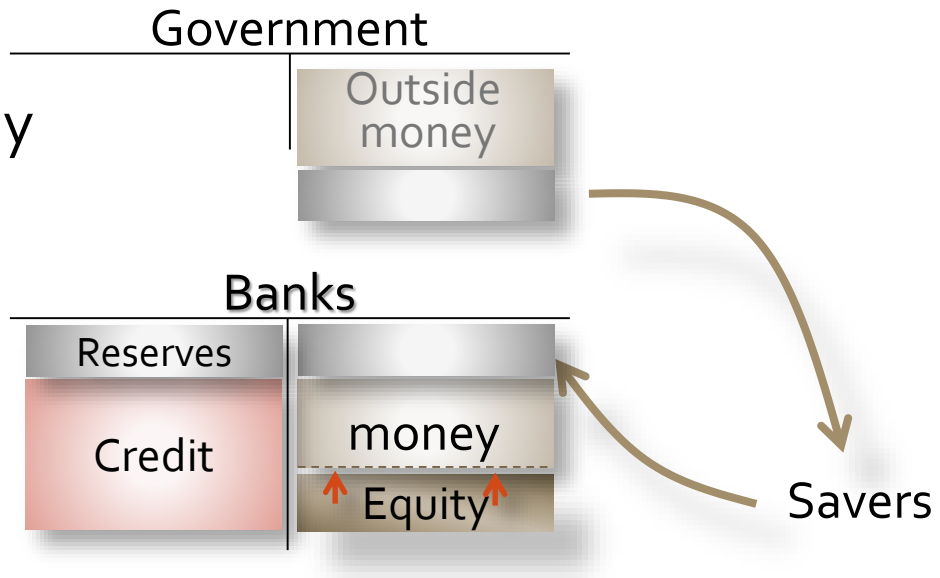


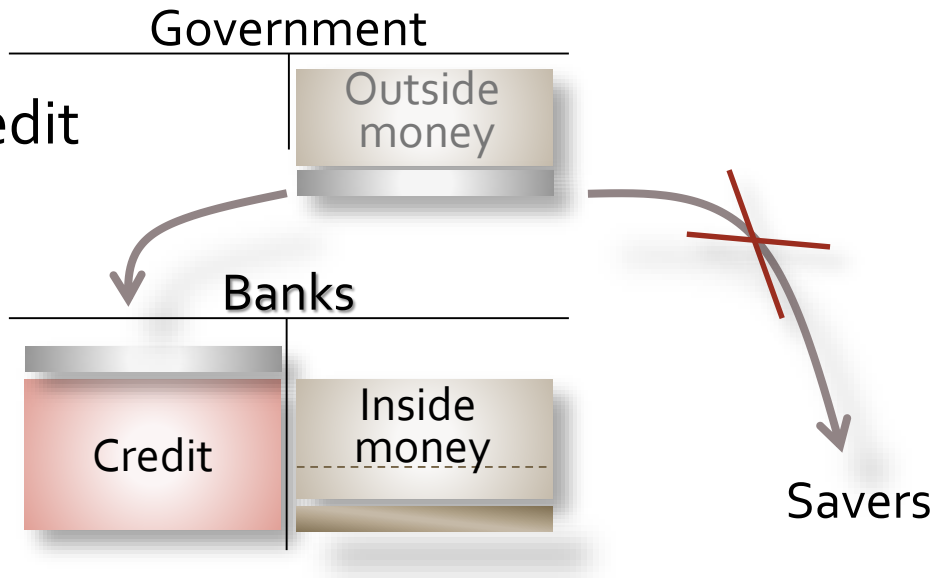
Money view

- Restore money supply
- Switches off Deflationary spiral
  - Bankers are better capitalized
  - Slightly more credit BUT credit is not restored



Credit view

- Restore "healthy" credit
  - Not Zombie banks
  - Not Vampire banks



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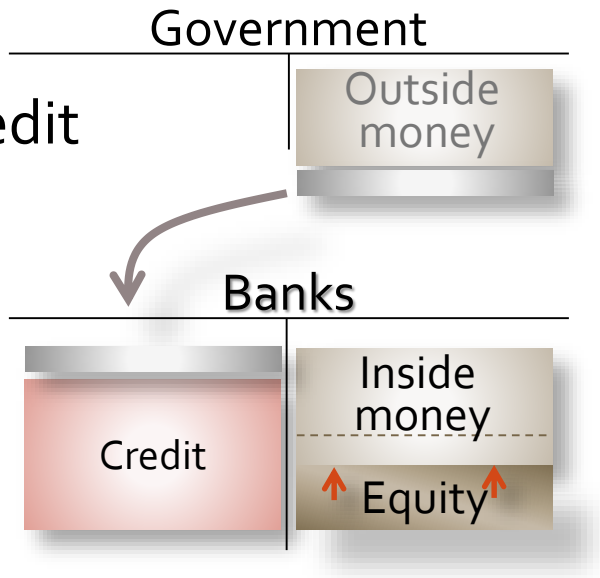
  - Gift to solvent banks



Credit View

- Restore "healthy" credit
  - Not Zombie banks
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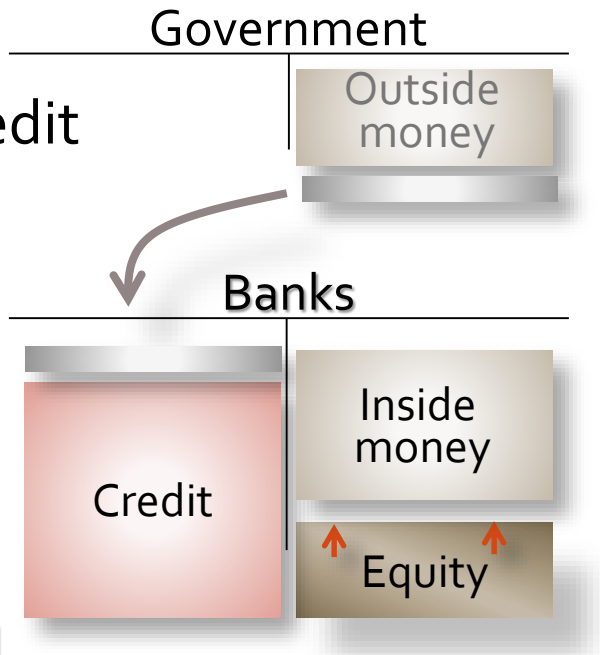
- Recapitalization
  - Gift to solvent banks
- Switches off
  - Deflationary spiral
  - Liquidity spiral
    - Credit is restored, as banks are recapitalized



- Next, "stealth recapitalization of banks"

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Monetary policy in reality

- So far, outside money fixed, pays no interest
  - Fiscal authority uses tax revenues to slowly buy money - baseline deflation
  - $\tau = 0$ corresponds to "Gold Standard"

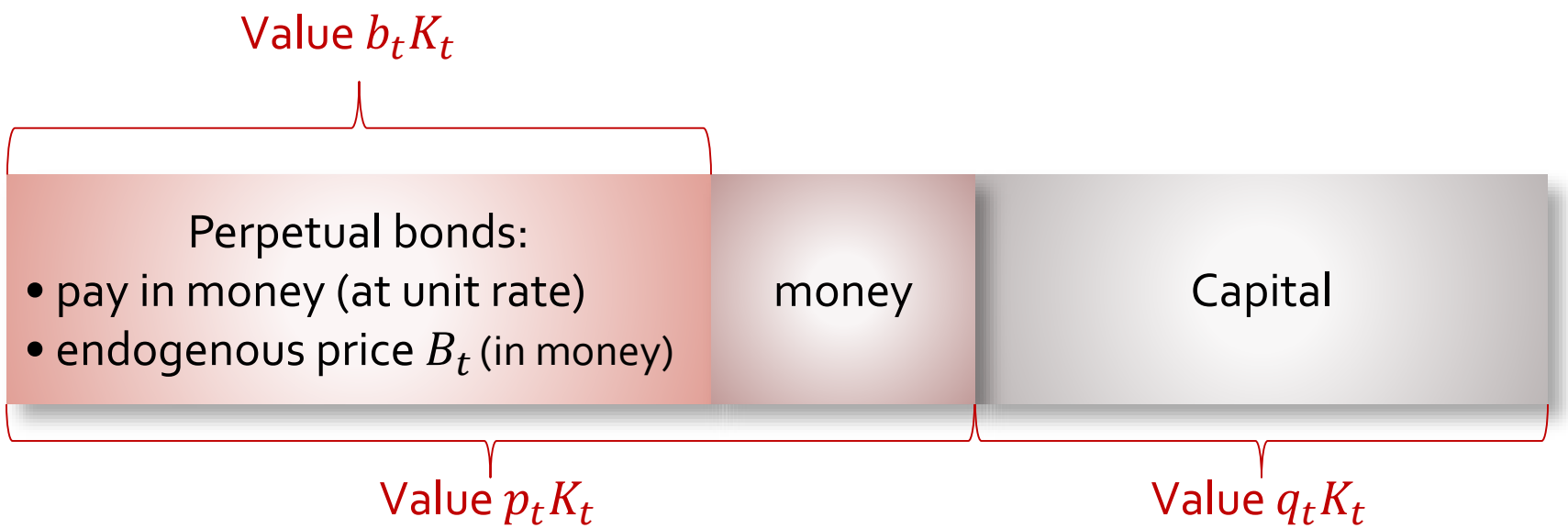
- Government issues long-term (perpetual) bonds
  - pays fixed interest (in money)

- Monetary policy
  - Central bank pays interest $i_t \geq 0$ on money (by printing)
  - Sets total outstanding value $b_t K_t$ of perpetual bond (through open market operations)

Money (incl. bonds) + physical capital

- Total wealth in the economy:

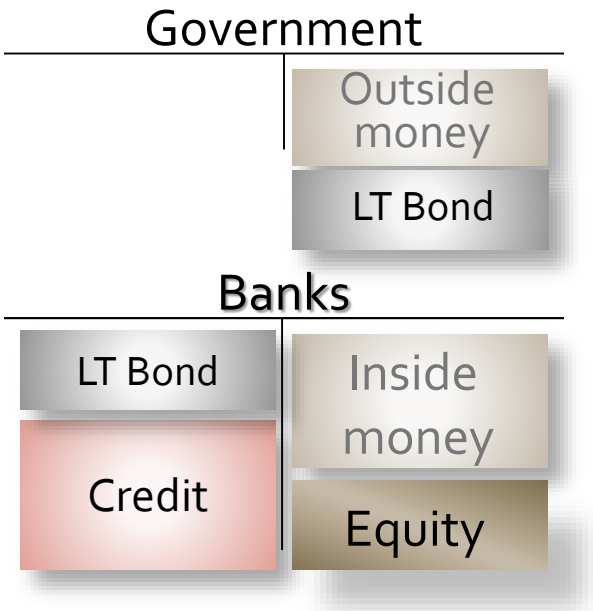
$$p_t K_t + q_t K_t$$



- Implies a complete yield curve

Monetary policy in reality

- Interest policy and OMO
- Introduce long-term Gov-bond
  - Fixed interest rate
  - No default
  - Held by banks
- Value of long-term bond rises when short-term interest rate falls
  - Increases the supply of assets that can be used to "store of value"



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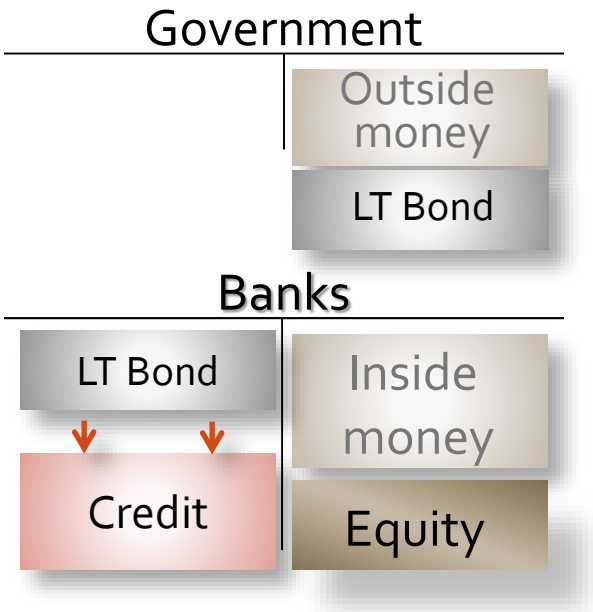

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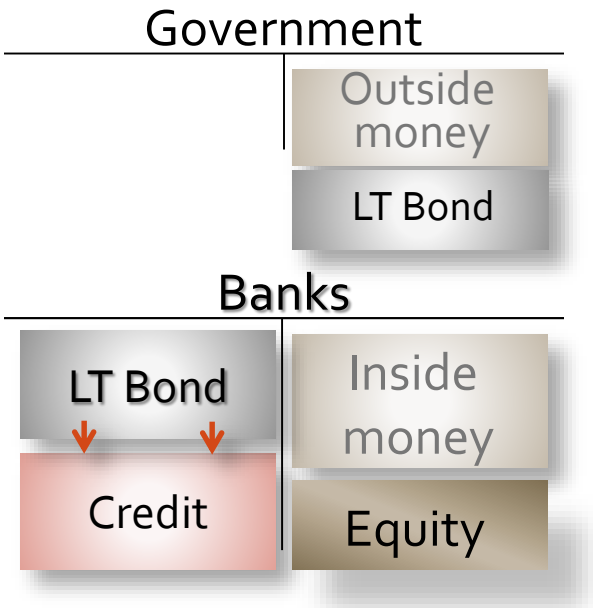
- Adverse shock
  - ⇒ value of credit/loans drops
- Monetary Policy Response:

Monetary policy in reality



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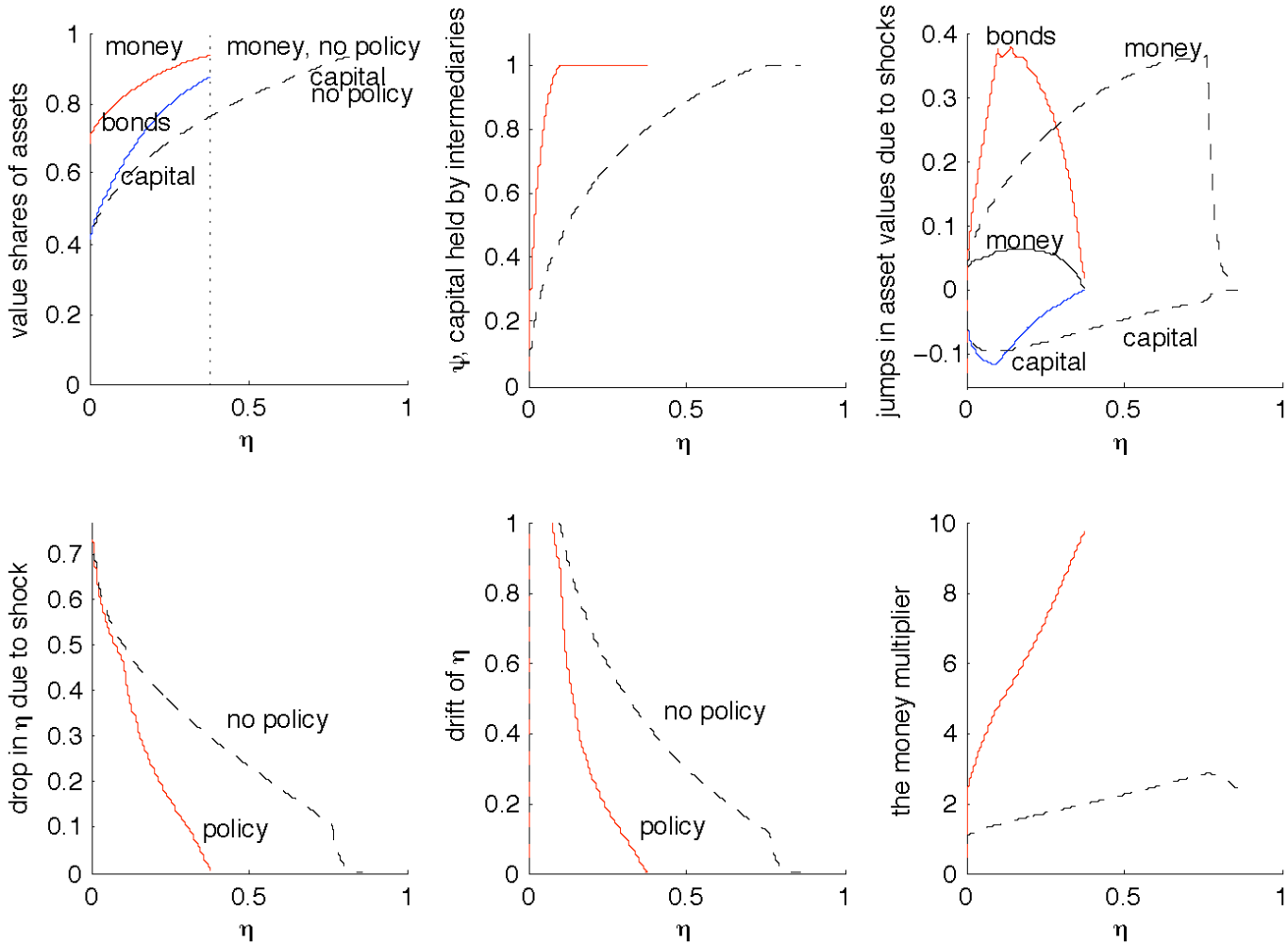
- Adverse shock
  - ⇒ value of credit/loans drops
- Monetary Policy Response: Cut short-term interest rate i_t
  - ⇒ value of long-term bond rises - "stealth recapitalization"
- ⇒ Liquidity & Deflationary Spiral are switched off

Example

- Parameters
  - $a = .1$
  - $g = .04$
  - $r = .05$
  - $\rho = .06$
  - $\tau = .1$
  - $\lambda = 1$
  - $\phi = .002$
  - $\underline{\phi} = .2$
  - Policy
    - $i_t = 0.25\% + .1\eta_t, \frac{b_t}{p_t} = .5$



Observations

- As interest rate are cut in downturns, bonds held by intermediaries appreciate, this
  - protects intermediaries against shocks
  - increases the supply of asset that can be used as storage (weakens deflation)
- Because downturns are softened, for all η
  - drop in financial sectors' capitalization conditional on a shock ↓
  - price of capital ↑
  - money multiplier ↑
  - price of money ↓
  - intermediary allocation to capital ↑
  - household allocation to capital ↓
  - risk premia (and thus the rate of recovery, conditional on no shocks) ↓

Short-term interest rate policy

- Without long-maturity assets changes in short-term interest rate have no effect
  - Interest rate change equals instantaneous inflation change
- With bonds: of all monetary instruments, fraction $p_t/(p_t+b_t)$ is cash and $b_t/(p_t+b_t)$ are bonds
  - deflationary spiral is less pronounced because as η goes down, growing demand for money is absorbed by increase in value of long-term bonds
  - also, intermediaries hedge risks better by holding long-term bonds
  - however, intermediaries also have greater incentives to increase leverage/risk-taking ex-ante
- Effectiveness of monetary policy depend on maturity structure (duration) of government debt

Overall welfare of ex-post redistribution

- Redistribution is not a zero sum game!

- When is ex-post redistribution most desirable?
  - Endogenous risk is large
    - Technological and market liquidity (redeployability) is low gap between first and second best use is large
  - Exogenous risk is small!

	New Keynesian	I-Theory
Key friction	Price stickiness & ZLB	Financial friction
Role of money	Unit of account	Store of value
Driver	Demand driven as firms are obliged to meet demand at sticky price	Misallocation of funds
Monetary policy • implementation • First order effects	Optimal price setting over time Affect HH's intertemporal trade-off Nominal interest rate impact real interest rate due to price stickiness	Ex-ante insurance "complete markets" Ex-post: redistributional effects Ex-ante: insurance
Time consistency	Wage stickiness Price stickiness + monopolistic competition	Moral hazard in risk taking (bubbles) - Greenspan put -
Yield curve	Expectation hypothesis only	Term/inflation risk premia

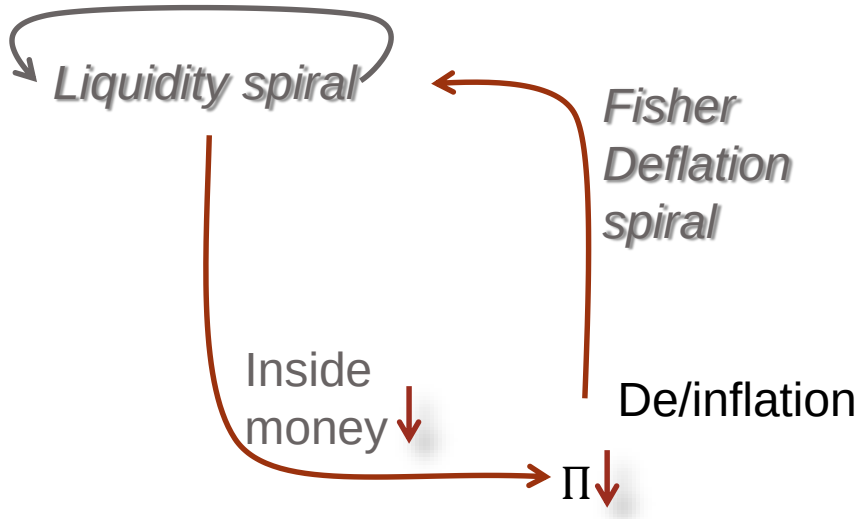
	FTPL	I-Theory
Key friction	None	Financial friction
Role of money	Store of value	Store of value
Driver	$\frac{B_t}{P_t} = E\left[M_{t,t+\tau} X_{t+\tau}\right]$ $X_{t+\tau}$ real primary surplus	Misallocation of funds
Monetary policy	Affects B_t and $X_{t+\tau}$	Affects also $M_{t,t+\tau}$

Financial Stability ↔ Price Stability ↔ Debt Sustainability

Financial Regulators

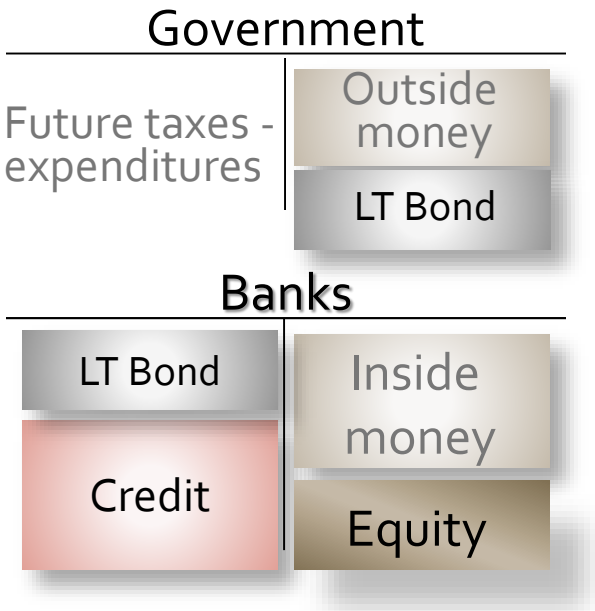
Central Bank

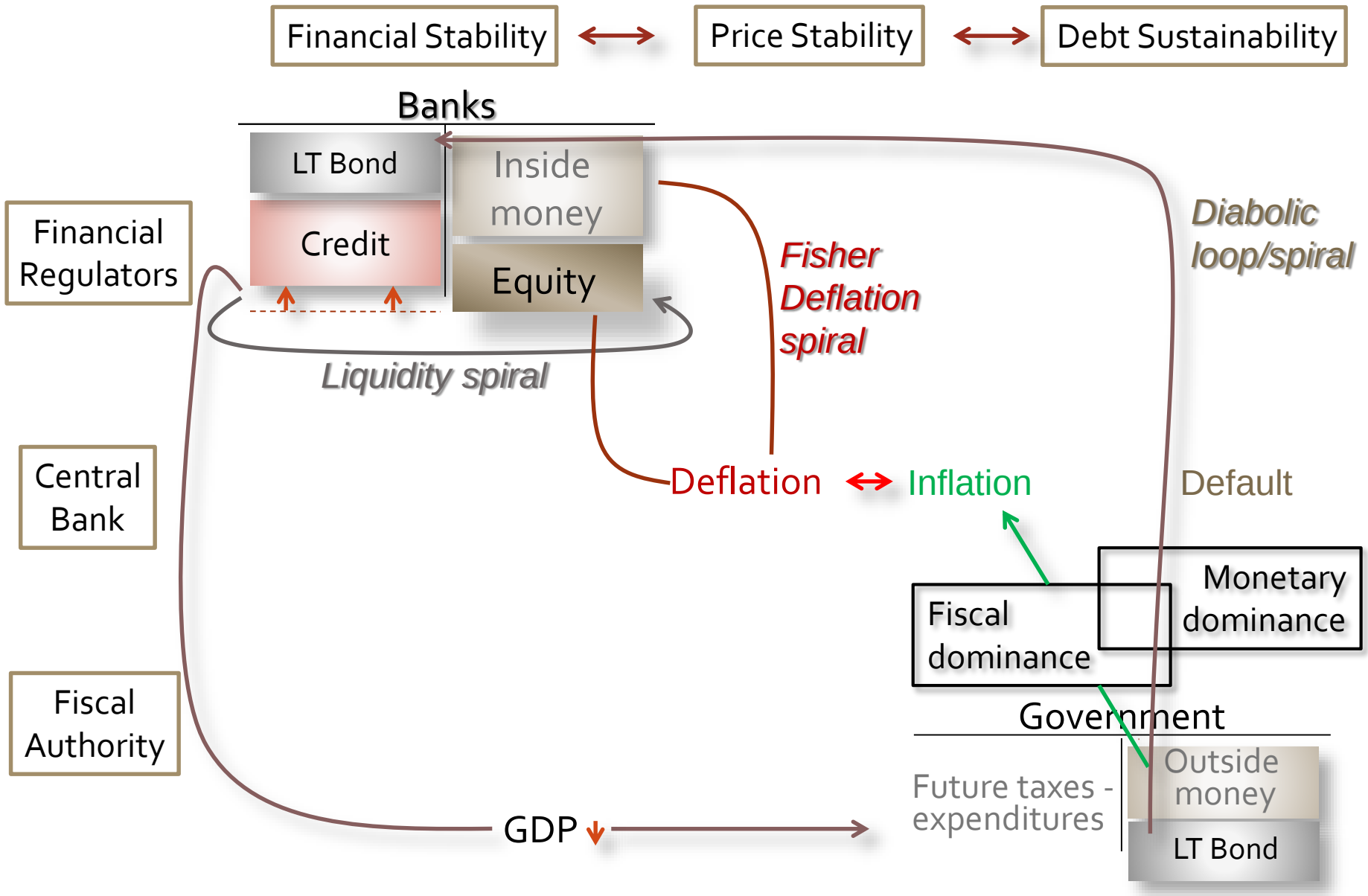
Fiscal Authority



Link: … & Fiscal debt sustainability

- So far, Gov. bond default-free
  - Now: "fear" of default
- Fiscal dominance
  - Unwillingness of governments to balance long-run budget
- Monetary dominance
  - Unwillingness of central bank to print money
- Financial dominance
  - Unwillingness of banks to raise equity





Brunnermeier & Sannikov 2013

Opposing de- and inflationary forces

- Difficult to balance
- System is very unforgiving towards small mistakes

- Divergence in inflation expectations
- Possibly high inflation risk premium

Conclusion

- New perspective – focus on
  - Financial frictions, less on price stickiness
  - Store of value of money, not only unit of account
  - Wealth/income effects, not only substitution effects
- Crisis management: "Bottle-neck monetary economics"
  1. Figure out which sector is undercapitalized (debt overhang)
  2. Redistribute monetary policy in (i) wealth & (ii) risk
  - Monetary policy reduces endogenous (self-generated) risk
  - Avoid moral hazard
- Crisis prevention – measure sectors' debt/GDP ratios
- Stability concepts are highly interlinked