Money and Capital in a persistent Liquidity Trap

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ESCB Research Cluster 1 on Monetary Economics
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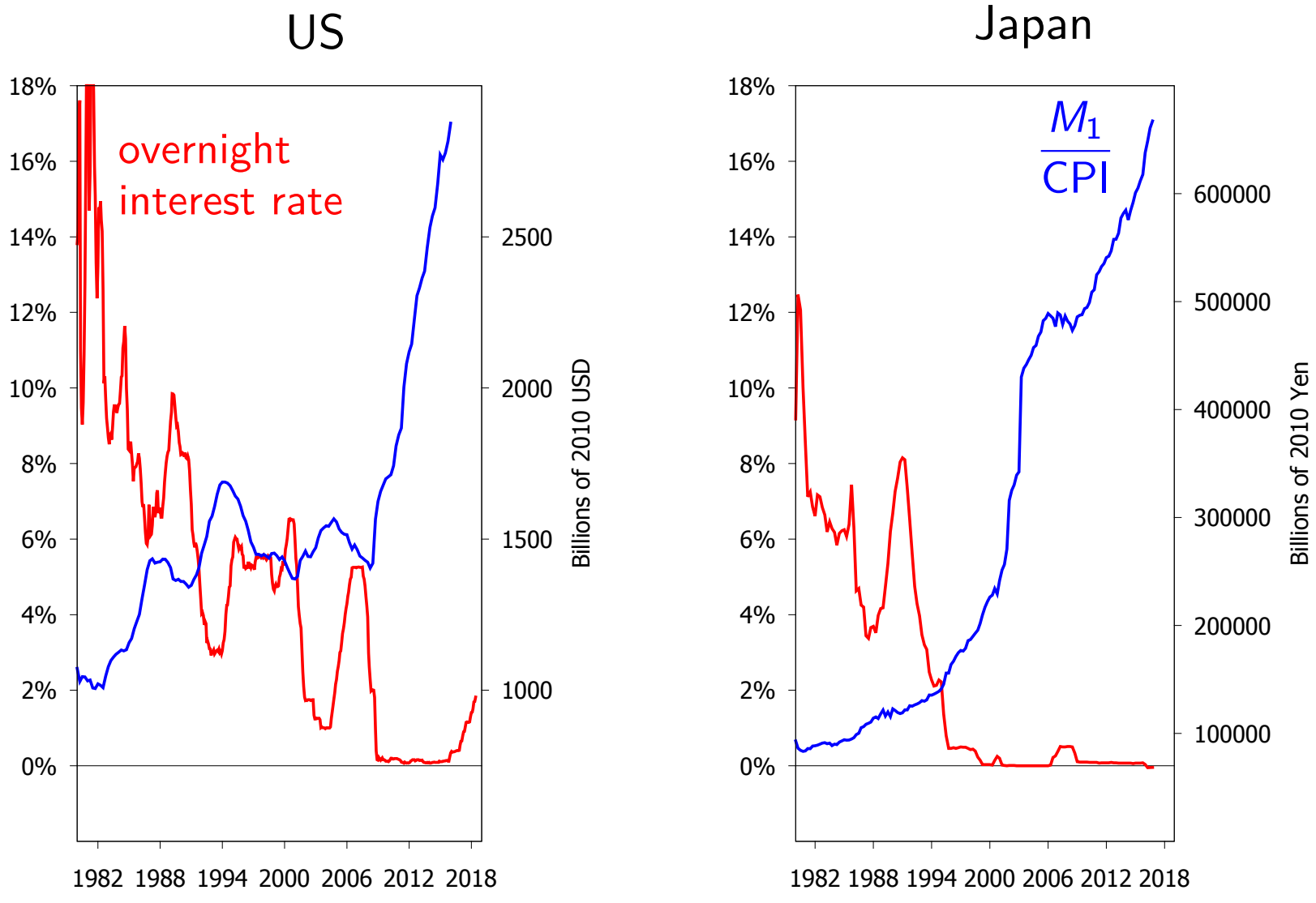
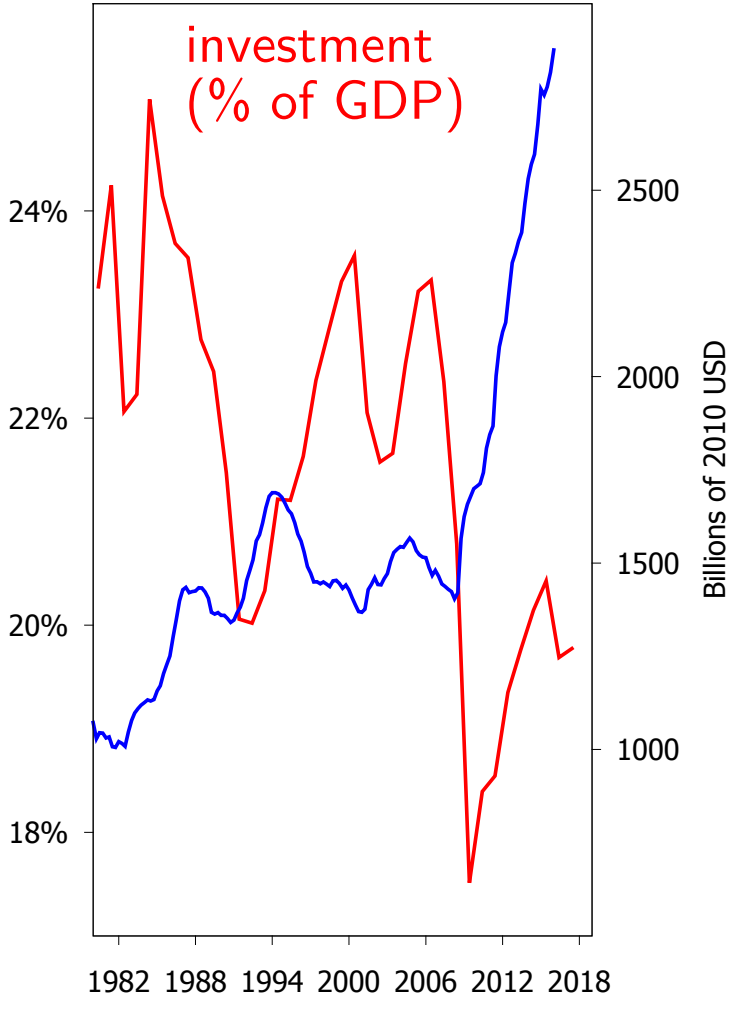
Persistent liquidity traps

Increased real cash holdings in persistent liquidity traps

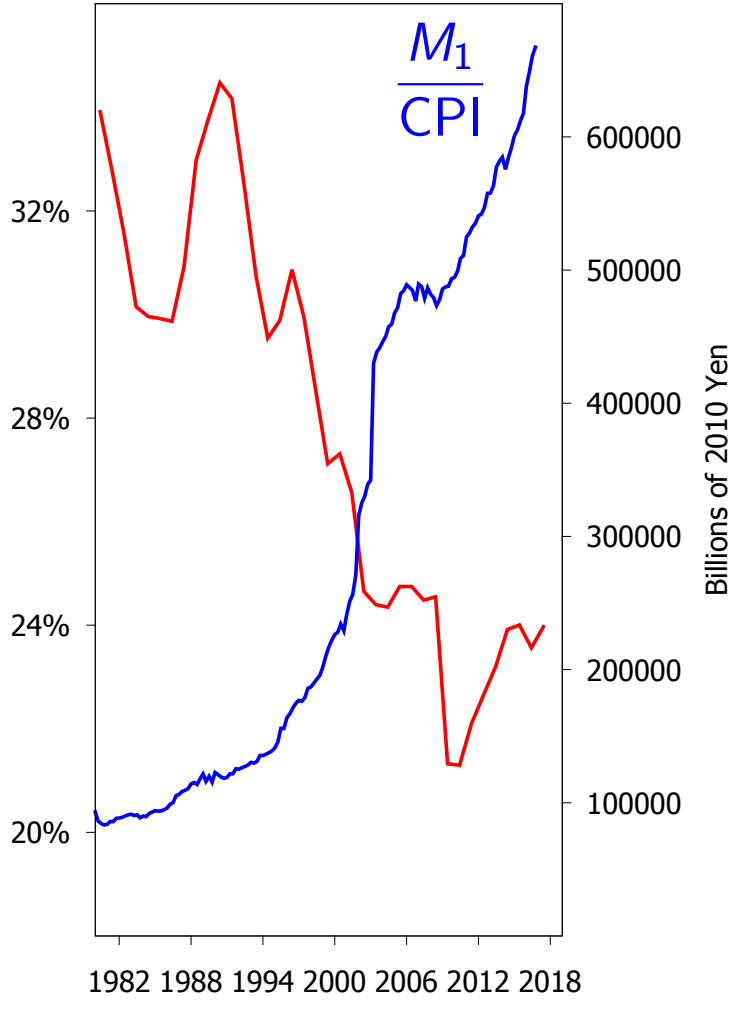


Investment slowdown in persistent liquidity traps

US



Japan



Can increased real money holdings crowd out physical capital?

A model of scarce assets with money

model of scarce assets

- credit-constrained investors hold assets to finance investment
- deleveraging: borrowing constraint reduces supply of assets
- w/o money: arbitrarily low equilibrium interest rate (shadow rate)

introduce money explicitly

- sets ZLB and creates gap between effective and shadow rate
- outside ZLB: only provides transaction services
- at ZLB: used as saving instrument

medium term analysis

- first study flexible price steady states (after prices have adjusted)
- supply-side view ($\neq$ usual demand-side analyses)
- also look at transition dynamics with short-run nominal rigidities

Main results

Consider a deleveraging shock that reduces net supply of assets

outside ZLB	• interest rate decline: stimulates the supply of assets • deleveraging shock need not affect capital and output
at ZLB	• interest rate gap widens & investors increase money holdings • medium-term decline of capital and output • why? low return of money & real balance effect
policy implications	• exit the trap: decrease effective rate or increase shadow rate • higher Gov't debt helps exiting ZLB but can lead to lower output • QE widens interest rate gap and can extend the liquidity trap

Relation to the literature

Persistent liquidity traps in standard NK models: insufficient demand

- persistently negative output gap $\Leftrightarrow$ persistent nominal rigidities
- Schmitt-Grohe-Uribe 2013, Eggertsson and Mehrotra 2014, Caballero-Farhi 2015, Benigno-Fornaro 2015, Michau 2015

Supply-side effects at the ZLB

- Buera-Nicolini 2014, Guerrieri-Lorenzoni 2015, Ragot 2016

Money and liquidity

- fiat money as a saving instrument: OLG model of Samuelson 1958, turnpike model of Townends 1980
- external liquidity (public debt) and investment: Woodford 1990, Holmström-Tirole 1997, Kiyotaki-Moore 2008, Kocherlakota 2009, Farhi-Tirole 2012, Benhima-Bacchetta 2015

Real balance effect

- the Pigou effect: Pigou 1943, Patinkin 1956
- which also obtains in non-ricardian heterogenous-agent models: Weil 1991, Ireland 2005, Benassy 2008, Devereux 2011

A model with scarce assets and money

Main assumptions

One-good economy with nominal bonds and money

Two types of agents: investors and workers

Investors have a demand for assets

- they save, waiting for investment opportunities
  (as in Woodford, 1990)
- investing phase: issue bonds to finance investment
  but subject to borrowing constraint
- Bonds dominate money as a saving vehicle, except at ZLB

Workers need money for transactions

Baseline model: perfect foresight & flexible prices

Investors

Maximize $U_t = \sum_{s=0}^{\infty} \beta^s \log(c_{t+s})$

Alternate between investing and saving phase

gross real interest rate $= \frac{i_{t+1} P_t}{P_{t+1}}$

Investing phase in t: $c_t^I + k_{t+1} = a_t + \frac{M_t^S}{P_t} + \frac{b_{t+1}}{r_{t+1}}$

Saving phase in t: $c_t^S + \frac{a_{t+1}}{r_{t+1}} + \frac{M_{t+1}^S}{P_t} = \rho_t k_t - b_t$

Borrowing constraint (relevant for investing phase)

$$b_{t+1} \leq \phi_t \rho_{t+1} k_{t+1}$$

deleveraging shock: $\phi \downarrow$

Capital rented to firms with production function $y_t = k_t^{\alpha} h_t^{1-\alpha}$

- $\rho_t k_t = \alpha y_t$ (full depreciation in benchmark model)

Other agents

Workers

Cash-in-advance constraint:

$$M^w_{t+1} = \text{wage bill} = (1-\alpha)P_t y_t$$

Exogenous real debt limit l^w

Government

Budget constraint:

$$\frac{M_{t+1}}{P_t} - \frac{M_t}{P_t} + \frac{l^g_{t+1}}{r_{t+1}} = \frac{T^w}{P_t} + l^g_t$$

Fiscal policy sets real debt l^g

Monetary policy:

$$M_{t+1}/M_t = \theta \geq 1$$

(pins down long-term inflation)

Shortage of assets

Equilibrium on the bond market

$$\underbrace{b_{t+1}}_{\leq \phi_t \alpha y_{t+1}} + \underbrace{I^w_{t+1} + I^g_{t+1}}_{\equiv I_{t+1}} = a_{t+1}$$

net supply of bonds to investors

Asset-scarce equilibrium

if ϕ and I low

borrowing constraints are binding

$r < 1/\beta$ in the steady state

Assume "autarkic" investors

I is net position of investors

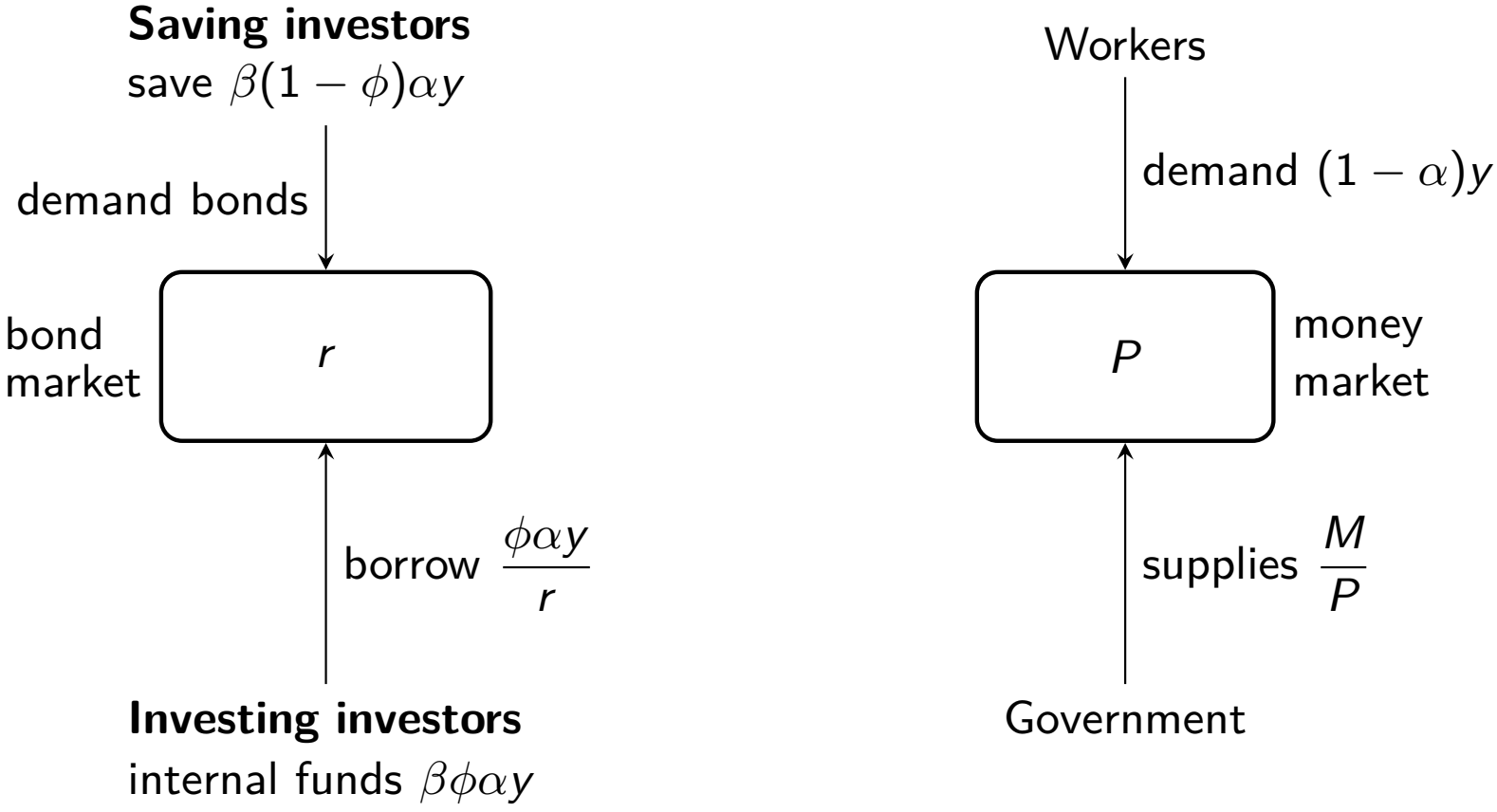
case $I = 0$ is actually realistic

implies $b = a$

The effect of deleveraging

Analytical results for steady states

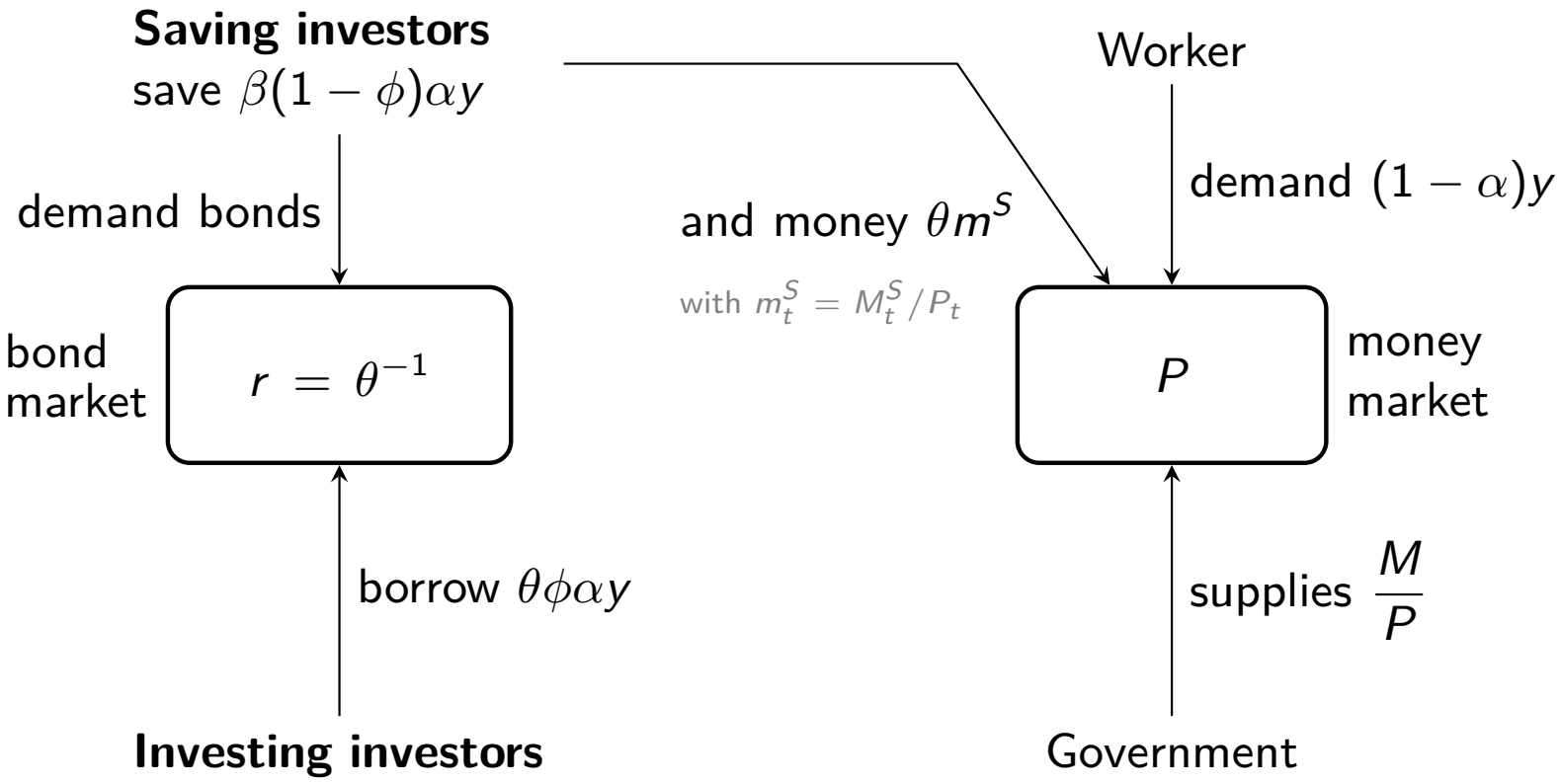
Normal equilibrium: $i > 1, r > \theta^{-1}$



Adjusting to deleveraging shock $\phi \downarrow$

r	m^S	k	P
$\downarrow$	0	$=$	$=$

ZLB equilibrium: $i = 1, r = \theta^{-1}$



- invest $k = \beta\alpha y - \theta m^S + \beta m^S$

low return ($\theta > \beta$)
take away resources from investment

crowding-out effect

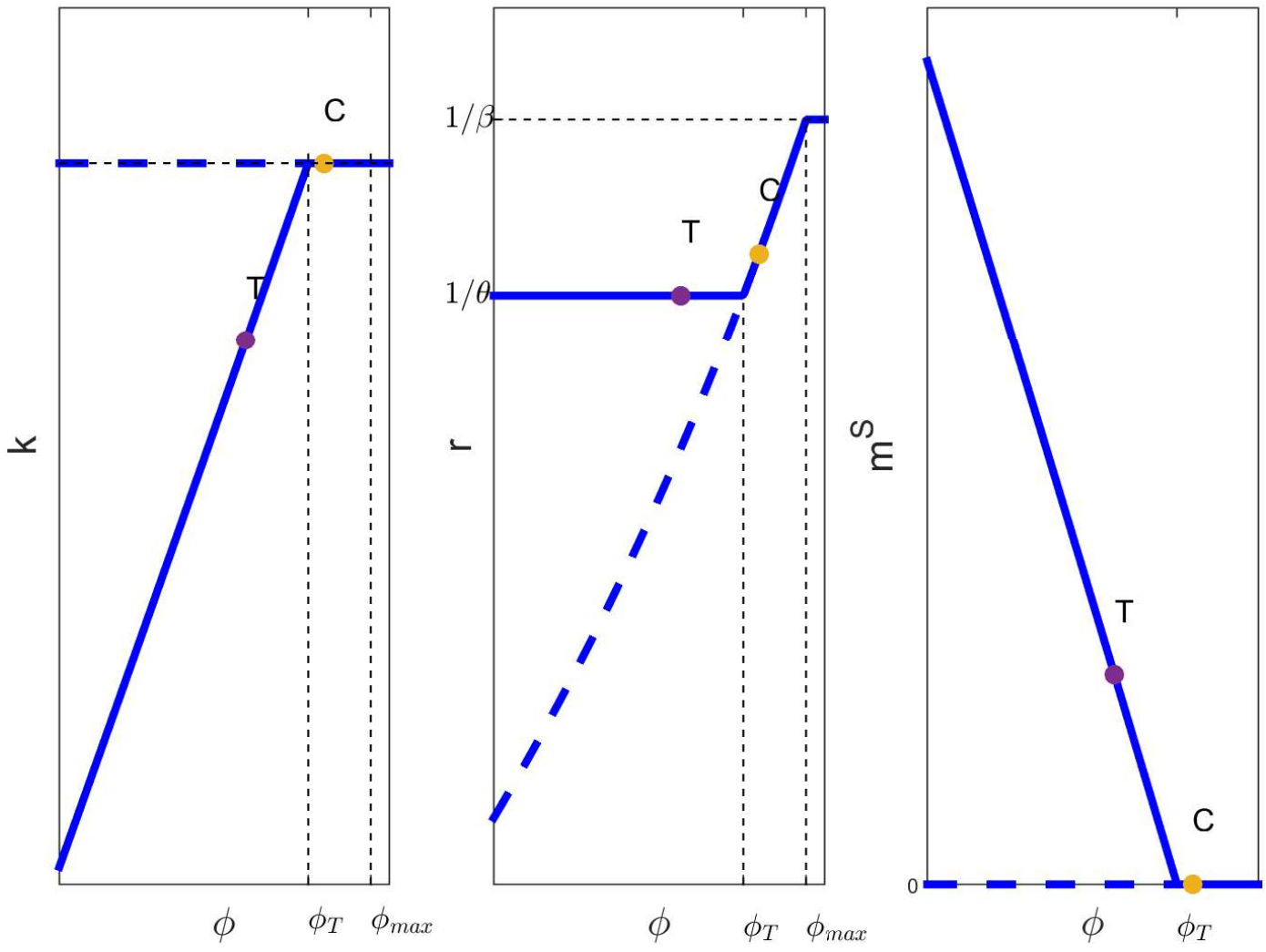
liquidity effect

Adjusting to deleveraging shock $\phi \downarrow$

r	m^S	k	P
$=$	$\uparrow$	$\downarrow$	$\downarrow$

with nominal rigidity: $y \downarrow$

Investors' deleveraging



Dashed line = shadow variables

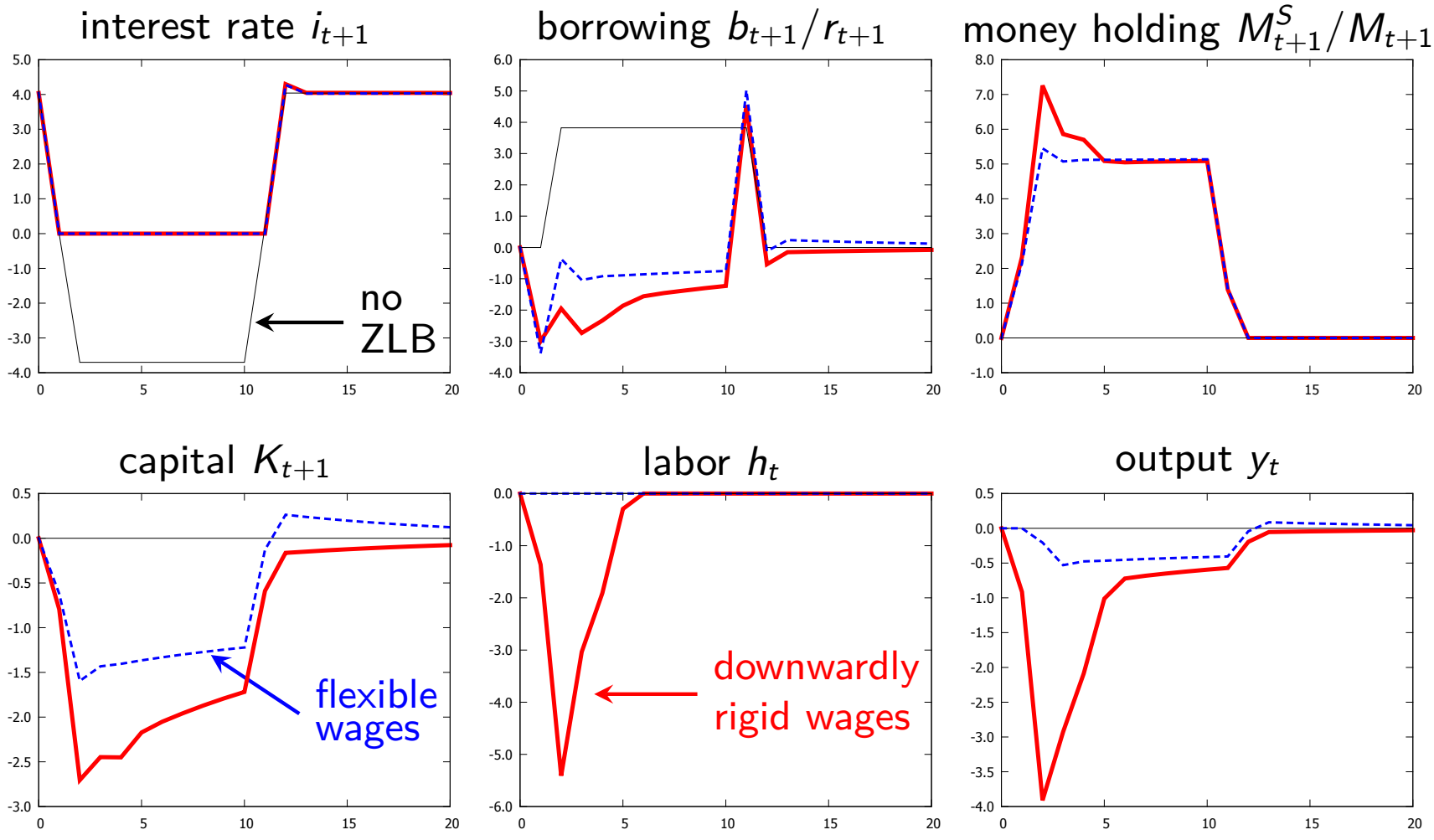
The effect of deleveraging

Simulation of transition dynamics

Calibration: US economy pre-crisis

Parameter	Value	Target
Time period = 1 year		
Balance sheet parameters		
I^g	0	Gov't supply of assets, net of RoW demand (Flow of Funds 2006)
I^w	0	Autarkic investors
Rates of return		
β	0.96	4% real return on capital
ϕ^H	0.495	2% real interest rate
Deleveraging parameters		
$\phi^L/\phi^H - 1$	-3.9%	20% peak-to-trough non-resid. investment
γ	1.01	5.5 pp increase civilian unemployment
π	0.10	10% probability of exit each year
Conventional parameters		
α	0.33	
δ	0.10	
θ	1.02	

Response to a 10 year deleveraging shock

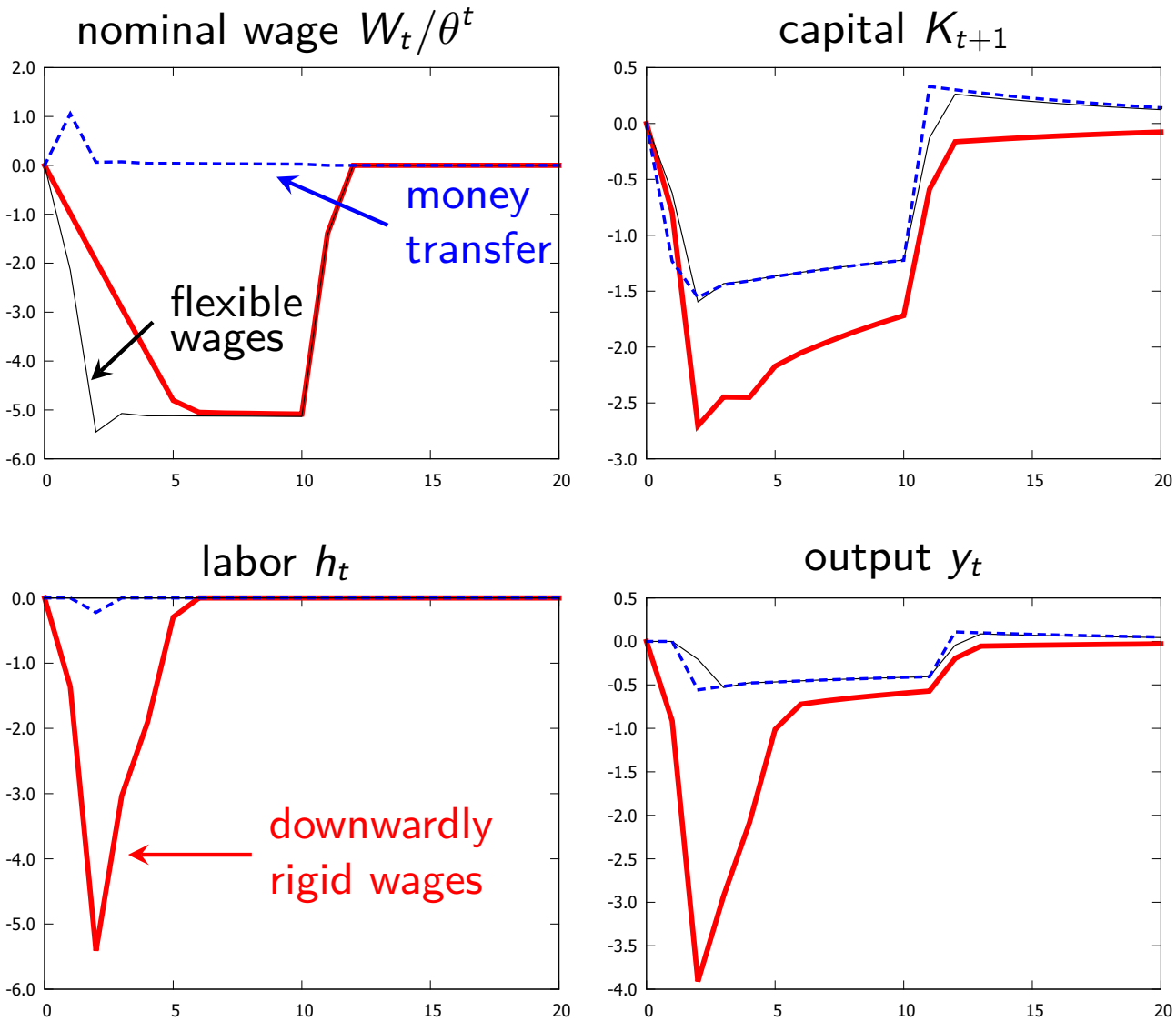


- strong keynesian demand-side effects in short run
- supply-side effects remain after wages have adjusted

Policies in a liquidity trap

Addressing short-run keynesian unemployment

Helicopter money can mimic flexible wages



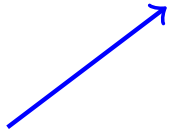
- in the following, focus on flexible wages

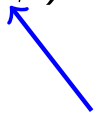
Exiting the liquidity trap

Exiting the liquidity trap

Requires closing the interest rate gap

$$r - r^S = \frac{i}{\theta} - \frac{\phi + (I^w + I^g)/(\alpha y)}{\beta(1-\phi)}$$





Decrease effective rate

- higher inflation θ
- negative nominal rate i

Increase shadow rate

- increase public debt I^g = public supply of liquidity
- QE = decrease shadow rate and deepens liquidity trap

What is the effect on capital and output?

Scarce-asset setting: low rates are inefficient
(impair consumption smoothing and in some cases lead to capital overaccumulation)

Decrease effective rate

Large enough decrease: exit ZLB

- higher capital and output

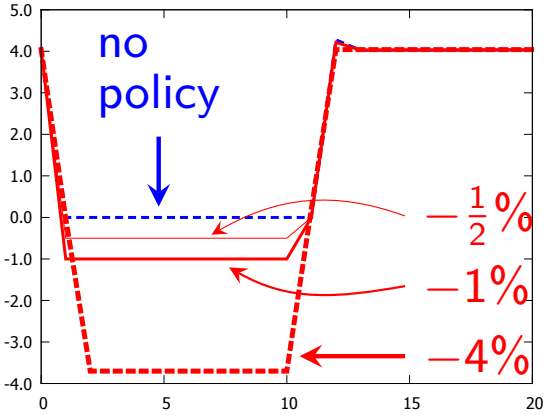
But timid decrease has ambiguous impact on capital and output

- low real rate decreases the demand for money
  (b/c relaxes borrowing constraint)
- but also decreases real return on money

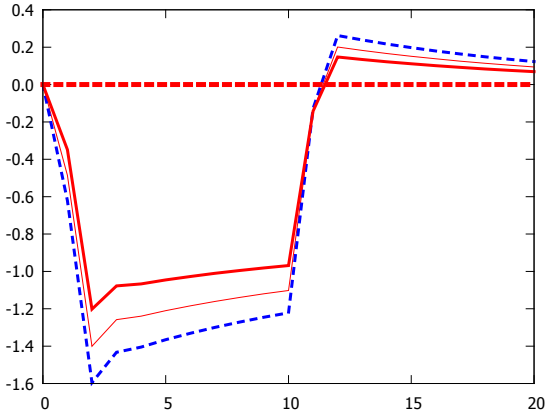
Negative interest rate

Baseline deleveraging shock (4%, with $\pi = 1/10$)

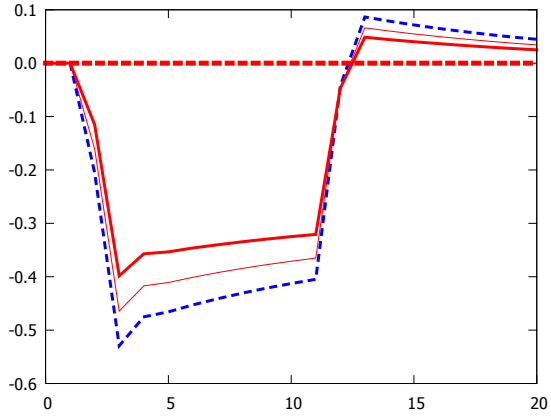
interest rate i_{t+1}



capital K_{t+1}

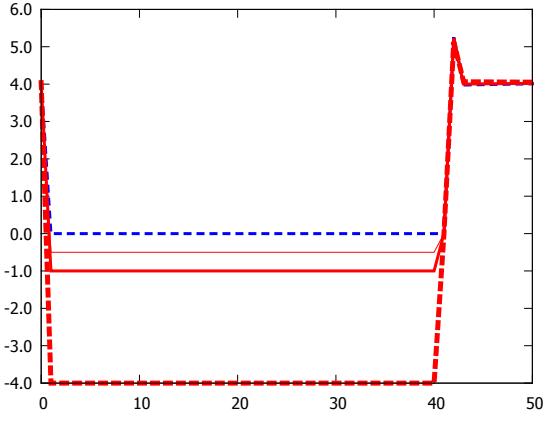


output y_t

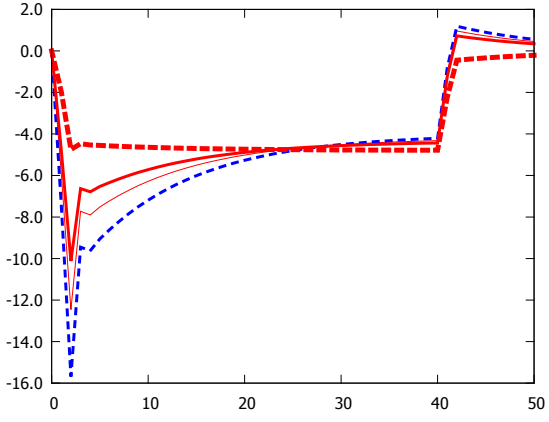


Stronger deleveraging shock (9%, with $\pi = 1/20$)

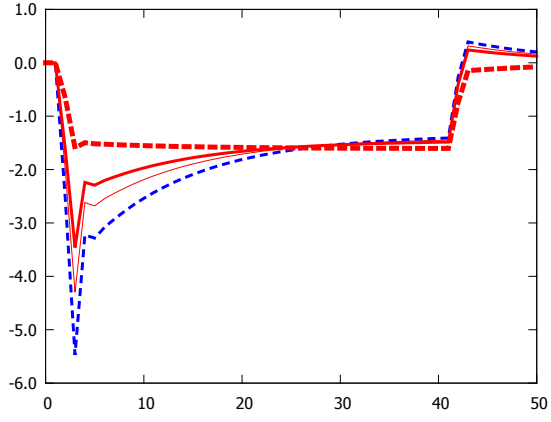
interest rate i_{t+1}



capital K_{t+1}



output y_t



Increase shadow rate

Large enough increase of public debt: exit ZLB

- small increase offset by $\downarrow m^S$

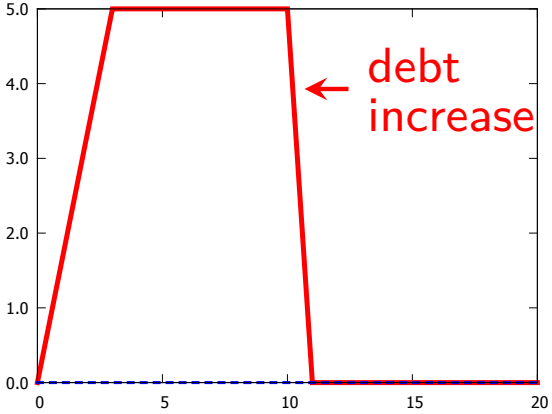
When exiting the liquidity trap

- possible negative impact on capital and output for small increase in I^g
- positive impact if large enough increase in I^g

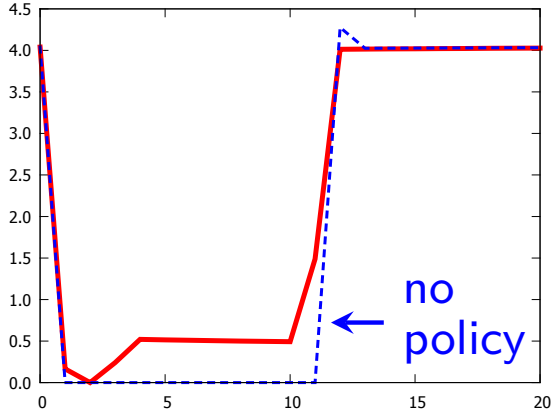
Increase Government debt

Debt increase by 5% of GDP in 2 years
baseline deleveraging shock (4%, with $\pi = 1/10$)

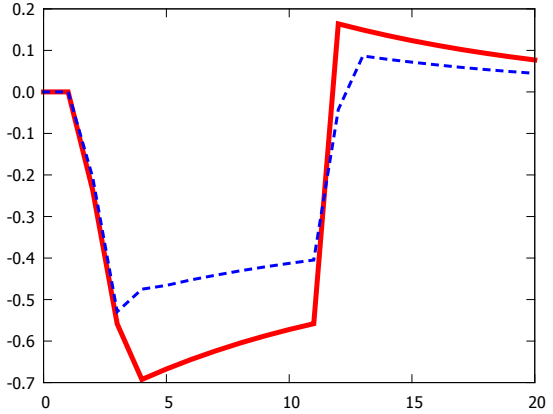
bonds l^g_{t+1}/y_{t+1}



interest rate i_{t+1}

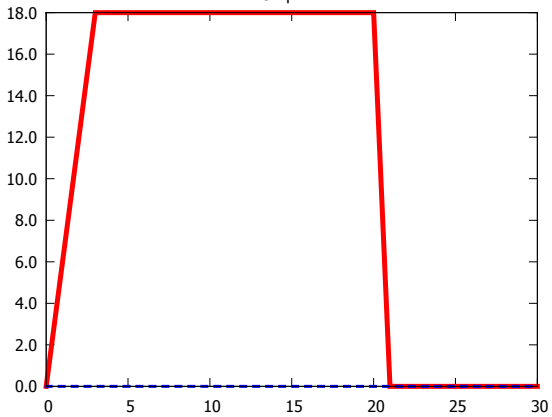


output y_t

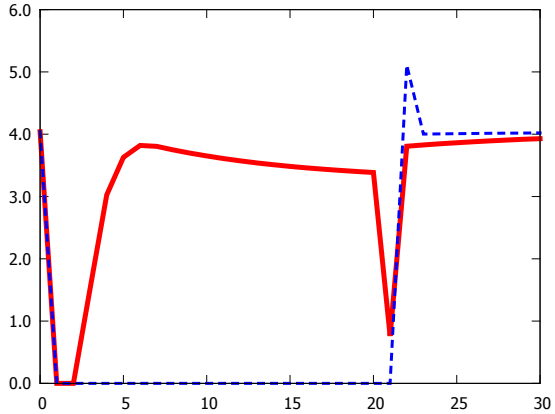


Debt increase by 18% of GDP in 2 years
stronger deleveraging shock (8%, with $\pi = 1/20$)

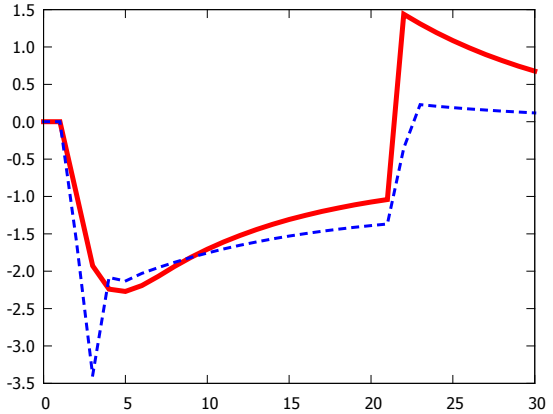
bonds l^g_{t+1}/y_{t+1}



interest rate i_{t+1}

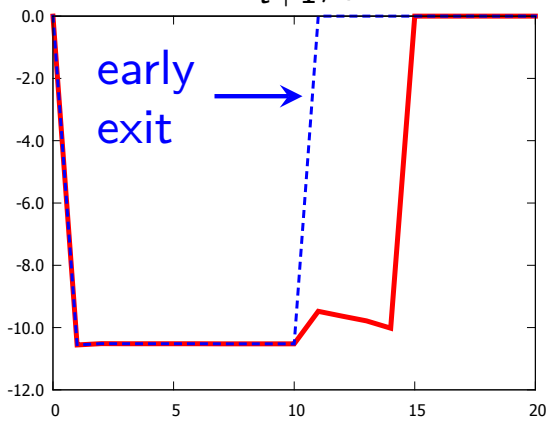


output y_t

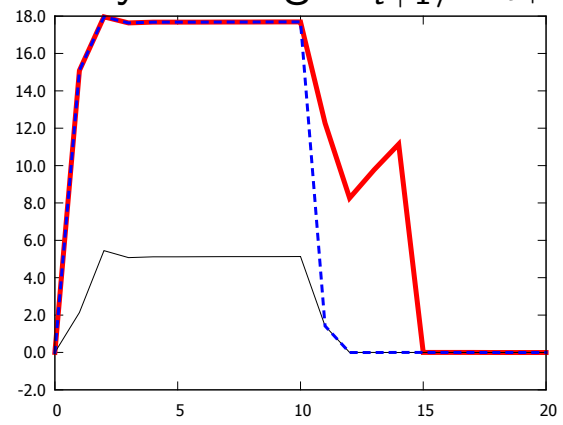


QE with late exit can extend the liquidity trap

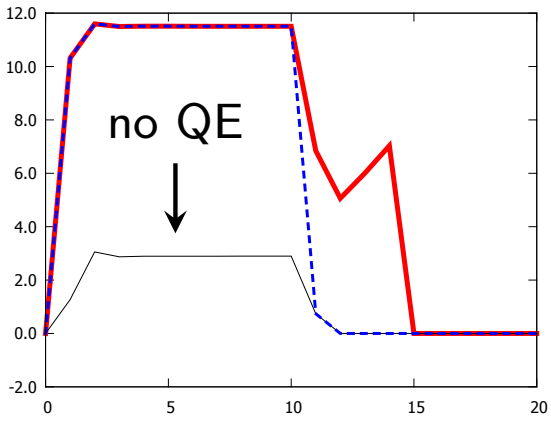
bonds l^g_{t+1}/y_{t+1}



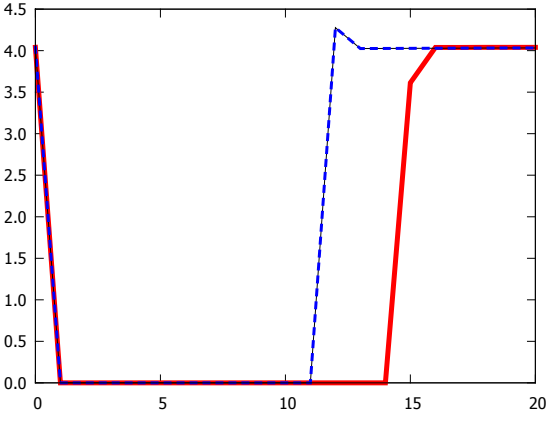
money holding M^S_{t+1}/M_{t+1}



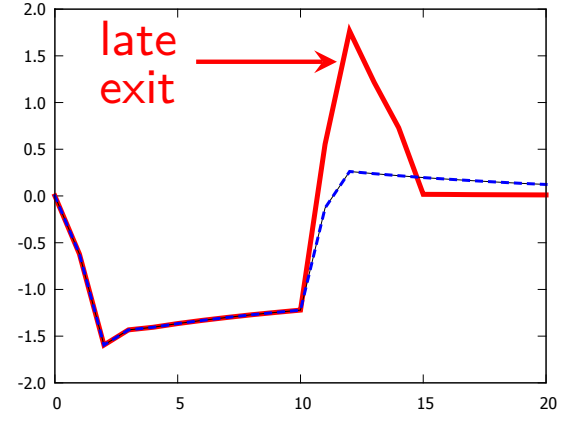
gap Δ_{t+1}



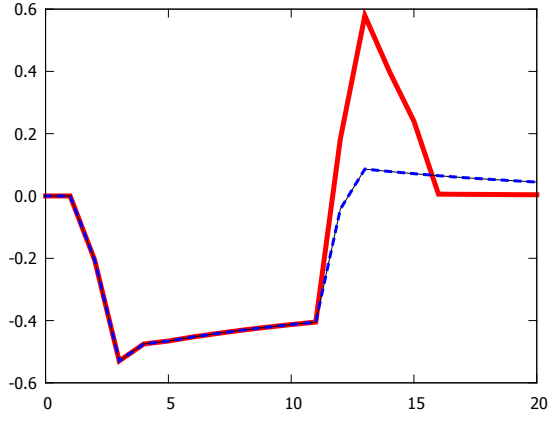
interest rate i_{t+1}



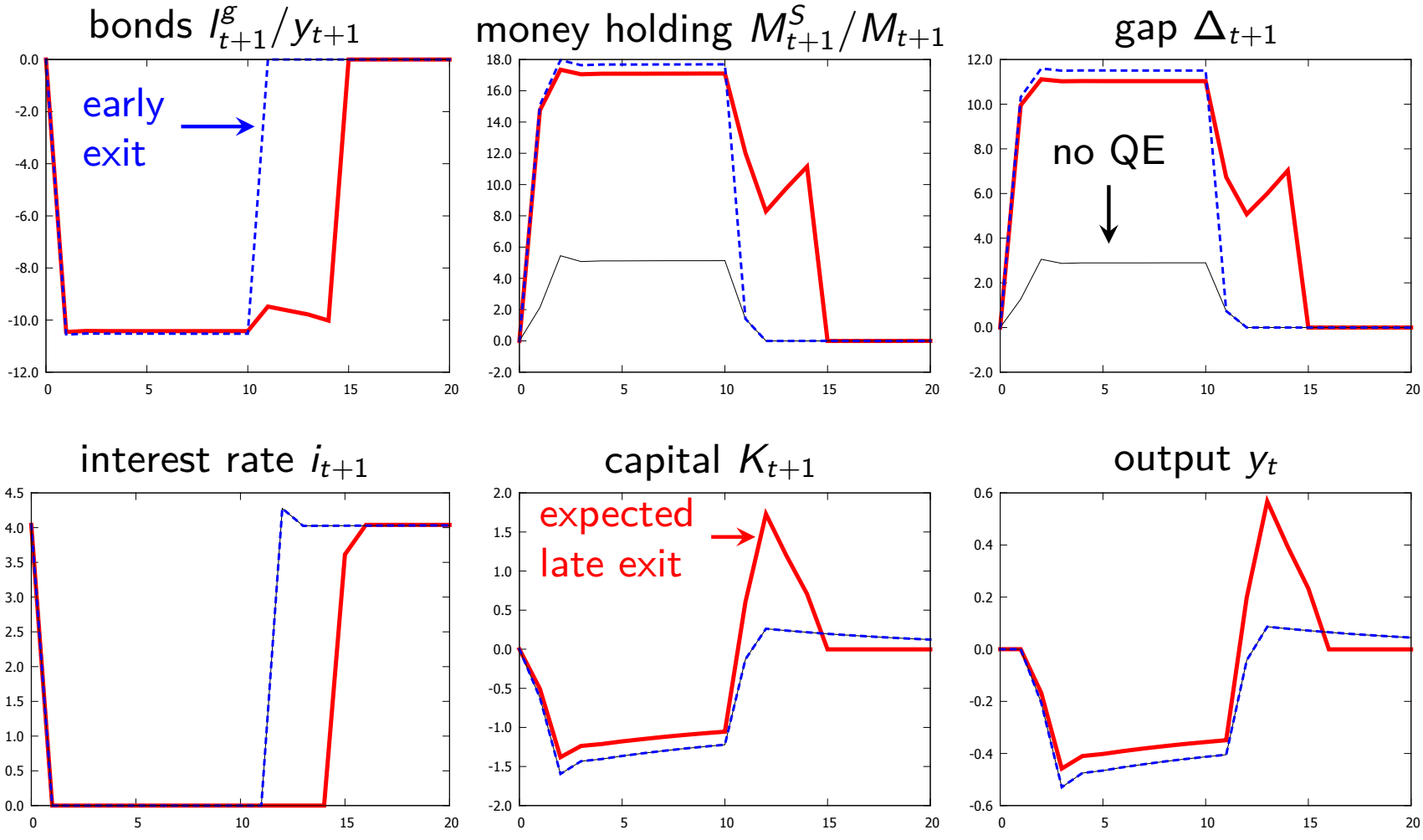
capital K_{t+1}



output y_t



QE with late exit can extend the liquidity trap



- if expected, late exit sustains somewhat output during deleveraging

First best policy

A non-ZLB steady state with high enough public debt is Pareto-efficient

but need to (i) make sure investment is not hurt by higher rates during transition

- capital subsidy

(ii) help investors smooth consumption during transition

- corporate tax

and (iii) make sure no agent is worse off

- consumption tax

Conclusion

Deleveraging of investors in a liquidity trap can explain both:

- cash hoarding
- persistent slowdown in investment

Persistent liquidity trap has supply-side policy implications

- focus on the supply of assets
- complementary to demand-side policies in the short term

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Appendix

Extensions

workers' deleveraging

- tightening workers' borrowing limit also decreases asset supply
- same effect on interest rate and money holdings
- but positive effect on capital and output [more]

bubbles

- bubble can appear when $r \leq 1$, both at/outside ZLB
- bubble sustains a higher interest rate
- ambiguous effect on capital [more]

preference and growth shocks

- $\uparrow$ in discount factor or $\downarrow$ in productivity growth can lead to ZLB
- but no negative medium-run impact on capital
- because saving increases

other

- financial intermediation, inefficient saving technology, idiosyncratic uncertainty [more]
- similar results

Investors are in autarky in the US data

Balance sheet for Nonfinancial Corporate Business
in Financial Accounts of the US

Simple definition of net position

- Net worth - Nonfinancial Assets
- between -2% of GDP in 2000 and 6% of GDP in 2006

More restricted definition

- Net position in interest bearing assets
- between -9% of GDP in 2000 and -2% of GDP in 2006

[back]

Calibration of balance sheet parameters

Financial Accounts of the US in 2006

Net position of Government (incl. monetary authority) in interest-bearing instruments $\approx$ -40% of GDP

Net position of rest of world in interest-bearing instruments $\approx$ 40% of GDP

- available supply of Governement assets ≈ 0

[back]

Investors' deleveraging with $I \neq 0$

normal equil.

- shadow rate r^S increases with I: $r = \frac{\phi + I/(\alpha y)}{\beta(1-\phi)}$
- $k = \beta\alpha y - (\frac{1}{r} - \beta)I$ now depends on r and ϕ

liquidity trap

- total liquidity $s = m^S + I = \alpha \left[(1-\phi)\frac{\beta}{\theta} - \phi\right] y$ $\nearrow$ when $\phi \searrow$
- $k = \beta\alpha y - (\theta - \beta)s$ $\searrow$ when $\phi \searrow$

Workers' deleveraging

Workers' deleveraging ($l^w \searrow$)

Outside ZLB

similar to investors's deleveraging

- asset shortage: $r \searrow$
- lower r has a positive effect on capital

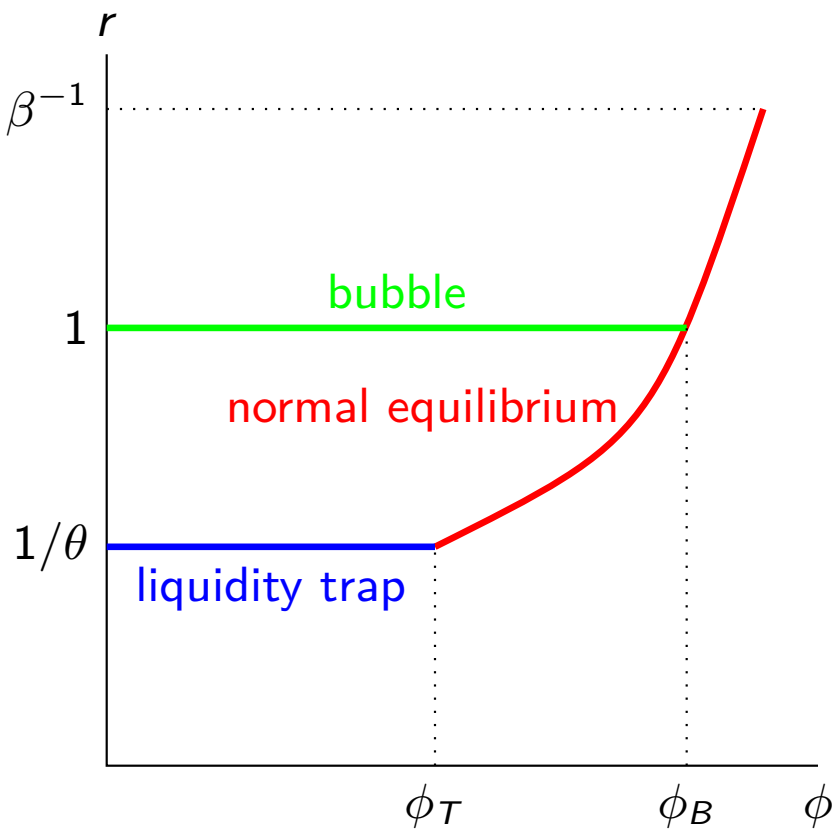
Liquidity trap

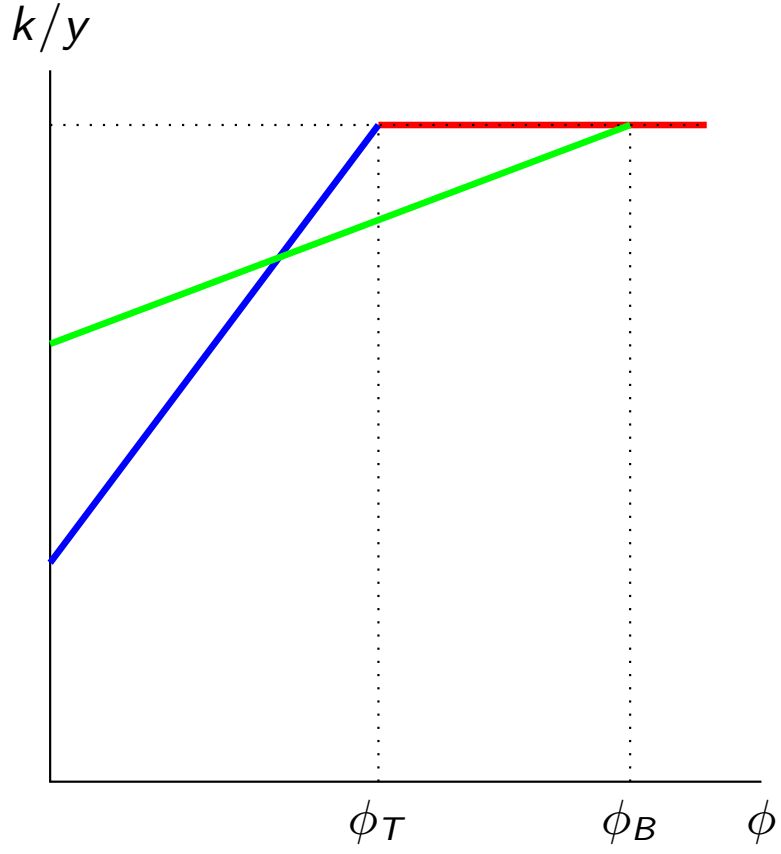
no effect on k

- does not affect investors' asset demand, which is still $\alpha[(1-\phi)\beta/\theta - \phi]y$
- effect on supply of assets to investors $m^S + l$ is fully offset by increase in m^S

[back]

Bubbles





- bubble can appear when $r \leq 1$
- equivalent to money when $\theta = 1$

- intermediate (low) leverage: bubble crowds out (in) capital

[back]

Financial intermediation

- money mainly in bank deposits
- a model with banks is isomorphic to baseline model
- increase in cash holdings by investors at ZLB shows up as an increase in excess bank reserves at the Central Bank

[back]