Liquidity, Business Cycles, and Monetary Policy

Nobuhiro Kiyotaki and John Moore

Sveriges Riksbank

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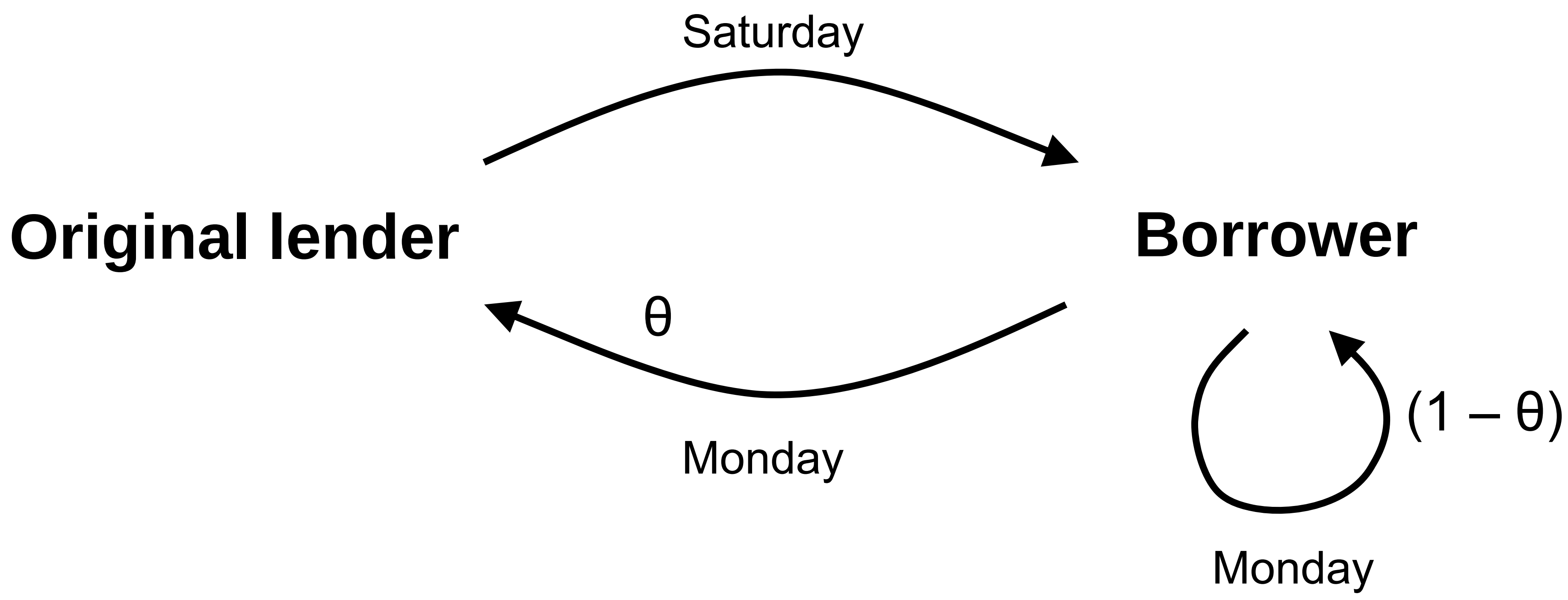
Aims:

Develop model of a “monetary economy”

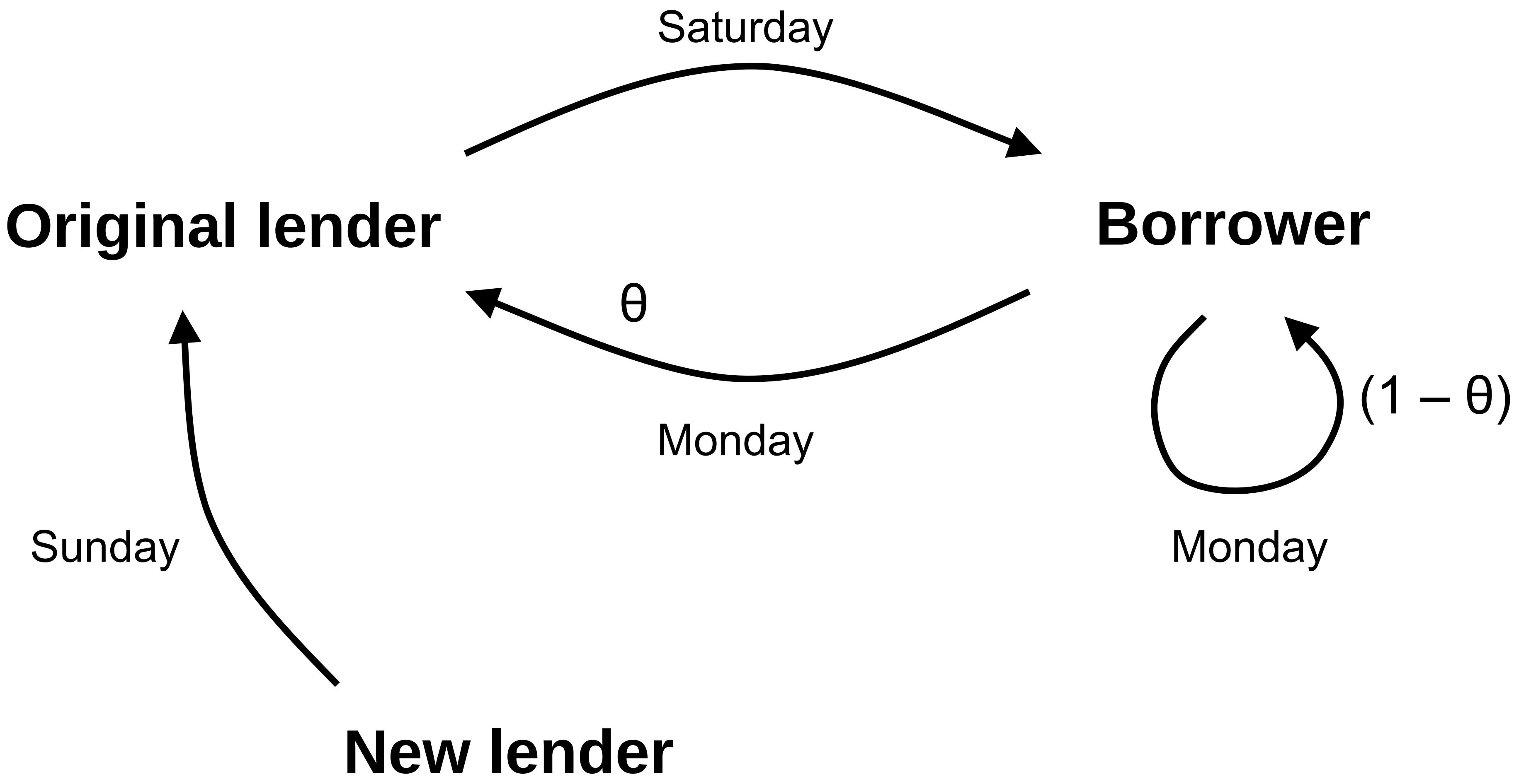
- i.e. where money is essential for the smooth running of the economy

Subject economy to productivity and liquidity shocks

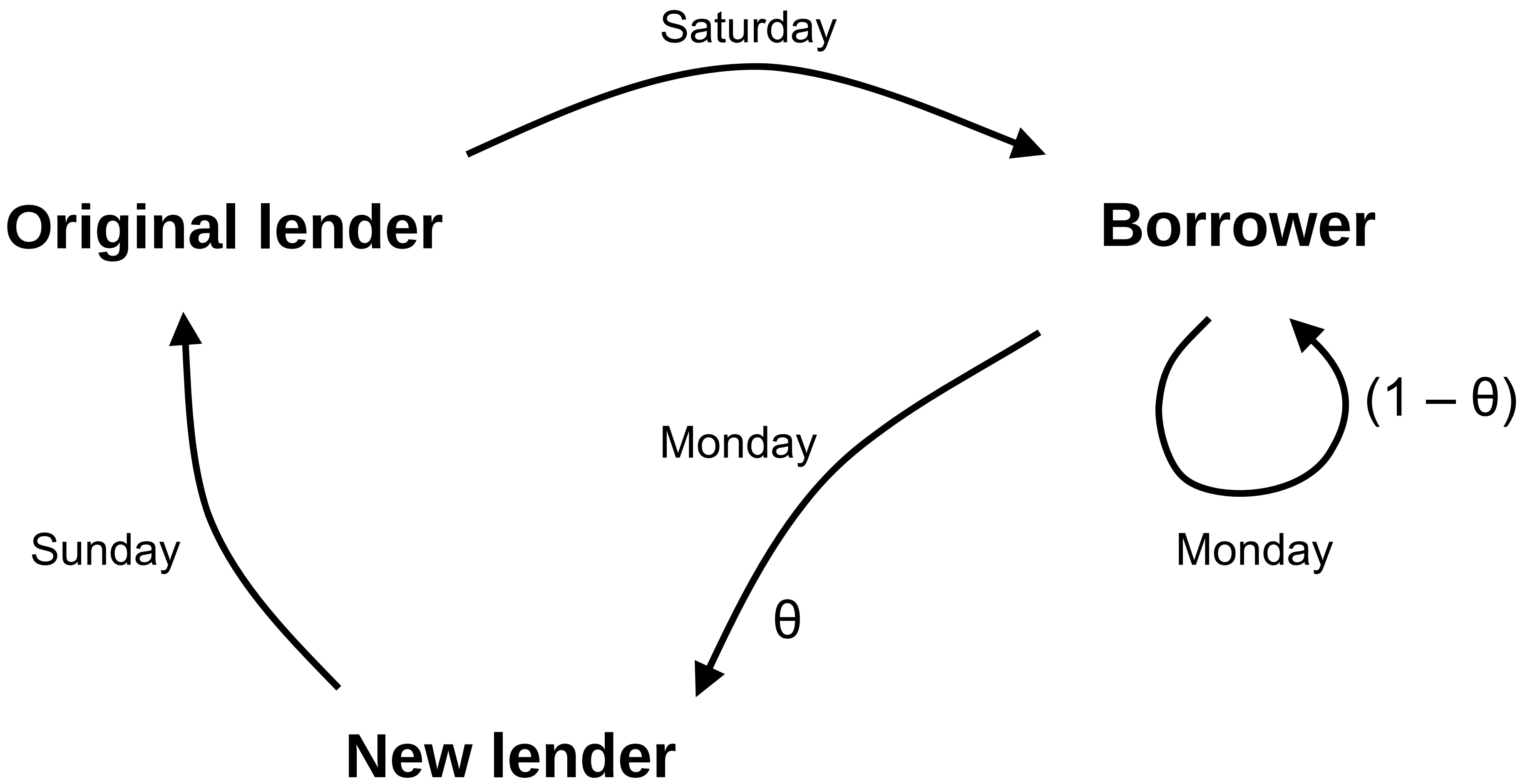
Examine role of (unconventional) monetary policy



θ < 1   (borrowing constraint)



Saturday
Original lender
Borrower
θ
(1 – θ)
Monday
Sunday
Monday
New lender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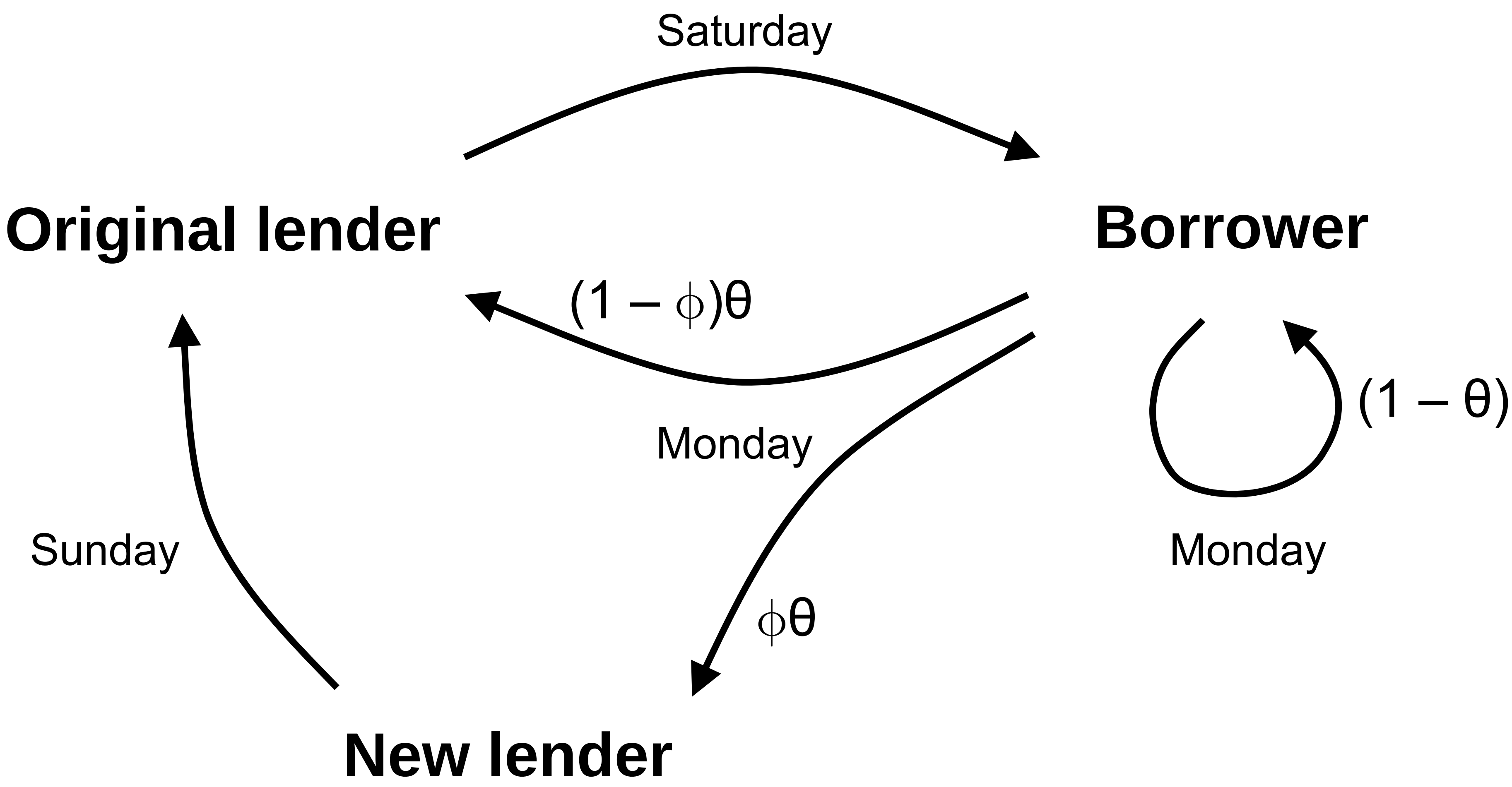
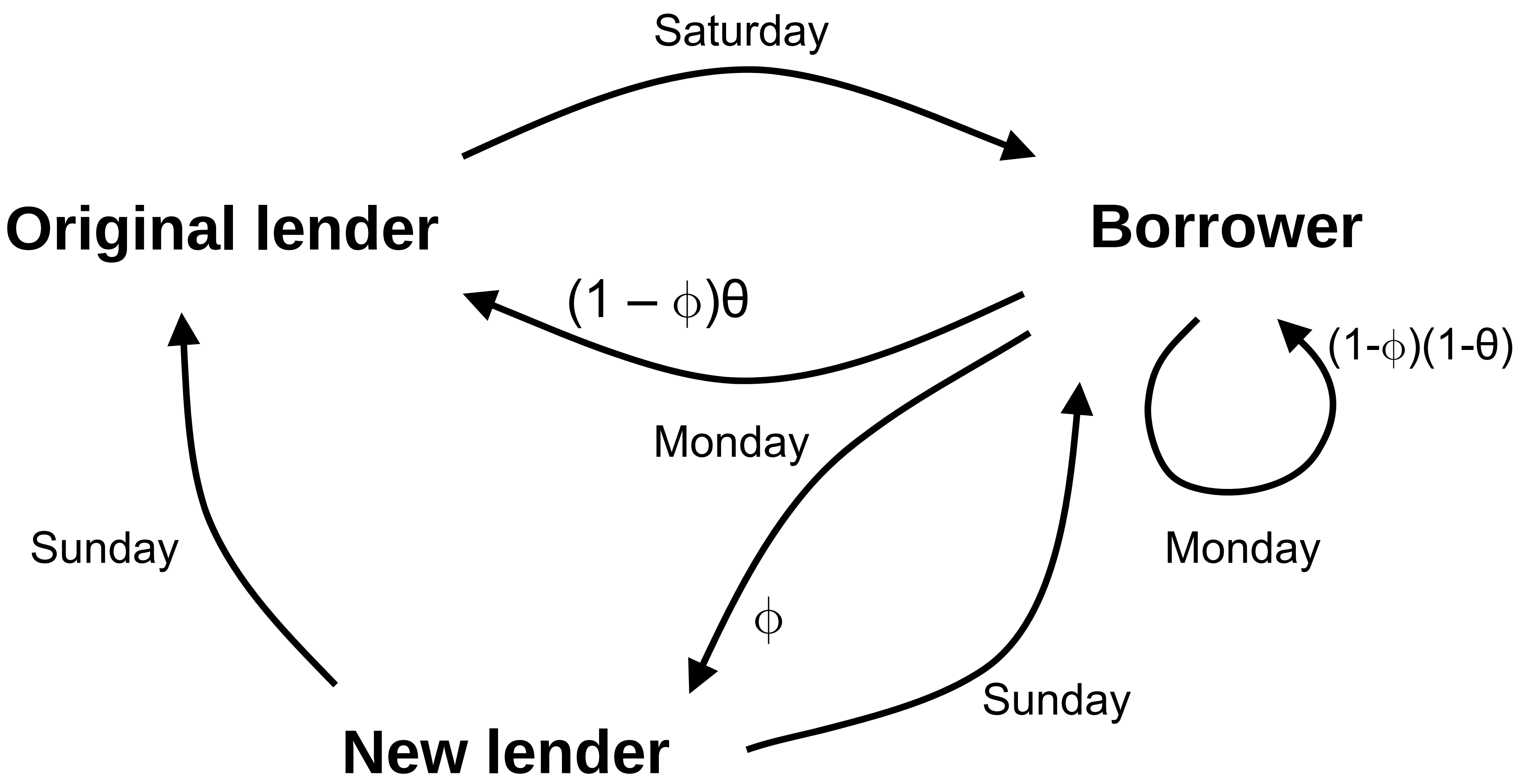


$\phi < 1$ (resaleability constraint)



ϕ = fraction of asset that can be resold at each date

(cf “peeling an onion”)

Model

discrete time: $t = 0, 1, 2, \ldots$

at each date t: homogeneous output, Y_t
capital, K_t
fiat money, M_t

agents, measure 1, utility

$$E_t \sum_{s=t}^{\infty} \beta^{s-t} \log c_s \qquad \beta < 1$$

of consumption path $\{c_t, c_{t+1}, c_{t+2}, \ldots\}$

all agents use their capital to produce goods:

start of date t | end of date t

$$k_t \text{ capital} \longrightarrow \begin{cases} r_t k_t \text{ goods} \\ \lambda k_t \text{ capital} \end{cases} \qquad \lambda < 1$$

individually constant returns, but decreasing returns in aggregate:

$$r_t = a_t K_t^{\alpha-1} \qquad \alpha < 1$$

$$Y_t = r_t K_t = a_t K_t^{\alpha}$$

only a fraction $\pi < 1$ of agents can use goods to produce new capital:

start of date t   end of date t

i_t goods $\longrightarrow$ i_t new capital

(new capital produces goods only from t+1 on)

these investment opportunities are i.i.d.,
across agents, through time

agents cannot insure against the arrival of an investment opportunity capital is specific to the agent who produces it, but he can mortgage future returns by issuing <u>equity</u>:

one unit of equity issued at date t promises

$$r_{t+1}, \lambda r_{t+2}, \lambda^2 r_{t+3}, \ldots$$

Borrowing constraint:

an investing agent can mortgage at most θ of future returns from his new capital production think of unmortgaged capital as “inside equity”

Resaleability constraint:

at each date t, an agent can resell at most ϕ_t of his (inside or outside) equity holdings

borrowing and resaleability constraints

$\equiv$ “liquidity constraints”

NB there is a subscript t on both

a_t (productivity shock) and ϕ_t (liquidity shock)

balance sheet at end of date t

assets	liabilities
capital stock	own equity issued
others' equity purchased	net worth
money m_{t+1}	

let n_{t+1} = capital stock – own equity issued
+ others' equity purchased

= inside equity + outside equity

let q_t = price of equity

p_t = price of money (upside down!)

flow-of-funds constraint:

$$c_t + i_t + q_t(n_{t+1} - i_t) + p_t m_{t+1}$$
$$= (r_t + \lambda q_t) n_t + p_t m_t$$

liquidity constraint:

$$n_{t+1} \geq (1 - \theta) i_t + (1 - \phi_t) \lambda n_t$$

$$m_{t+1} \geq 0$$

government

at date t, government chooses its :

G_t within-period net spending/transfers

N^g_{t+1} end-of-period holding of private equity

M_{t+1} end-of-period money supply

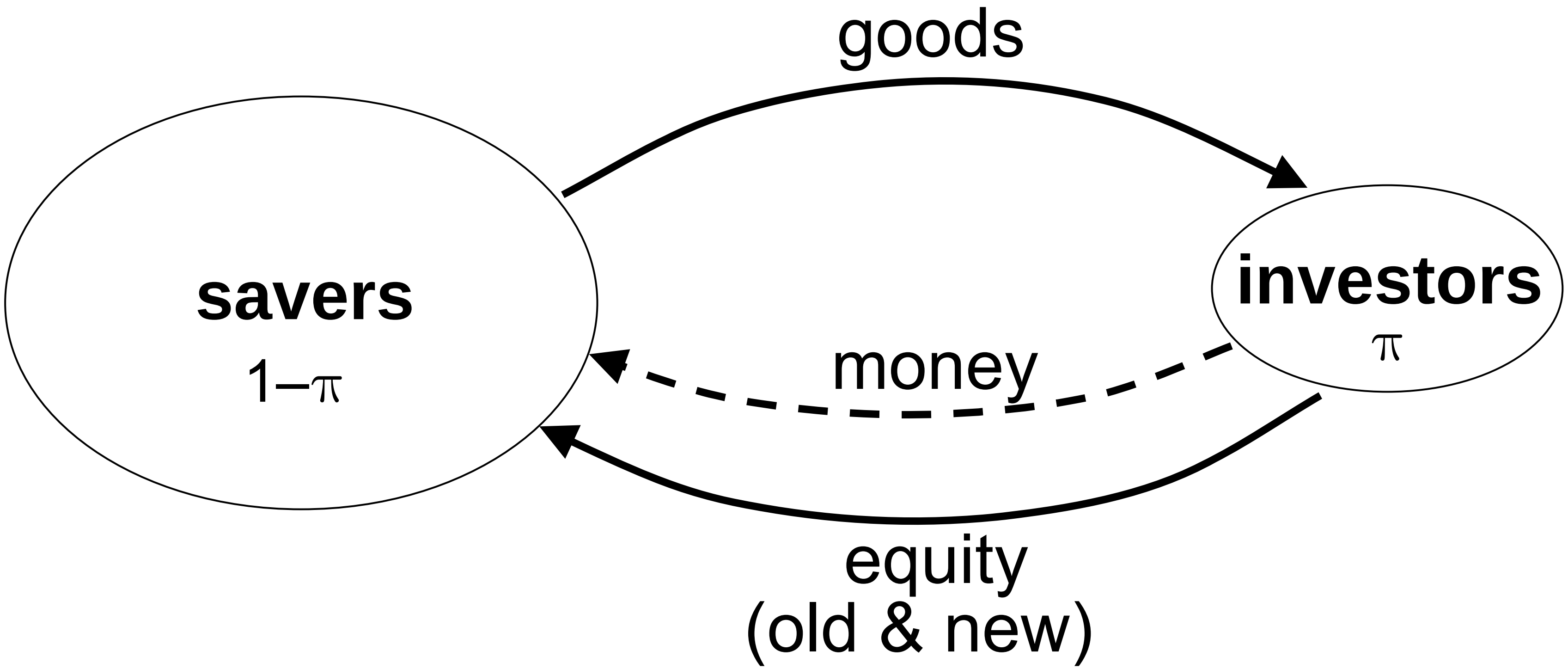
subject to flow-of-funds constraint

$$G_t + q_t(N^g_{t+1} - \lambda N^g_t) = r_t N^g_t + p_t(M_{t+1} - M_t)$$

and resaleability constraint

$$N^g_{t+1} \geq (1 - \phi_t)\lambda N^g_t$$

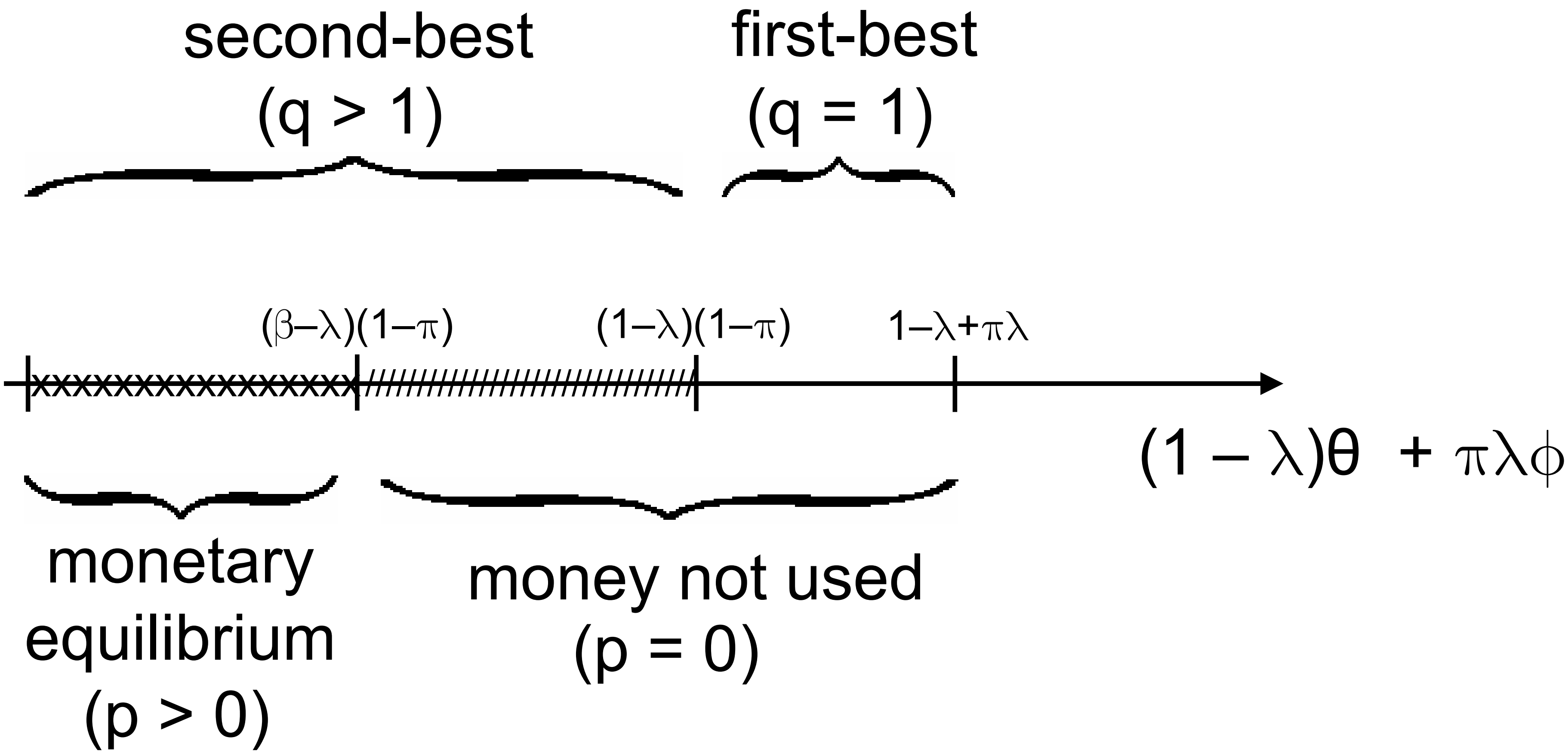
private economy tries to funnel funds from agents who do not have an investment opportunity ("savers") into the hands of agents who do ("investors"):



think of this as a "liquidity-in-advance" model

for the moment, ignore government
(set $G_t \equiv N_t^g \equiv 0$ and $M_t \equiv M$)

<u>Proposition</u> (steady-state: $a_t \equiv a$, $\phi_t \equiv \phi$)



q_t must lie below $1/\theta$ ∵ for an INVESTOR (he):

$$\text{investment } i_t = \frac{\text{available funds} - \text{consumption}}{(1 - \theta q_t)}$$

← required downpayment per unit of investment

$$\text{available funds} = [r_t + q_t\phi_t\lambda]n_t + p_t m_t$$

$$\text{consumption } c_t = (1 - \beta) \text{ x his net worth}$$

his net worth:

$$[r_t + q_t\phi_t\lambda + s_t(1 - \phi_t)\lambda]n_t + p_t m_t$$

s_t ↑ his shadow price of illiquid equity $= \dfrac{1 - \theta q_t}{1 - \theta} < 1$

SAVER (she): consumption c_t = $(1-\beta)$net worth

her net worth = $[r_t + q_t\phi_t\lambda + q_t(1-\phi_t)\lambda]n_t + p_t m_t$

↑ her shadow price of illiquid equity = market price of equity

her portfolio choice:

$$(1-\pi)E_t\left\{\frac{\dfrac{r_{t+1} + q_{t+1}\phi_{t+1}\lambda + q_{t+1}(1-\phi_{t+1})\lambda}{q_t} - \dfrac{p_{t+1}}{p_t}}{c_{t+1}\,\middle|\,\text{she is still a saver at t+1}}\right\}$$

$$= \quad \pi E_t\left\{\frac{\dfrac{p_{t+1}}{p_t} - \dfrac{r_{t+1} + q_{t+1}\phi_{t+1}\lambda + s_{t+1}(1-\phi_{t+1})\lambda}{q_t}}{c_{t+1}\,\middle|\,\text{she becomes an investor at t+1}}\right\}$$

these date t behavioural equations are all linear in n_t and m_t

$\Rightarrow$ aggregation is easy; we do not need to keep track of the evolution of the distribution of agents' individual asset holdings

$\Rightarrow$ relevant state variables: K_t (endogenous)

a_t , ϕ_t (exogenous)

IS equation:

$$Y_t = C_t^{savers} + C_t^{investors} + I_t + G_t$$

$$(1 - \beta) \times \text{Net Worths}$$

$$\frac{\pi \times \text{Available Funds} - C_t^{investors}}{(1 - \theta q_t)}$$

LM equation:

$$(1-\pi)E_t\left\{\frac{\dfrac{r_{t+1}+q_{t+1}\phi_{t+1}\lambda+q_{t+1}(1-\phi_{t+1})\lambda}{q_t}-\dfrac{p_{t+1}}{p_t}}{C_{t+1}^{savers}}\right\}$$

$$=\qquad \pi E_t\left\{\frac{\dfrac{p_{t+1}}{p_t}-\dfrac{r_{t+1}+q_{t+1}\phi_{t+1}\lambda+s_{t+1}(1-\phi_{t+1})\lambda}{q_t}}{C_{t+1}^{investors}}\right\}$$

$E_t r_{t+1} + \lambda \quad > \quad 1/\beta \qquad (K_t \text{ less than first-best})$

return on capital time preference

$$> \quad E_t \frac{r_{t+1} + q_{t+1}\phi_{t+1}\lambda + q_{t+1}(1 - \phi_{t+1})\lambda}{q_t}$$

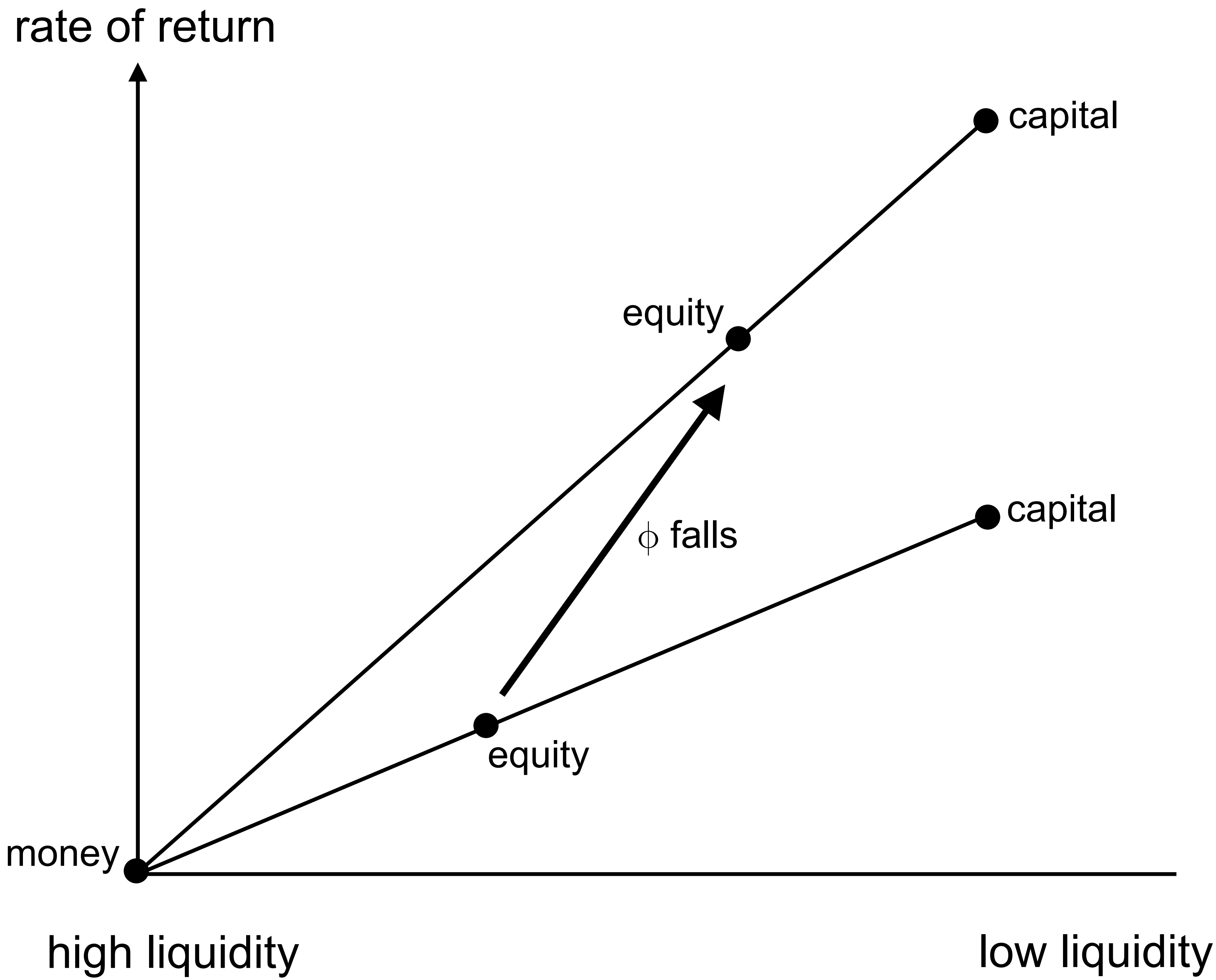
return on equity if still a saver at t+1

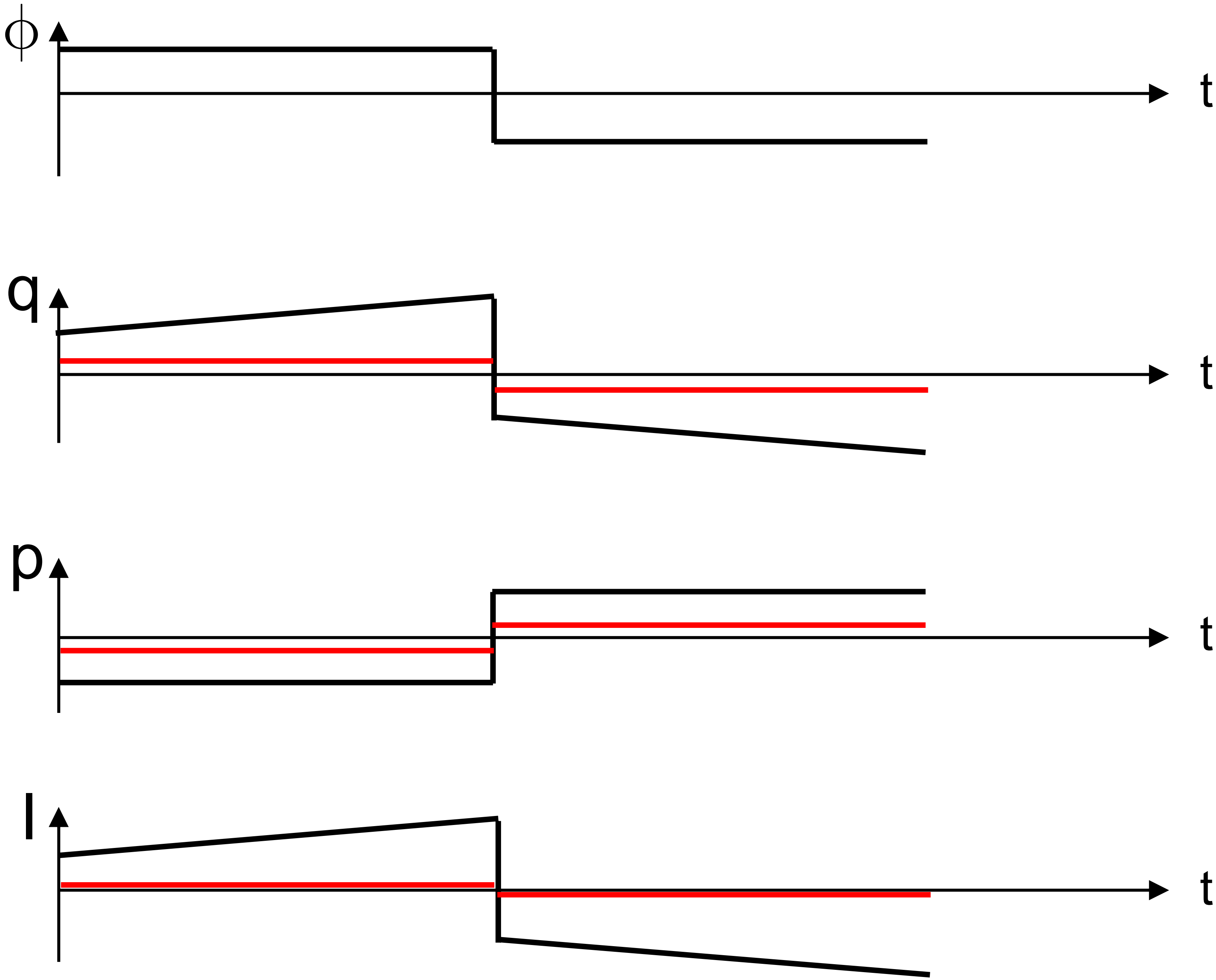
$$> \quad E_t \frac{p_{t+1}}{p_t}$$

return on money

$$> \quad E_t \frac{r_{t+1} + q_{t+1}\phi_{t+1}\lambda + s_{t+1}(1 - \phi_{t+1})\lambda}{q_t}$$

return on equity if become an investor at t+1


rate of return
capital
equity
ϕ falls
capital
equity
money
high liquidity
low liquidity



ϕ
t
q
t
p
t
I
t