Rational Sentiments and Economic Cycles

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Credit Market Sentiment ⇆ Real Fundamentals

Economies are subject to cycles!

- good times
  - abundant credit at small spread even to risky firms
  - deterioration of credit quality

    high credit market sentiments, overheated market
  - high output, positive output growth

- bad times
  - risky firms are squeezed, credit is expensive if there is any
  - issued credit is higher quality

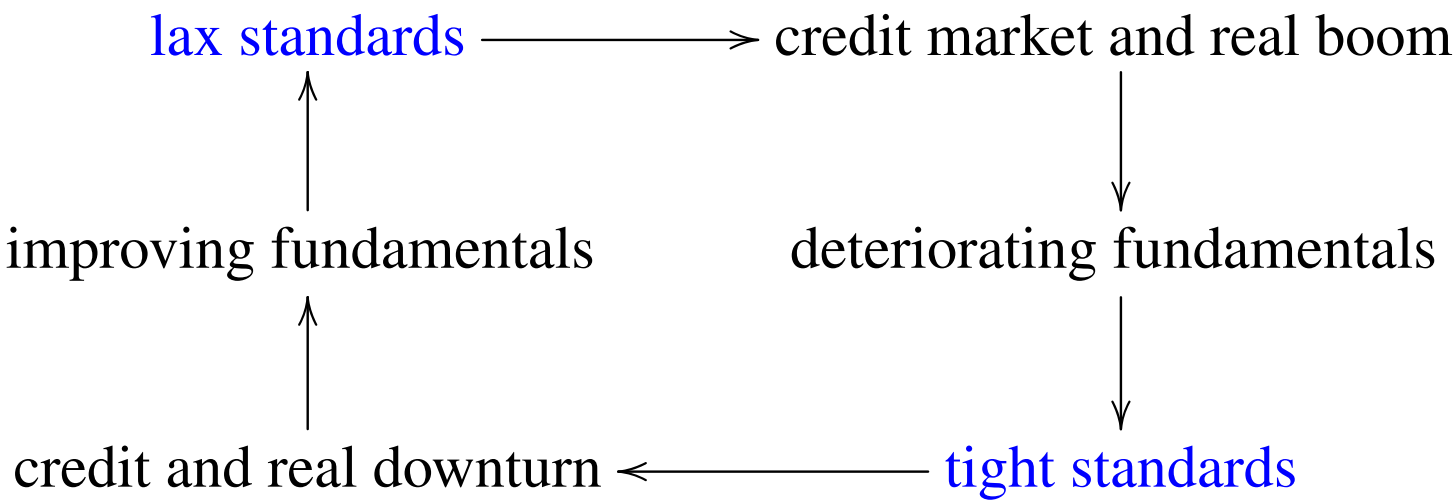
    low credit market sentiments
  - low output, negative output growth

Economic Cycles

- what predictably triggers
  - periods of credit market overheating?
  - transition into a recession
  - length of booms/recessions
- is the economy (constrained) efficient?
- cost and benefit of policy instruments

OVERVIEW

- **sentiment**: choice of lending standards
- rational model
  - two-way interaction between sentiments and real outcomes



$\Rightarrow$ **endogenous cycles**

- diverse cycles: various boom/bust lengths, lengthy recovery, double-dip recessions, $\cdots$
- compare macro-prudential/monetary policy instruments

Agents

- one good, infinite time $t = 0, 1, 2...$
  - each day: morning and evening
- agents: entrepreneurs produce, investors provide funding
  - risk neutral
  - maximize expected life-time utility
  - receive a unit endowment each morning
  - can save at $1 + r_f$ within period (but not overnight)

ENTREPRENEURS.

TYPE DISTRIBUTION

- unit measure
- good or bad (τ), transparent or opaque (ω)
- μ: measure of bad agents

	$\tau = g$: good	$\tau = b$: bad
$\omega = 1$: transparent	$(1 - \mu_{0,t} - \mu_{1,t})/2$	$\mu_{1,t}$
$\omega = 0$: opaque	$(1 - \mu_{0,t} - \mu_{1,t})/2$	$\mu_{0,t}$

Dynamics of Entrepreneur Type Distribution

- stochastic OLG model
- each entrepreneur is replaced by a newborn if
  1. dies with exogenous probability δ
  2. not granted credit
- outside distribution:

  λ bad, $1-\lambda$ good; $\frac{1}{2}$ opaque or transparent (iid)

  $\Rightarrow$ entrepreneur type distribution endogenously determined by credit market outcomes

  $\mu_{0,t}$ and $\mu_{1,t}$ endogenous, time-varying state variables

ENTREPRENEUR TECHNOLOGY

- each entrepreneur chooses investment $i(\tau, \omega)$ to produce with linear technology
- obtains credit $\ell(\tau, \omega)$ at interest rate $r(\tau, \omega)$ in the morning
- each unit of investment, i
  - costs 1, covered by endowment or credit: $i = \ell + 1$
  - returns $\rho > 1 + r_f$ in the evening
- credit is collateralized by i: $(1 + r)\ell = i \Rightarrow \ell = \frac{1}{r}$
  - financing each unit of investment requires r down-payment
- **friction:** bad collateral not seizeable

  $\Rightarrow$ bad entrepreneurs do not pay back

INVESTORS

- lives one period, replaced by same type next day
- two types
  - small measure of *Skilled* (w_1):
    observe type of entrepreneur/project
  - large measure of *Unskilled* (w_0):
    observe imperfect signals on the sample of loan applications they receive
  - signals are generated by a test **of investor choice**

Bold	good	bad
transparent	✔	✗
opaque	✔	✔

Cautious	good	bad
transparent	✔	✗
opaque	✗	✗

  - **either test costs** c

Credit Market

- main friction
  - bad entrepreneurs do not pay back
  - investors have imperfect information about entrepreneur type
- each investor advertises an interest rate $\tilde{r}$
- each unskilled investor picks a test
- each entrepreneur submits credit demand

Stage Game Equilibrium

- **key intermediate result!**

  investors choose bold test iff few bad (and opaque) entrepreneurs

- **trade-off:**

  (1) with bold test (lax lending standards) more lending, but some borrowers default

  (2) more defaults when $\mu_{0,t}$ large

  $\rightarrow$ cautious investors can offer lower interest rate than bold ones

$$\begin{cases} \mu_{0,t} \leq \frac{c}{1+r_f}\text{: all investors choose bold test} & \rightarrow \textbf{bold stage} \\ \mu_{0,t} > \frac{c}{1+r_f}\text{: all choose cautious test} & \rightarrow \textbf{cautious stage} \end{cases}$$

The Bold Stage

- bold investors lend to all good and some bad entrepreneurs
- investment and output are high
- all entrepreneurs raise funding at common (low) interest rate
- loan quality is low

booming economy, overheated credit market

The Cautious Stage

- cautious investors lend to good-transparent firms only
- good-opaque are constrained by scarce skilled capital
  - limited credit, high interest rate, low output
- no bad credit
  - investment and output is low
  - credit spread: dispersion in interest rate
  - loan quality is high

low sentiment credit market

So let us see how credit market outcomes feed back to the law of motion of the type distribution. Note that in the cautiuos stage purifies the economy, as bad enterpeneurs are denied credit. This impleis that in a permanently cautious stage the economy would converge to a lower mu0 than in a permanently bold stage. Now suppose that treshold to switch between the cautuos and the bold test is in between these two mubars.

DYNAMIC EQUILIBRIUM

- dynamics: the law of motion for μ_0
  1. cautious stage:

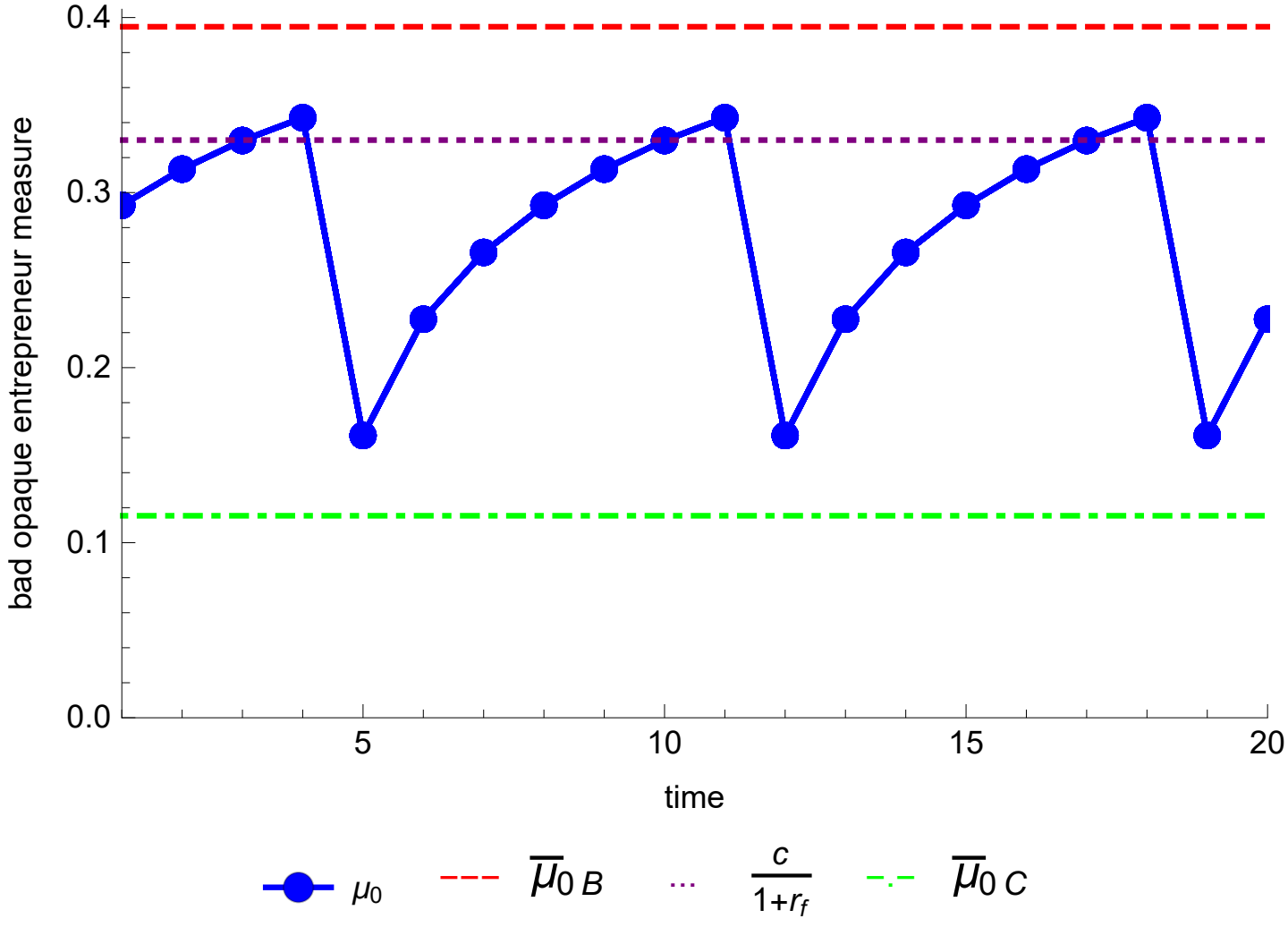
     bad entrepreneurs die at higher rate (no credit)

     $\Rightarrow$ *steady state:* $\bar{\mu}_{0,C} < \bar{\mu}_{0,B}$
  2. investors become cautious when μ_0 high

$$\bar{\mu}_C < \frac{c}{1+r_f} < \bar{\mu}_B\text{: cycle}$$

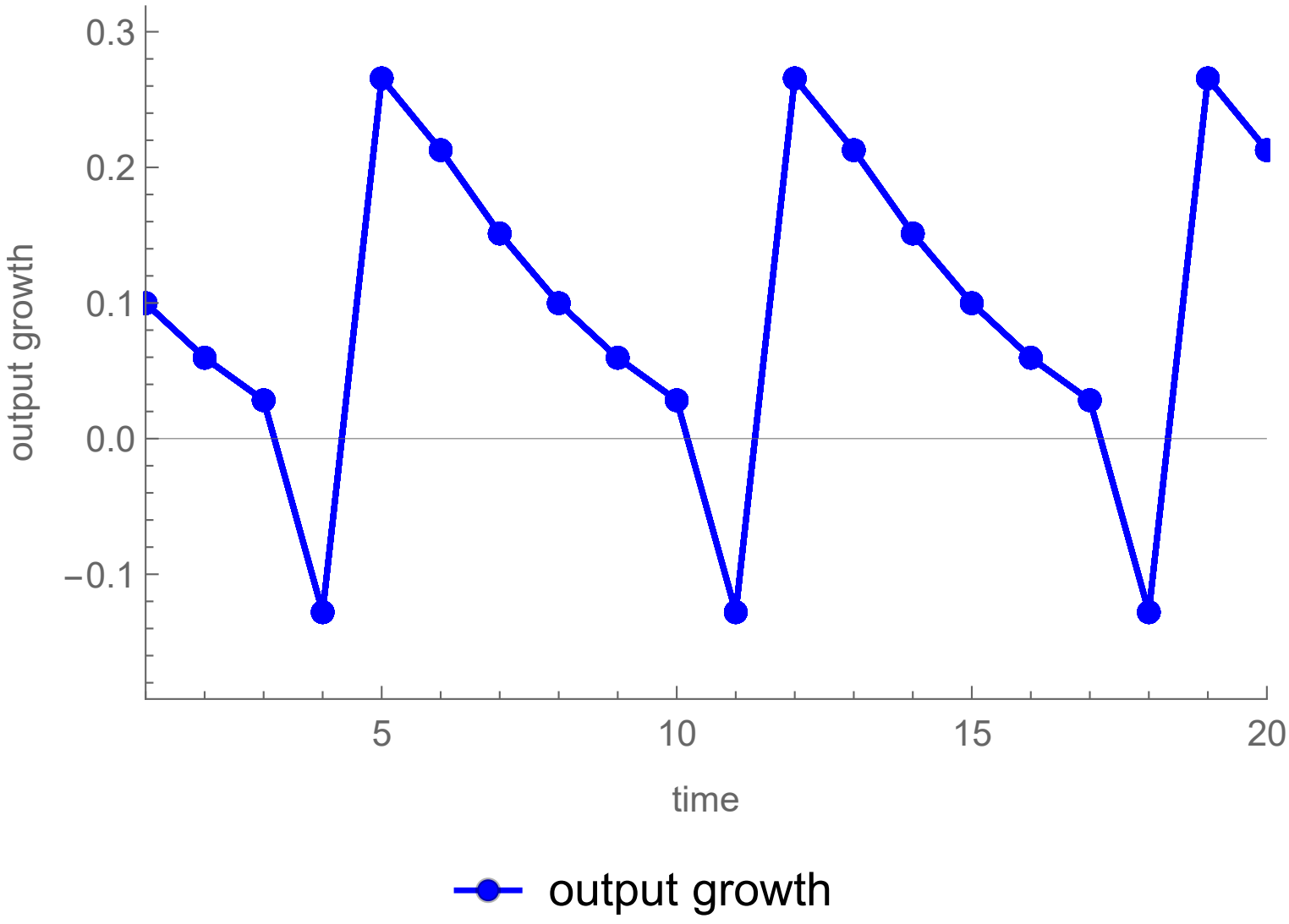
Cycling Type Distribution.

Measure of bad opaque entrepreneurs

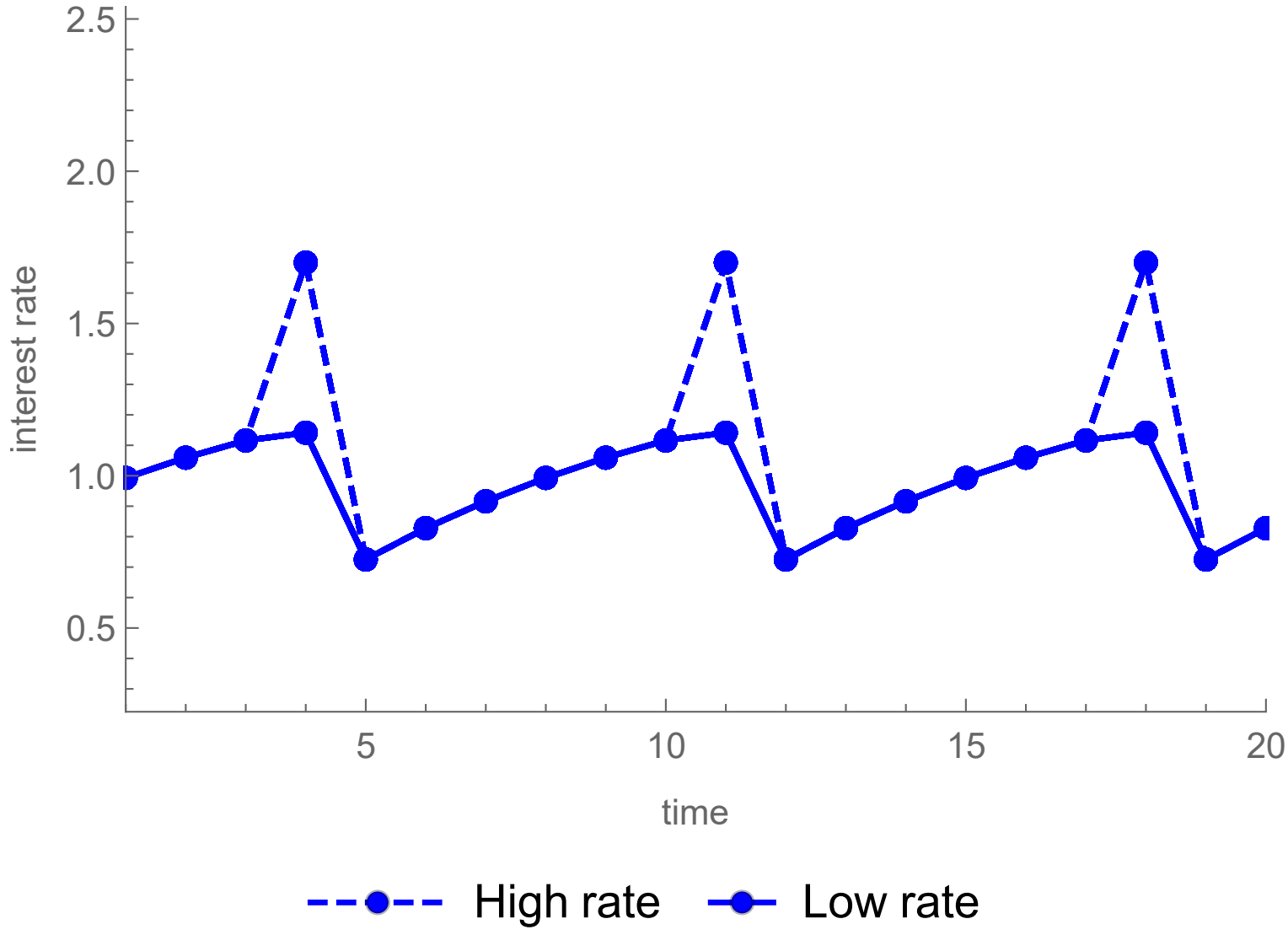


then the economy is cycling in the long run. In this figure I show you the long run evolution of the state variable. In this particular simulation, starting from a small fraction of bad opaque types the economy is in the bold stage, implying an increasing fraction, then, when this fraction jumps above the treshold, all investors switch to cautious, which leads to a drop in bad types.

Cycling Output Growth



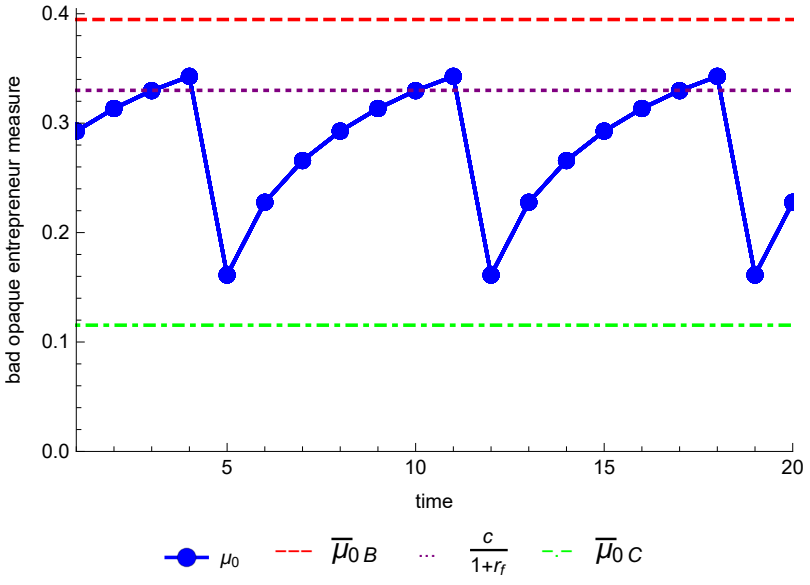
Cycling Credit Spread



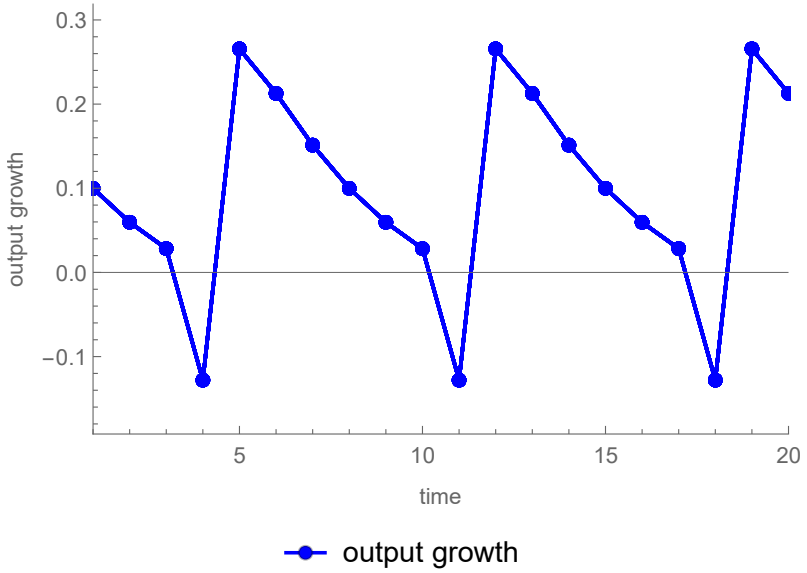
Three Major Classes of Cycles

- normal expansion and contraction
- prolonged recovery
- double-dip recession

Normal Expansion and Contraction

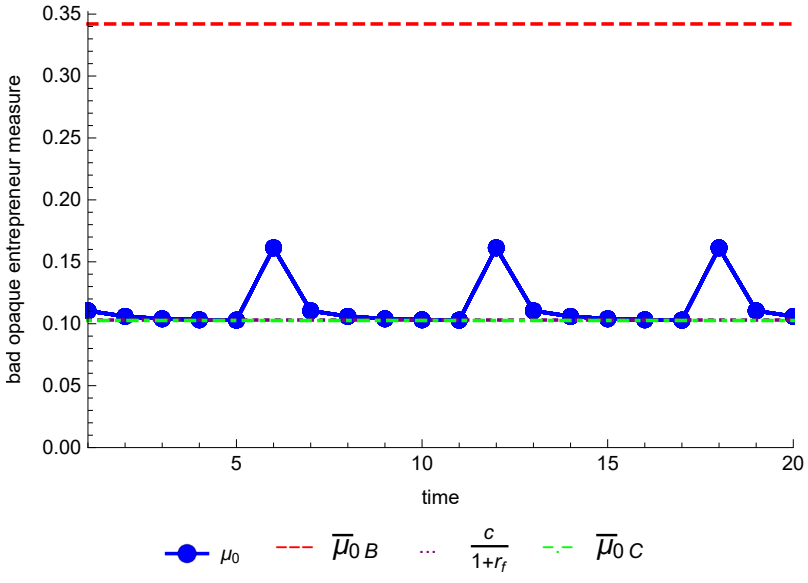


(A) state variable μ_0

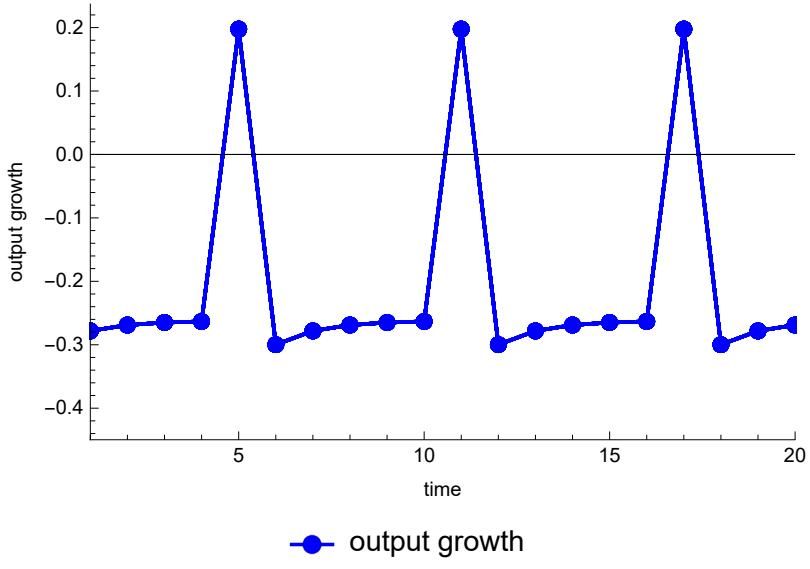


(B) output growth

PROLONGED RECOVERY

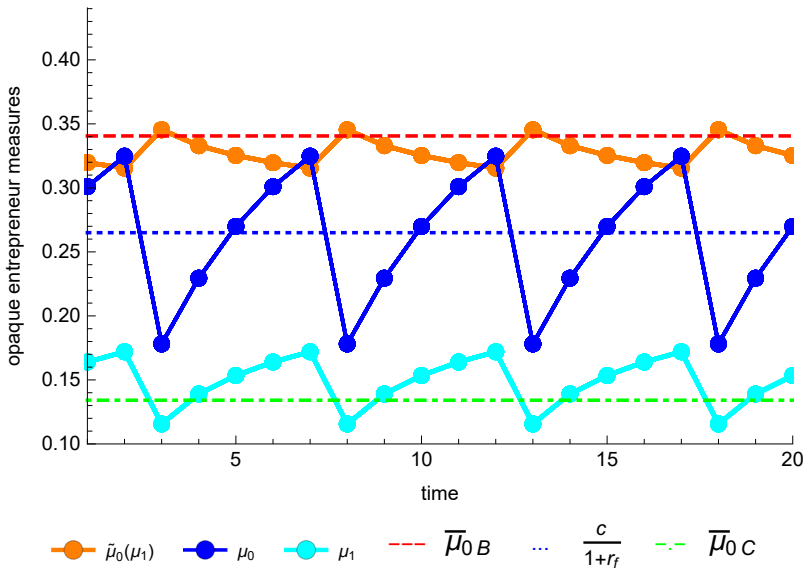


(A) state variable μ_0

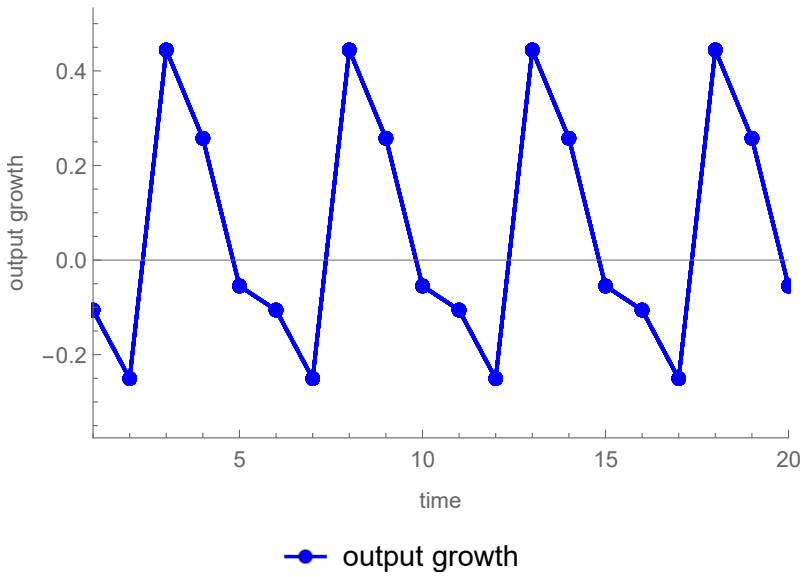


(B) output growth

DOUBLE-DIP RECESSION



(A) state variables (μ_0, μ_1)



(B) output growth

Optimal Cycles and Economic Policy

- constrained planner: chooses which test the investors run
  - change the bold-cautious threshold
- constraint optimal outcome
  - **cyclical**
  - if fraction of newborn bad intermediate

    enough persistence (death rate not too high)
- equilibrium *not* constraint efficient
  - cautious stage: **dynamic welfare gain**

    keeps fraction of bad projects at bay

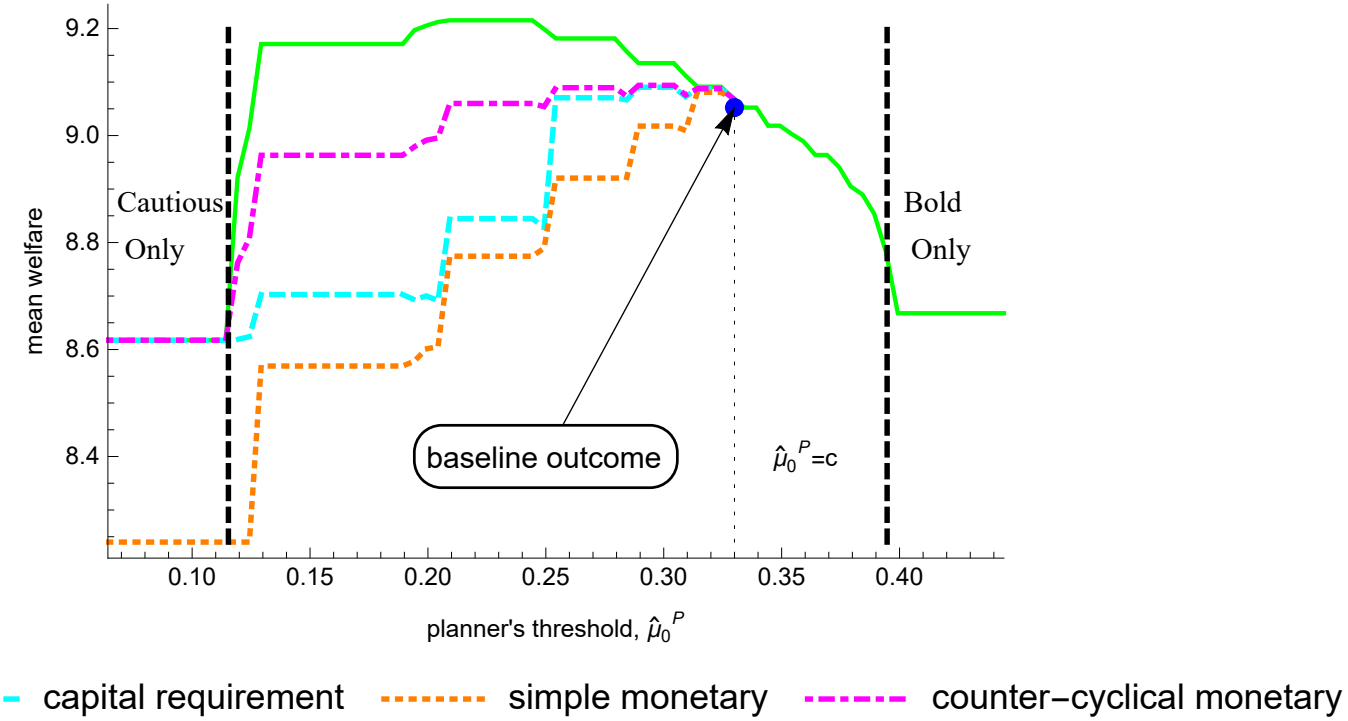
    $\Rightarrow$ makes boom more welfare enhancing
  - individual investor does not internalize her effect on the evolution of state

POLICY

1. *simple monetary policy:* risk-free asset with interest rate r_f in every stage
2. *counter-cyclical monetary policy:* 0 interest rate in a cautious stage, $r_f > 0$ in bold stage
3. *macro-prudential policy:* capital requirement for "risky" loans (issued by bold test)

how do they rank?

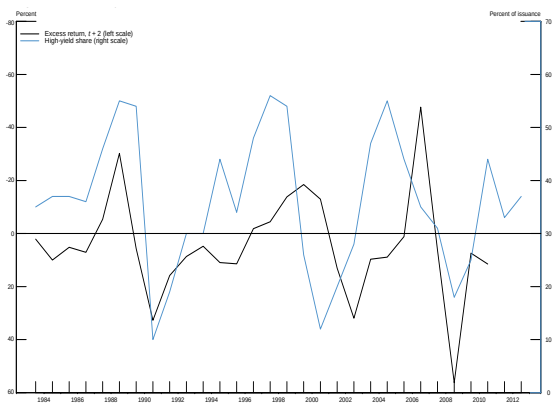
Optimal Cycles and Economic Policy



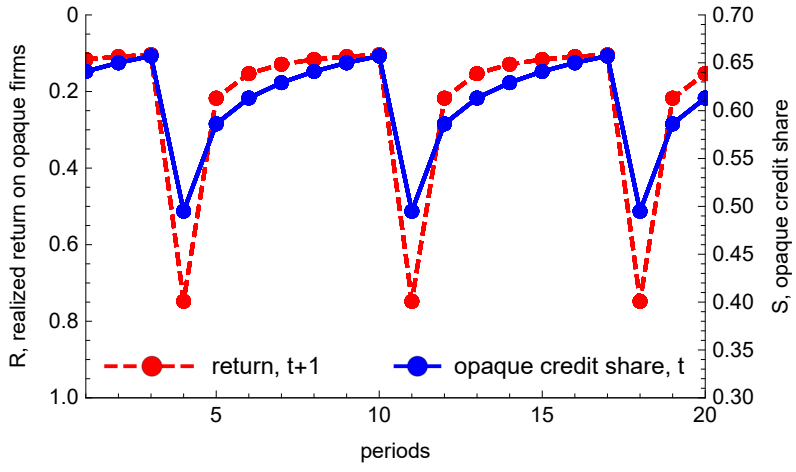
Equilibrium, Planner, and Policy Outcomes

Model and Facts

1. counter-cyclical quality spread



(A) Stein 2013: high yield share and excess realized returns



(B) model: opaque credit share and realized excess return

Model and Facts

2. heterogeneous portfolio rebalancing
3. terms and quality of credit cycle
   - credit standards are lax in booms
   - average quality of issued credit is deteriorating in booms
   - less dispersed interest rates in booms than busts

Conclusion

- two-way interaction between rational sentiment and real outcomes

  endogenous cycles

- normal expansion and contraction, prolonged recovery, double-dip recession
- decentralized equilibrium not constrained efficient
  - investors fail to internalize effect of their lending standards on quality of future investment
  - typically planner can push the economy to a higher-welfare cycle
  - policy instruments
    - achieve same cycle at different cost (higher lending rate)

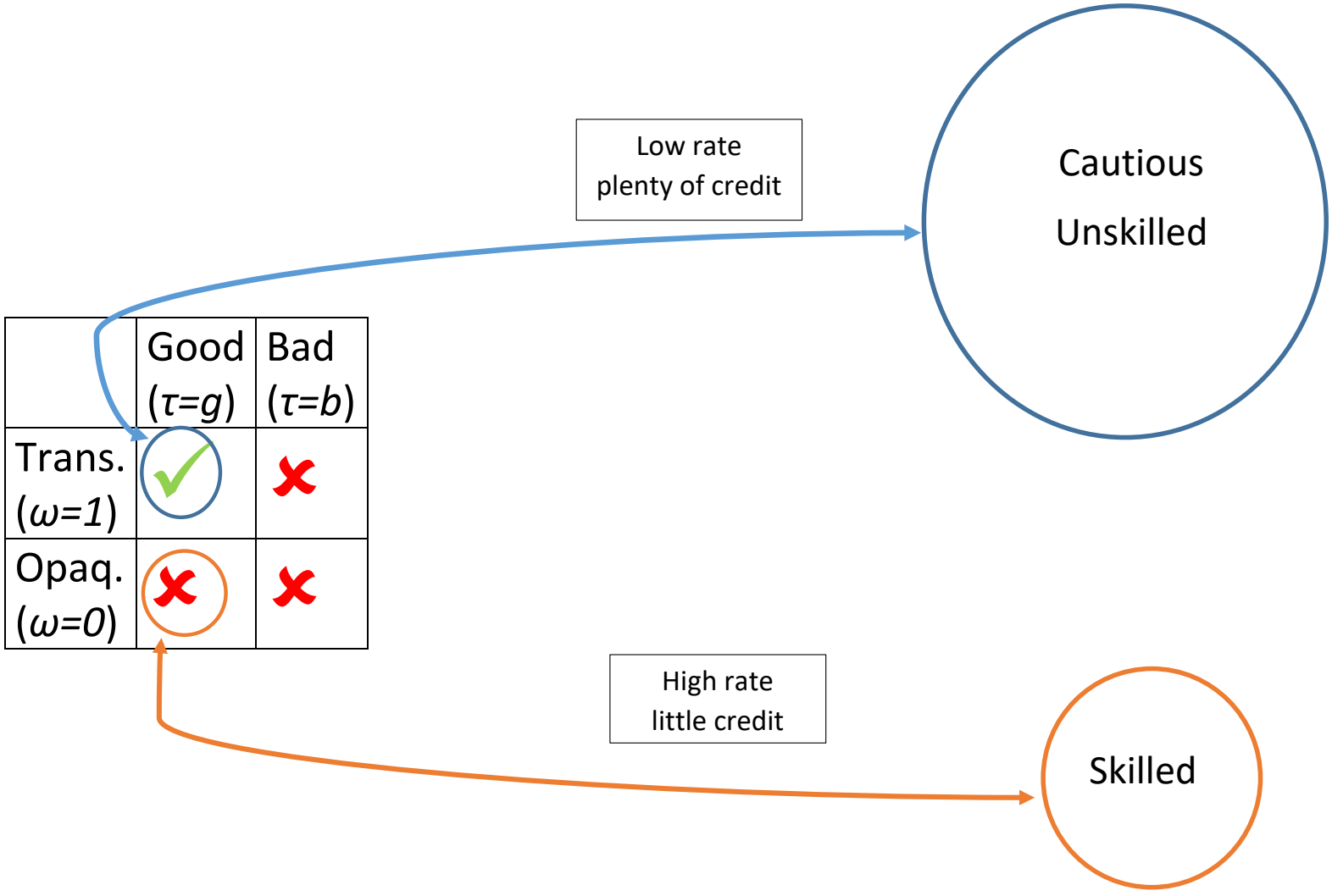
CREDIT MARKET

sampling and market clearing

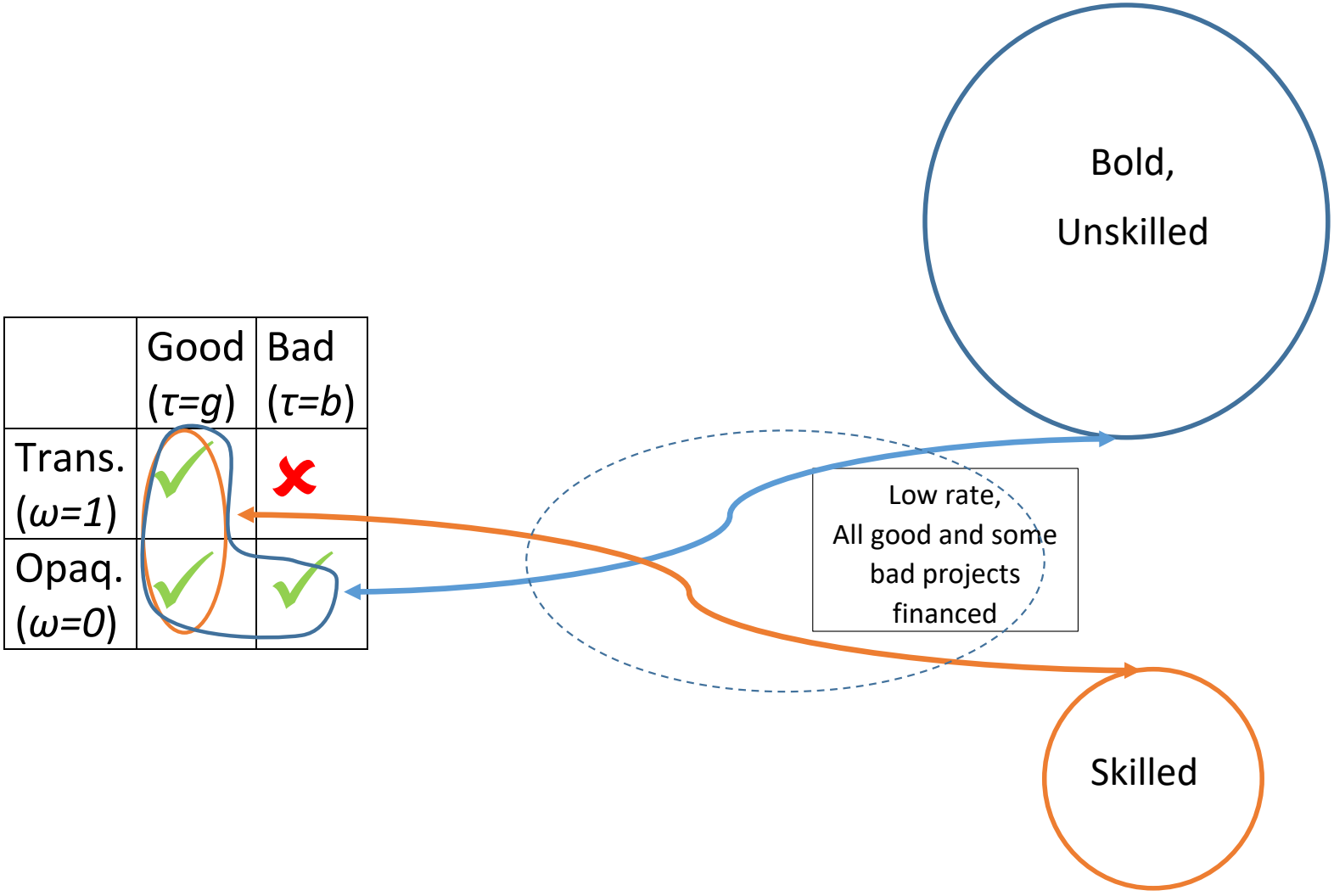
- start at the smallest advertised rate, r_0
  1. each entrepreneur with $\sigma(r_0, \tau, \omega) > 0$ has posted r_0 down-payment per application
  2. unskilled investors who advertised r_0
     - 2.1 sample applications pro-rata up to capacity by endowment and run test
     - 2.2 grant credit to passed applications
     - 2.3 credit + down-payment invested, i posted as collateral
  3. skilled investors who advertised r_0

     sample remaining good applications pro rata and (2.2)-(2.3)
  4. remaining endowments go to risk-free
- proceed to the next lowest advertised rate, if any

Many Bad Projects: Recession, Cool-off, Separation



Few Bad Projects: Boom, Overheating, Pooling

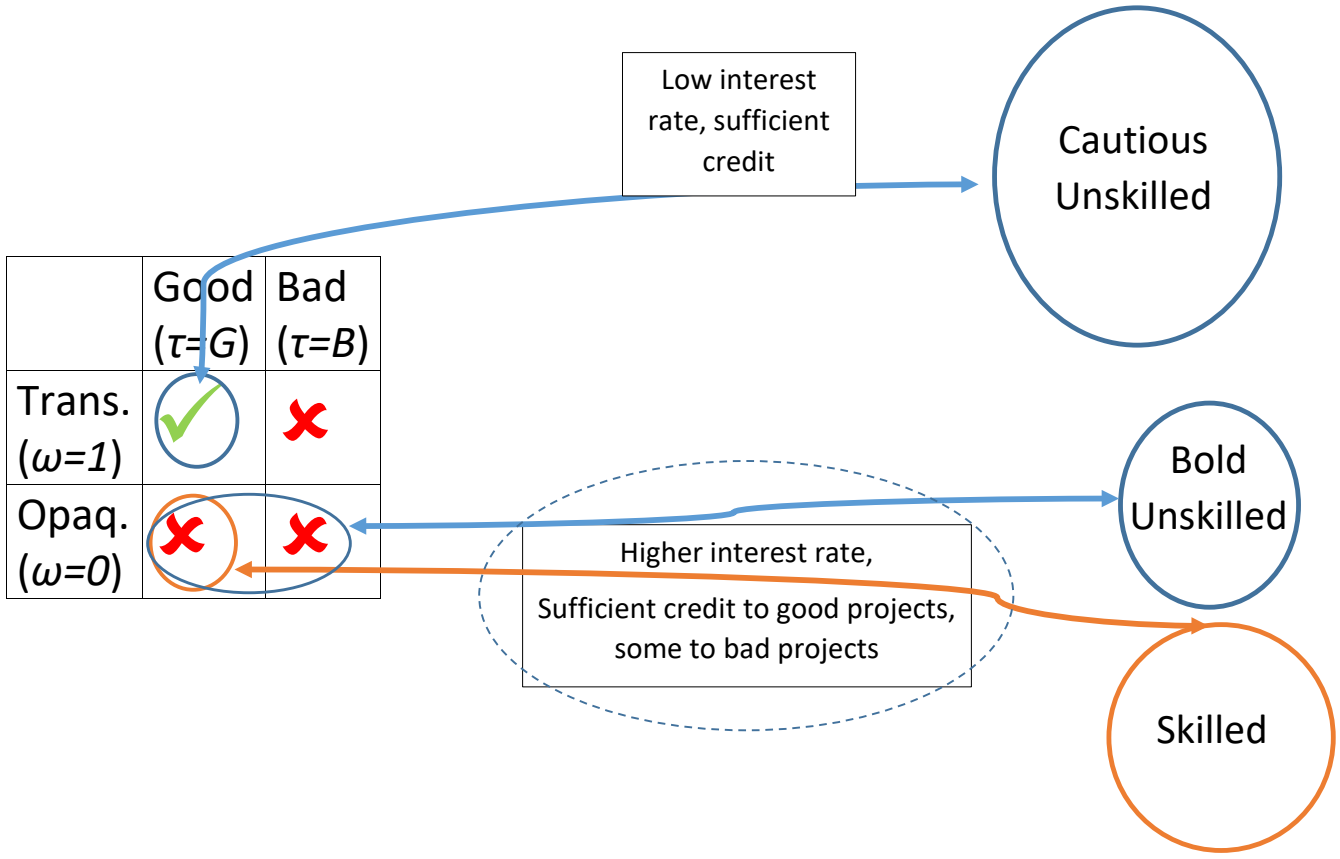


return

Double-Dip Recession

- not all recessions lead to a boom
  - some recessions are not sufficiently deep to trigger a purifying cautious stage
  - $\Rightarrow$ double-dip recession: another crash is needed to make recovery possible

THE MIX EQUILIBRIUM



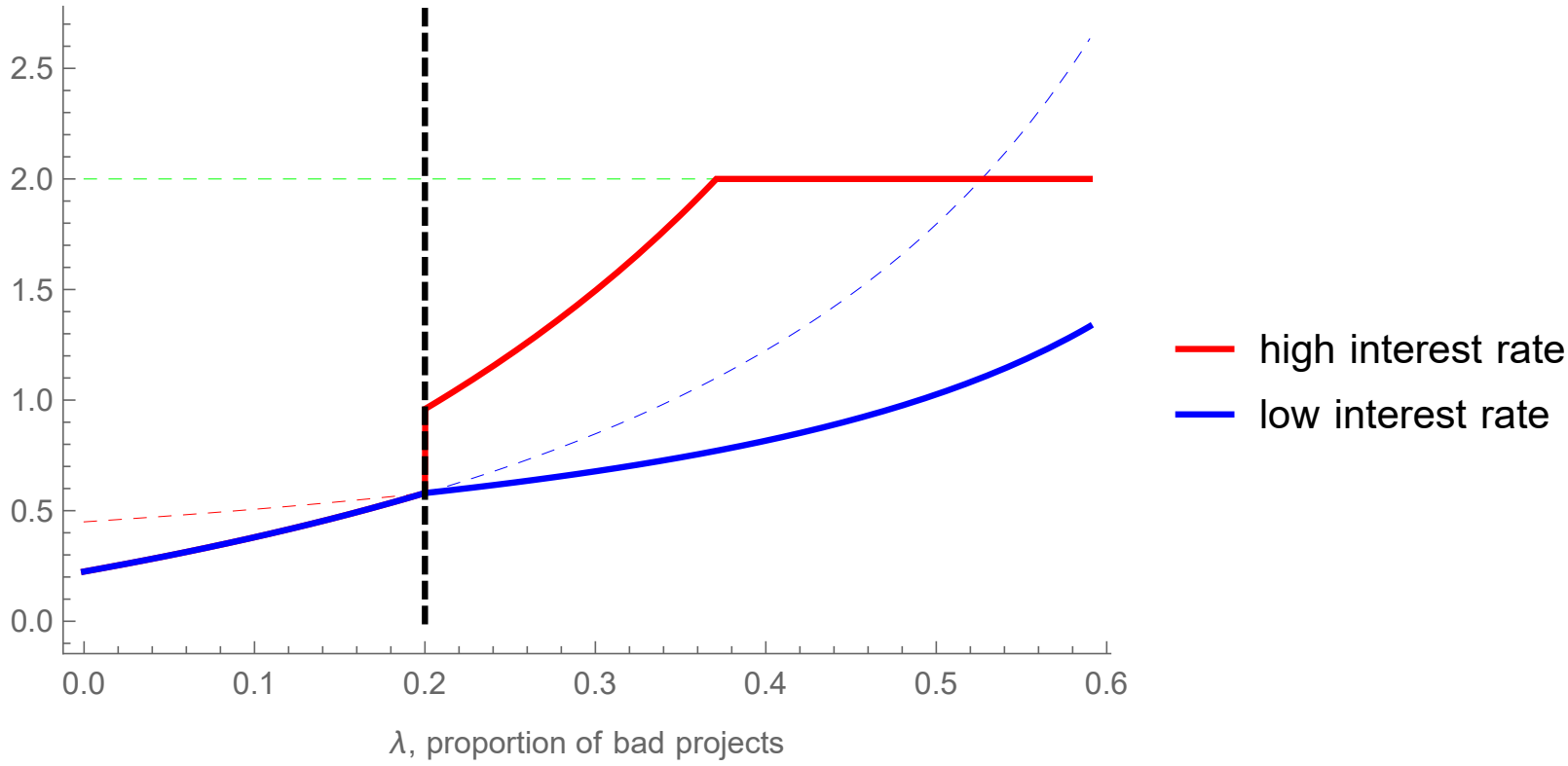
Mix equilibrium structure

3-STAGE ECONOMY: INTEREST RATE SCHEDULE

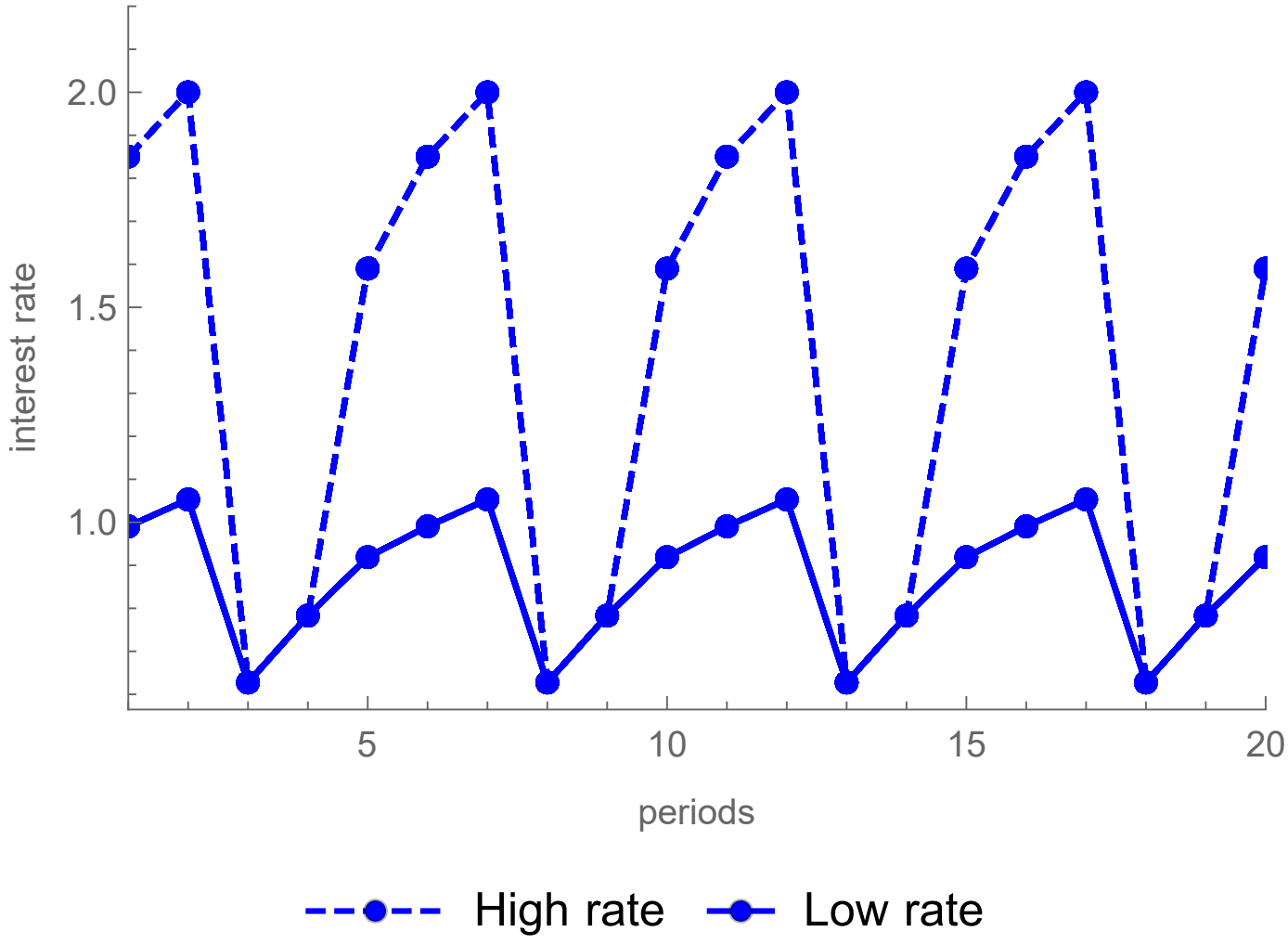
let $\tilde{\mu}_0(\mu_1) \equiv \frac{\bar{r}-r_f-c-\mu_1(\bar{r}+c-r_f)}{2+c+\bar{r}+r_f}$

1. there is a bold stage if $\mu_0 \in \left[0, \frac{c}{1+r_f}\right]$
2. there is a cautious stage if $\mu_0 \in \left[\max\{\frac{c}{1+r_f}, \tilde{\mu}_0(\mu_1)\}, 1\right]$
3. there is a mix stage if $\mu_0 \in \left[\frac{c}{1+r_f}, \max\{\frac{c}{1+r_f}, \tilde{\mu}_0(\mu_1)\}\right]$

3-STAGE ECONOMY: INTEREST RATE SCHEDULE

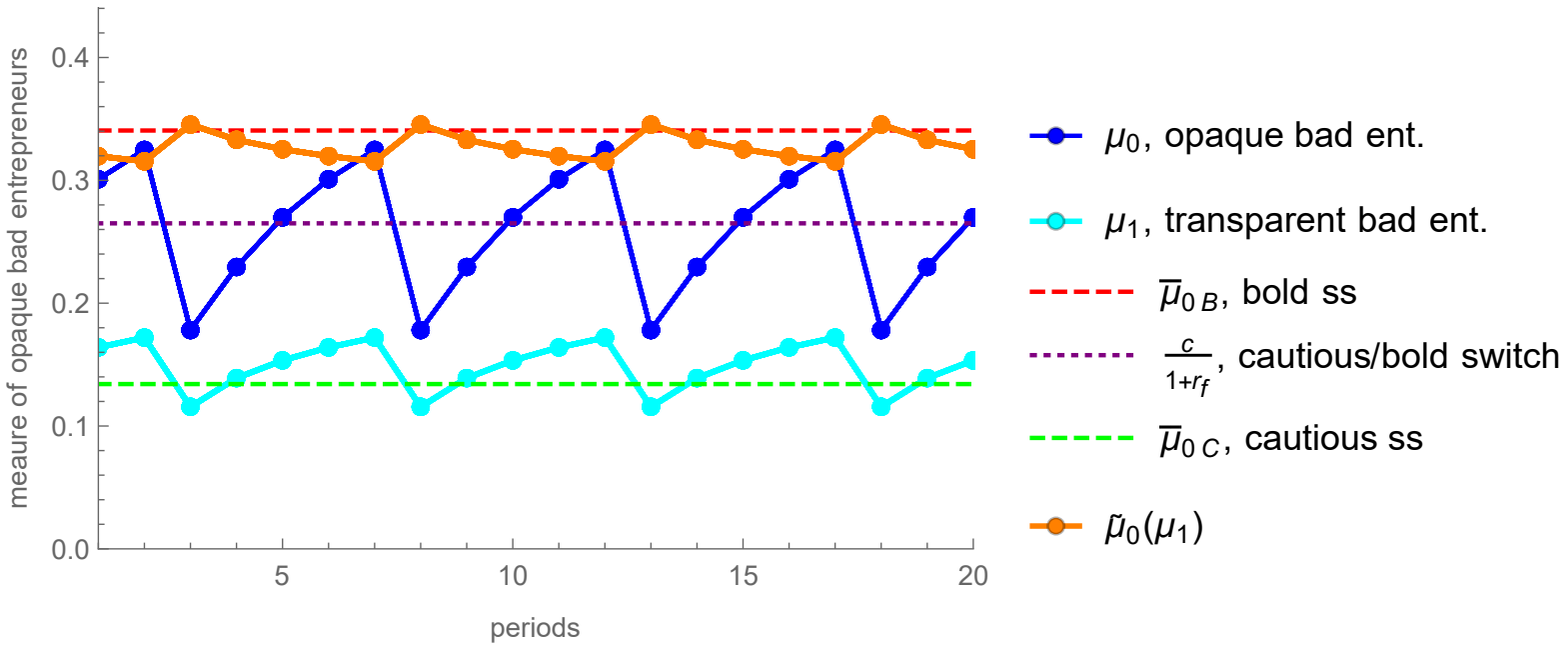


3-STAGE ECONOMY: INTEREST RATE



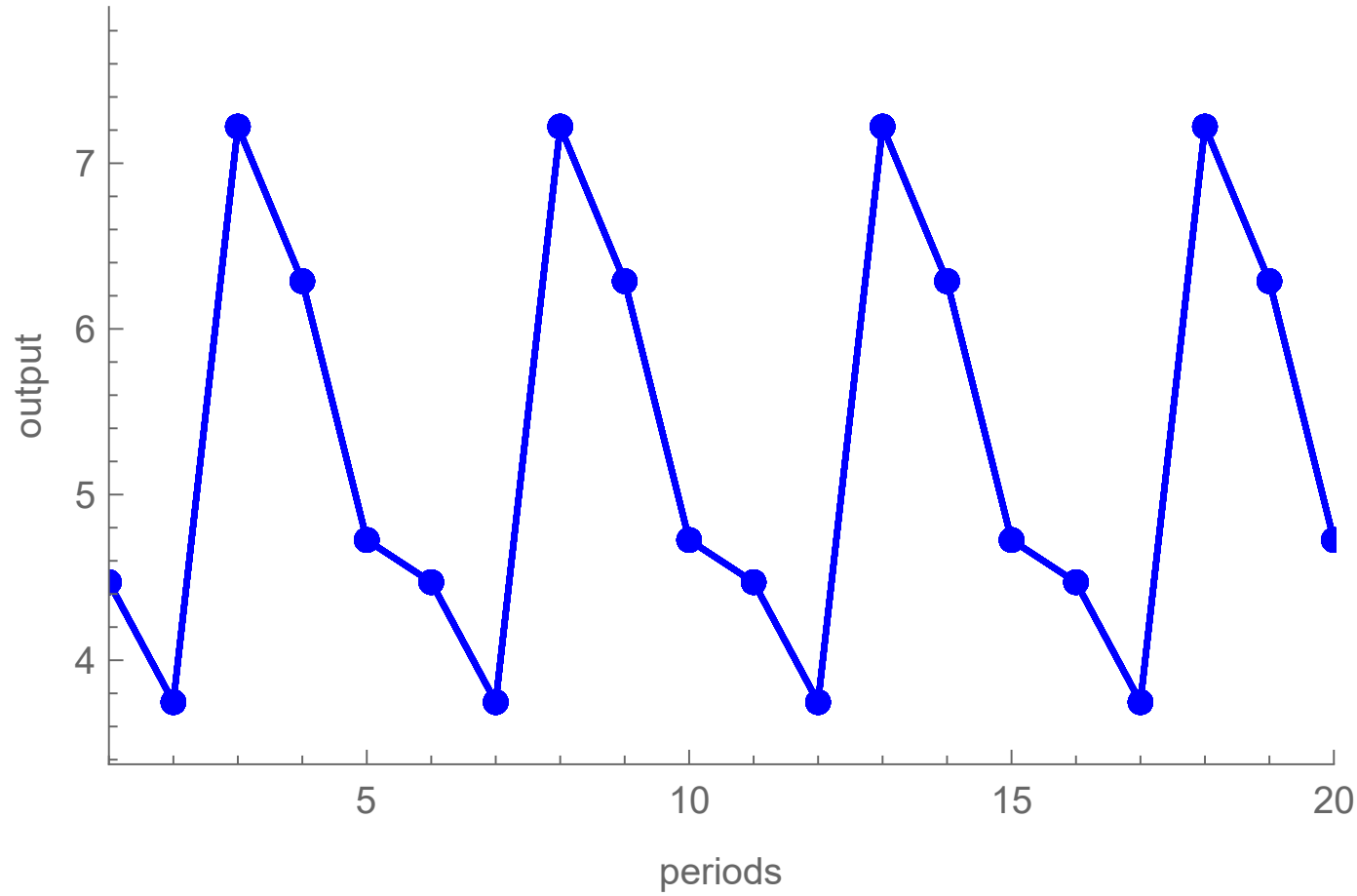
Return

3-STAGE ECONOMY: TYPE-DISTRIBUTION



◂ Return

3-STAGE ECONOMY: OUTPUT



◂ Return

PROPOSITION.
DYNAMIC EVOLUTION OF STATE VARIABLES

Assume $\min\{r_B, r_C\} < \bar{r}$.

1. $\mu_0 \in \left[0, \max\{\frac{c}{1+r_f}, \tilde{\mu}_0(\mu_1)\}\right]$

$$\mu_{0B}(\delta, \lambda, \mu_0, \mu_1) = (1-\delta)\mu_0 + \left(\delta + (1-\delta)\mu_1\right)\frac{\lambda}{2}$$

$$\mu_{1B}(\delta, \lambda, \mu_0, \mu_1) = \left(\delta + (1-\delta)\mu_1\right)\frac{\lambda}{2}$$

2. $\mu_0 \in [\max\{\frac{c}{1+r_f}, \tilde{\mu}_0(\mu_1)\}, 1]$

$$\mu_{0C}(\delta, \lambda, \mu_0, \mu_1) = \left(\delta + (1-\delta)(\mu_0+\mu_1)\right)\frac{\lambda}{2}$$

$$\mu_{1C}(\delta, \lambda, \mu_0, \mu_1) = \left(\delta + (1-\delta)(\mu_0+\mu_1)\right)\frac{\lambda}{2}$$

back

PROPOSITION. DYNAMIC EQUILIBRIUM

Consider $\bar{\mu}_{0B}(\delta,\lambda) > \mu^*_{0C}(\delta,\lambda) > \mu^*_{0B}(\delta,\lambda) > \bar{\mu}_{0C}(\delta,\lambda)$,

1. $\frac{c}{1+r_f} \geq \bar{\mu}_{0B}$: $\mu_0 \to \bar{\mu}_{0B}$
   degenerate ergodic distribution, permanent bold stage
2. $\frac{c}{1+r_f} < \bar{\mu}_{0C}$: $\mu_0 \to \bar{\mu}_{0C}$
   degenerate ergodic distribution, permanent cautious stage
3. $\mu^*_{0B} \leq \frac{c}{1+r_f} \leq \mu^*_{0C}$:
   ergodic distribution: two-point support, μ^*_{0C} and μ^*_{0B}.
   cycle between 1-period bold and 1-period cautious stage
4. $\mu^*_{0C} < \frac{c}{1+r_f} < \bar{\mu}_{0B}$:
   ergodic distribution: more than two points of support.
   multi-period bold stage ($\mu_0 \uparrow$), followed by a one-period cautious stage ($\mu_0 \downarrow\downarrow$)
5. $\bar{\mu}_{0C} \leq \frac{c}{1+r_f} < \mu^*_{0B}$:
   ergodic distribution: more than two points of support.
   multi-period cautious stage ($\mu_0 \downarrow$), followed by a one-period bold stage when ($\mu_0 \uparrow\uparrow$)

back

Output and Welfare

Proposition (Output)

When $r_B\left(\frac{c}{1+r_f}, \mu_1, c, r_f\right) < \bar{r}$*, total output jumps downward at* $\mu_0 = \frac{c}{1+r_f}$*, when the economy switches from the bold stage to the cautious stage in a two-stage economy.*

Proposition (Welfare)

Consider a two-stage economy. Welfare is decreasing in the measure of bad projects, μ_0*. There is a discontinuous drop in* $W(\mu_0, \mu_1)$ *at the threshold* $\mu_0 = \frac{c}{1+r_f}$*.*

Constraint Planner

Proposition (Cyclical Optimum)

Let $\lambda^{\min} \equiv \frac{2c+2r_f}{3c+3r_f+1} < \lambda^{\max} \equiv 2\frac{\rho-c-r_f-1}{2\rho-c-r_f-1}$, *and consider* $\lambda \in \left[\lambda^{\min}, \lambda^{\max}\right]$. *Then there exists a* $\bar{\delta}$ *such that for* $\delta < \bar{\delta}$, *the constrained planner's solution features endogenous cycles.*

back

POLICY

PROPOSITION (POLICY CYCLES)

Under policy profile π, the equilibrium is identical to decentralized equilibrium with adjusted interest rate functions $r_B^\pi(\mu_0, \mu_1, c, \pi), r_C^\pi(\mu_0, \mu_1, c, \pi)$, and $r_l^\pi(\mu_0, \mu_1, c, \pi)$, as well as $\hat{\mu}_0^\pi(\mu_1, c, \pi)$ and $\tilde{\mu}_0^\pi(\mu_1, c, \rho, \pi)$ as adjusted thresholds $\frac{c}{1+r_f}$ and $\tilde{\mu}_0(\mu_1, c, r_f, \rho)$.

Policy

Definition (Equivalent Policies)

Two policy profiles π and π' are equivalent (also to the planner's choice $\hat{\mu}_0^P$) if they imply the same ergodic distribution for the states (μ_0, μ_1).

Proposition (Macroprudential & Monetary Policy)

Consider a constraint optimal solution with more frequent cautious stages than the decentralized equilibrium.
Equivalent policies $\pi_{r_f^B}$ and π_x imply the same equilibrium interest rate for any entrepreneur in every stage.
The macroprudential policy delivers a slightly lower welfare than the countercyclical monetary policy.

back

PROPOSITION. STAGE GAME EQUILIBRIUM

There are $r_B(\mu_0, \mu_1, c, r_f) < r_C(\mu_0, \mu_1, c, r_f) < r_I(\mu_0, \mu_1, c, r_f) < \bar{r}$, and $\tilde{\mu}_0(\mu_1)$, such that if $\min\{r_B, r_C\} < \bar{r}$:

1. $\mu_0 \in [0, \frac{c}{1+r_f}]$: *bold stage*
   credit market: pooling equilibrium r_B
   every unskilled investor: bold test
   all good and some opaque bad: r_B
2. $\mu_0 \in [\max\{\frac{c}{1+r_f}, \tilde{\mu}_0(\mu_1)\}, 1]$: *cautious stage*
   credit market: separating equilibrium $(r_C, \bar{r})$
   every unskilled investor: cautious test
   transparent good: r_C, opaque good: $\bar{r}$, opaque bad: none
3. $\mu_0 \in [\frac{c}{1+r_f}, \max\{\frac{c}{1+r_f}, \tilde{\mu}_0(\mu_1)\}]$: *mix stage*
   credit market: semi-separating equilibrium (r_C, r_I)
   Some unskilled investors bold test, some cautious test
   transparent good: r_C, opaque good and bad: r_I

Otherwise: autarky.

back