Rational Sentiments and Economic Cycles

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July 07 2020

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

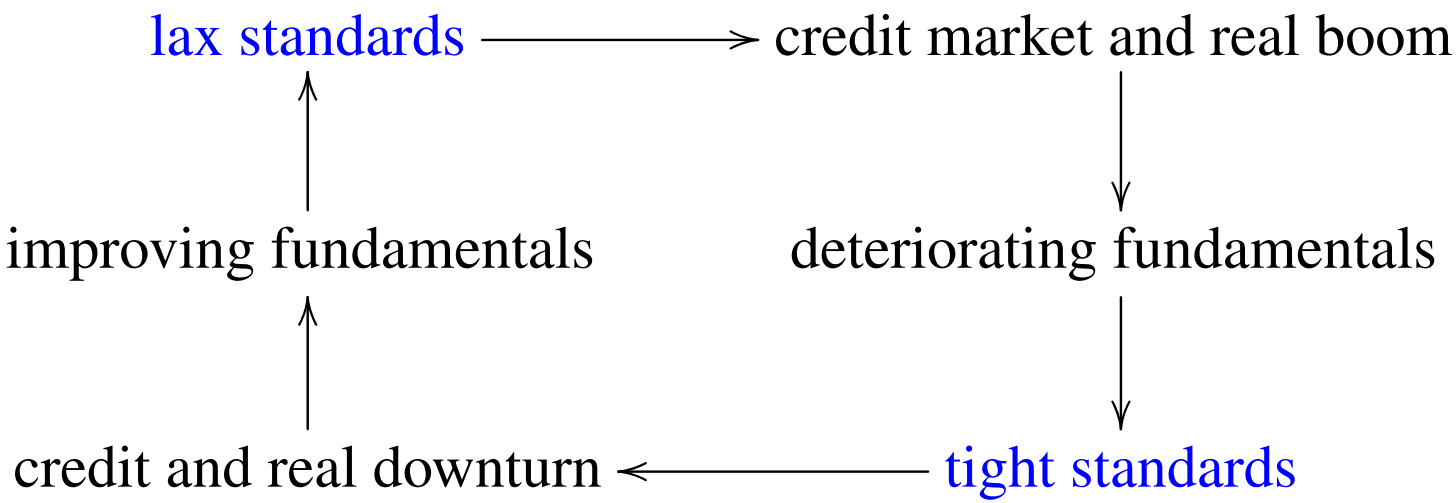
    low credit market sentiments
  - low output, negative output growth

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

DYNAMIC EQUILIBRIUM

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

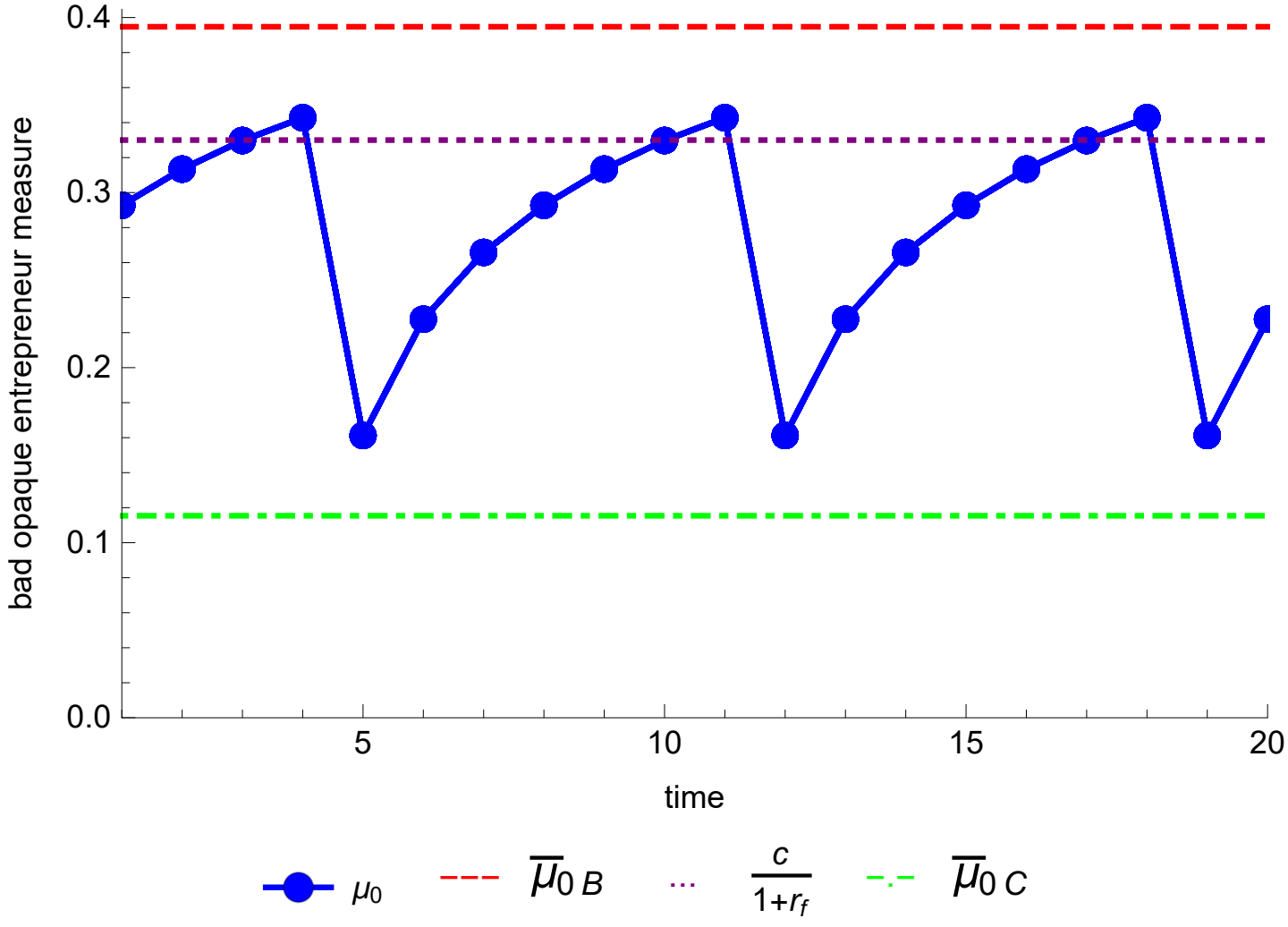
     bad entrepreneurs die at higher rate (no credit)

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

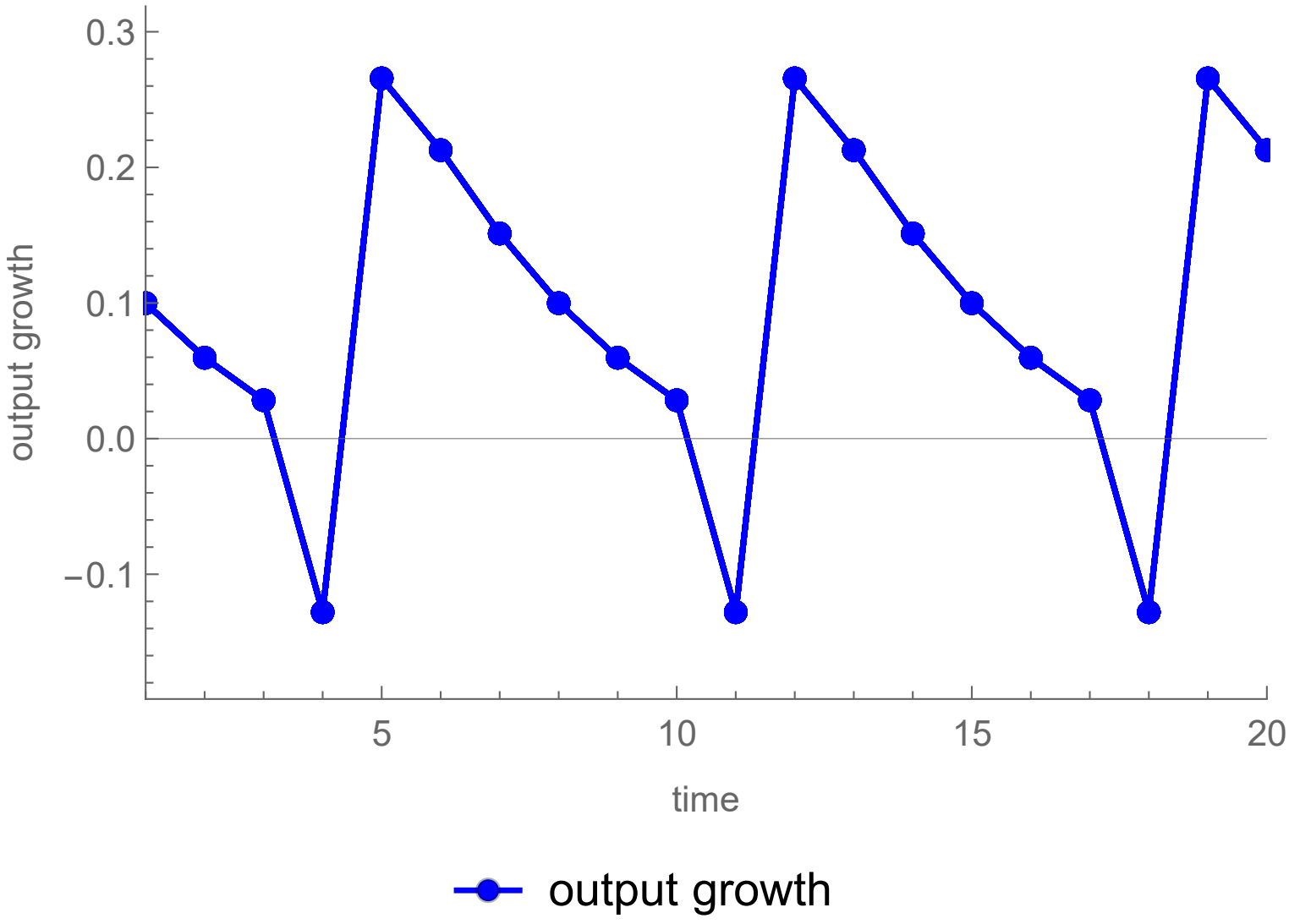
$$\bar{\mu}_C < \frac{c}{1+r_f} < \bar{\mu}_B\text{: cycle}$$

Cycling Type Distribution.

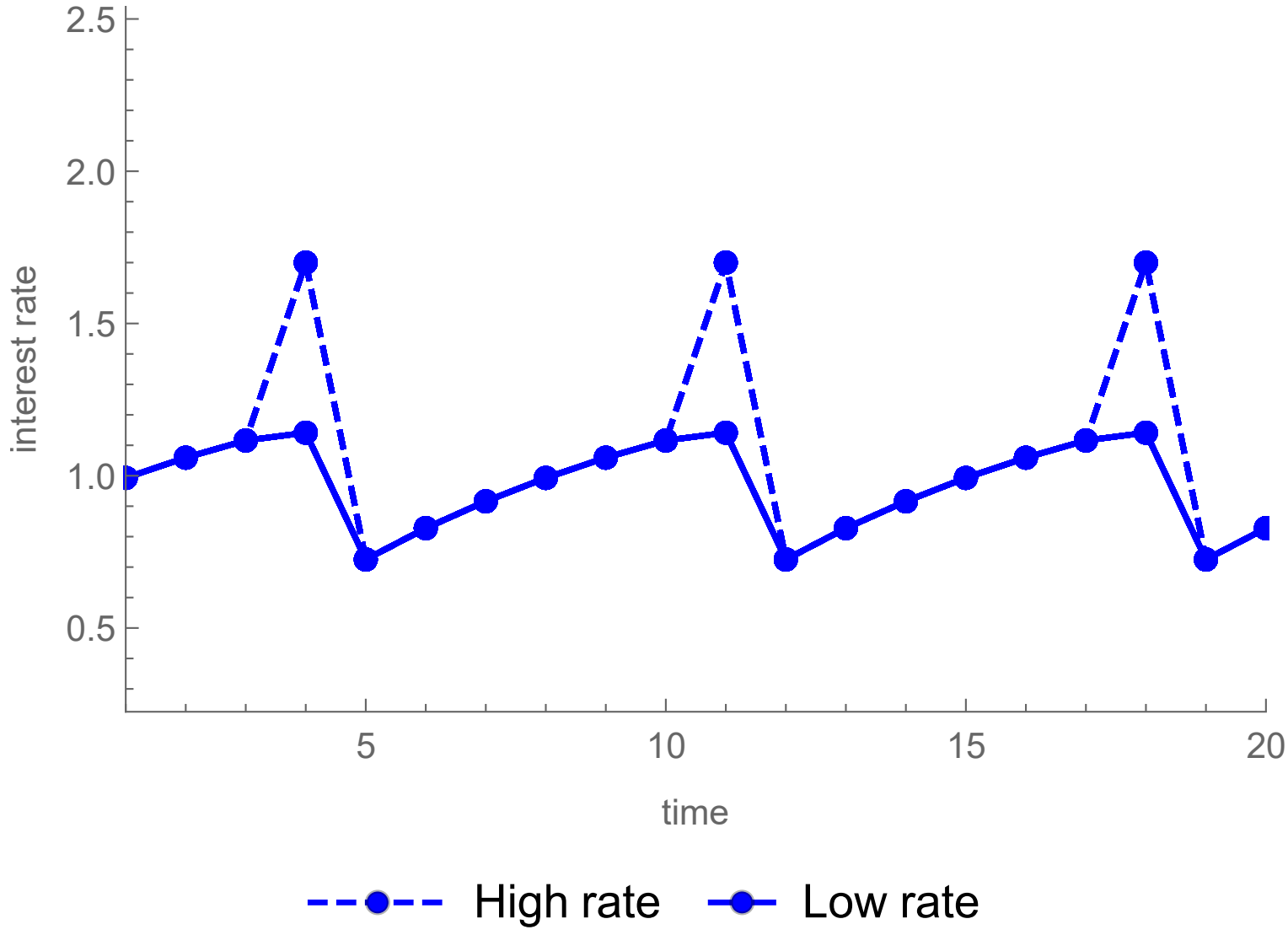
Measure of bad opaque entrepreneurs



Cycling Output Growth



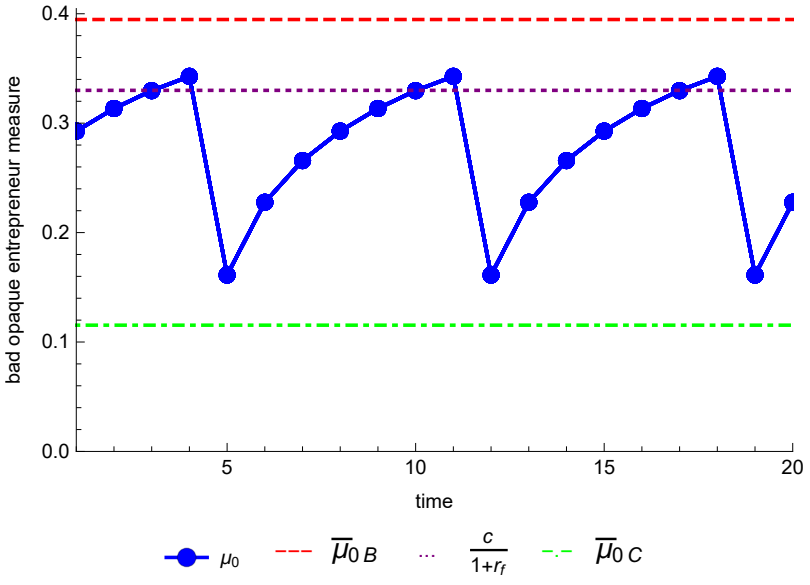
Cycling Credit Spread



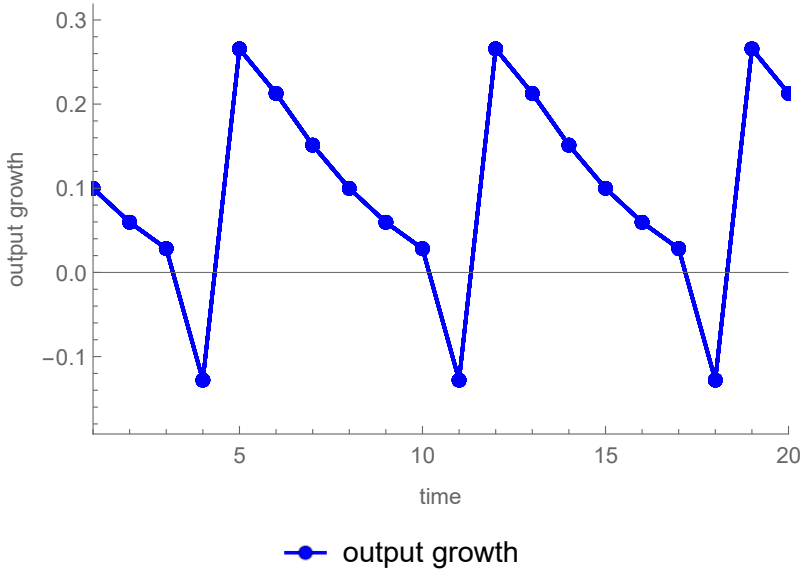
Three Major Classes of Cycles

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

Normal Expansion and Contraction

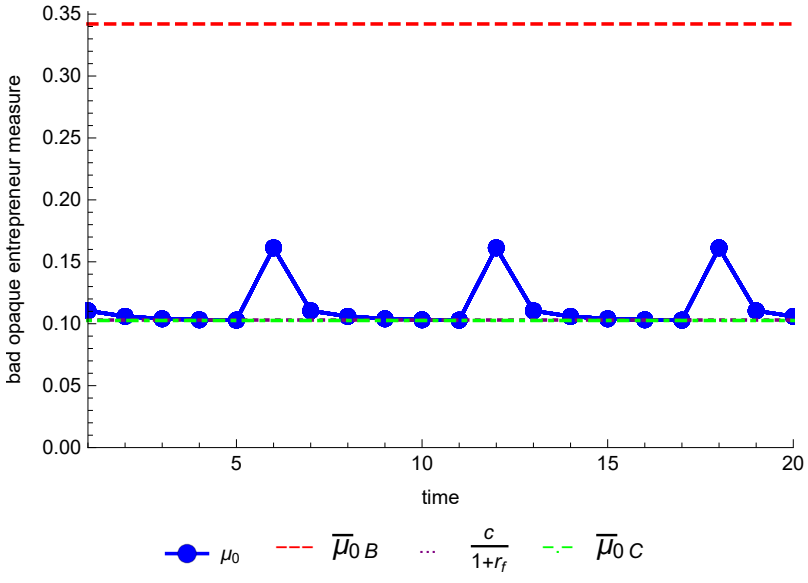


(A) state variable μ_0

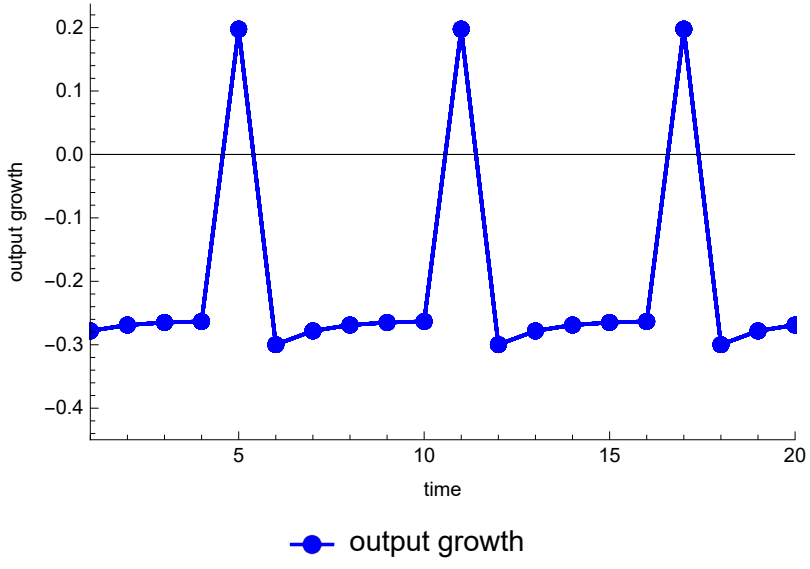


(B) output growth

PROLONGED RECOVERY

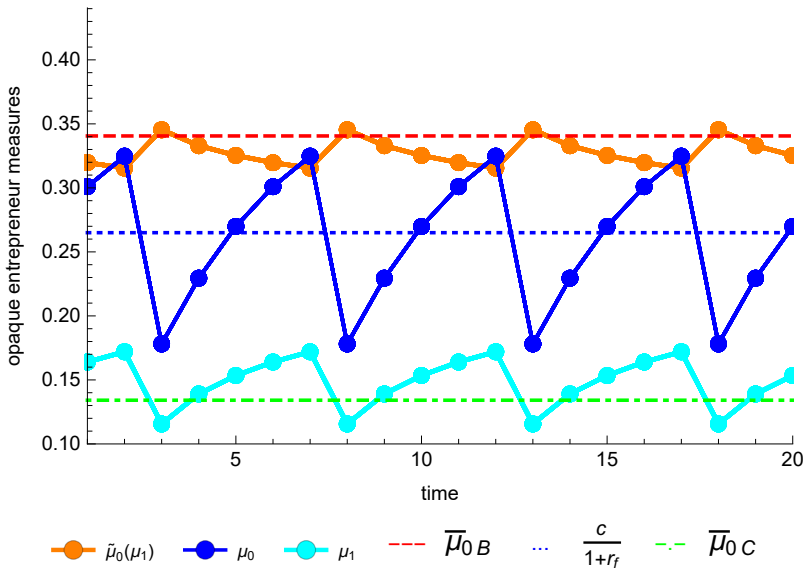


(A) state variable μ_0

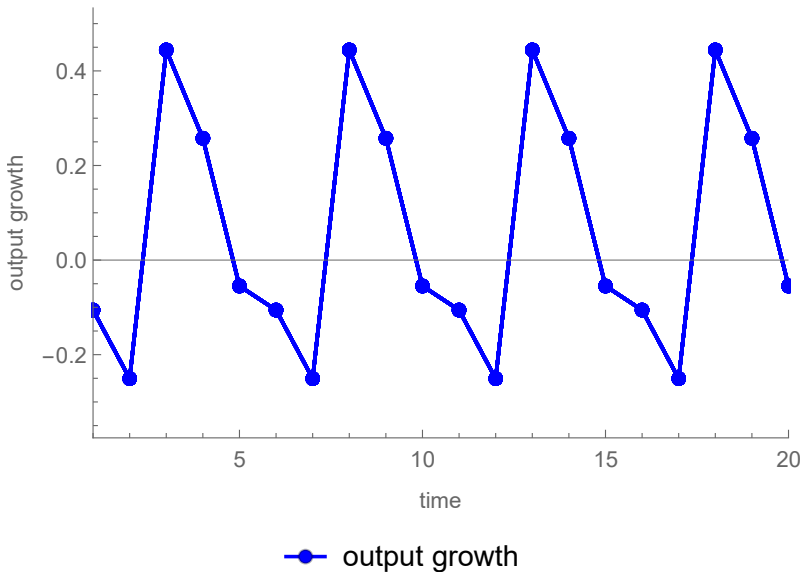


(B) output growth

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

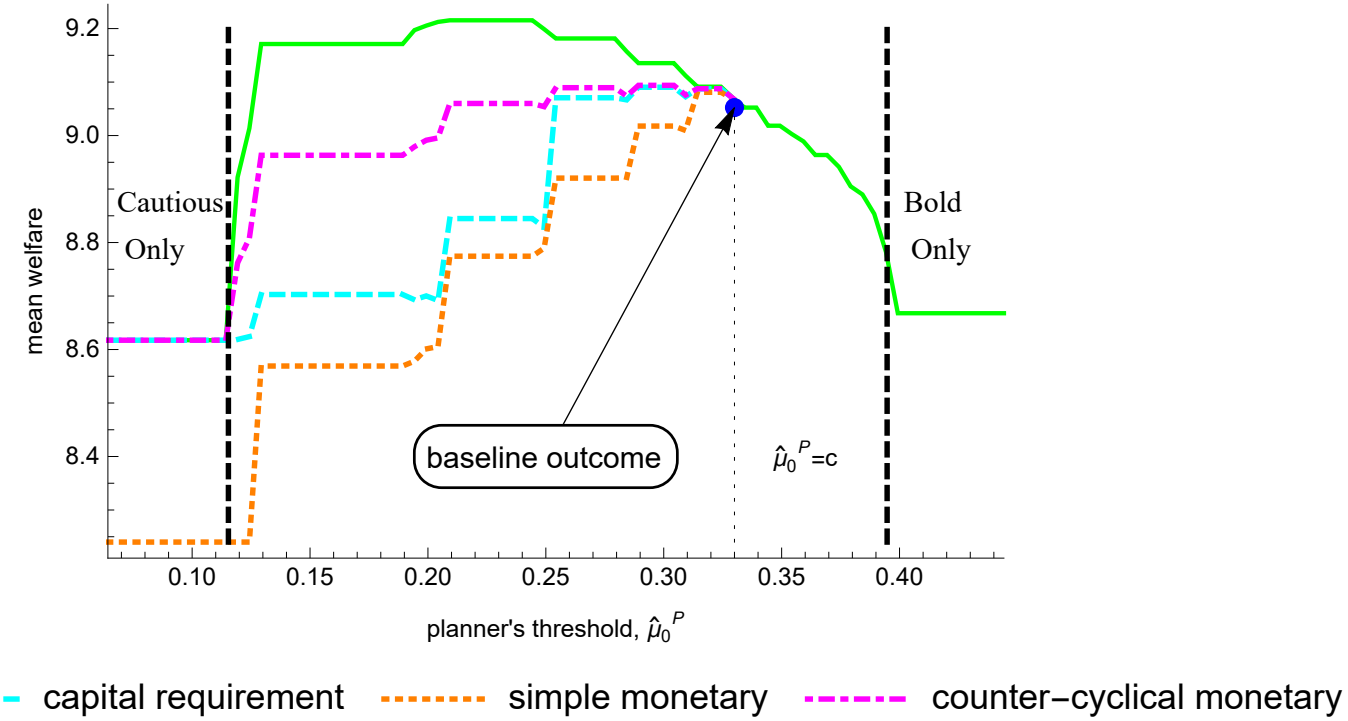
    $\Rightarrow$ makes boom more welfare enhancing
  - individual investor does not internalize her effect on the evolution of state

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?

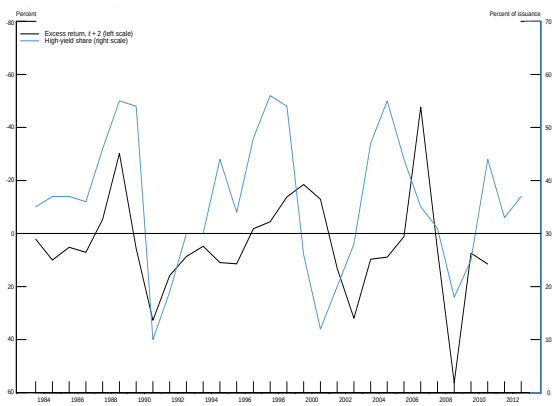
Optimal Cycles and Economic Policy



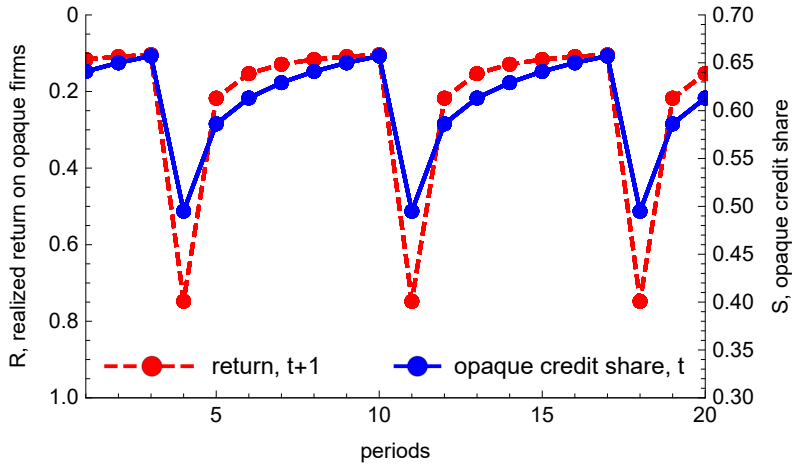
Equilibrium, Planner, and Policy Outcomes

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)

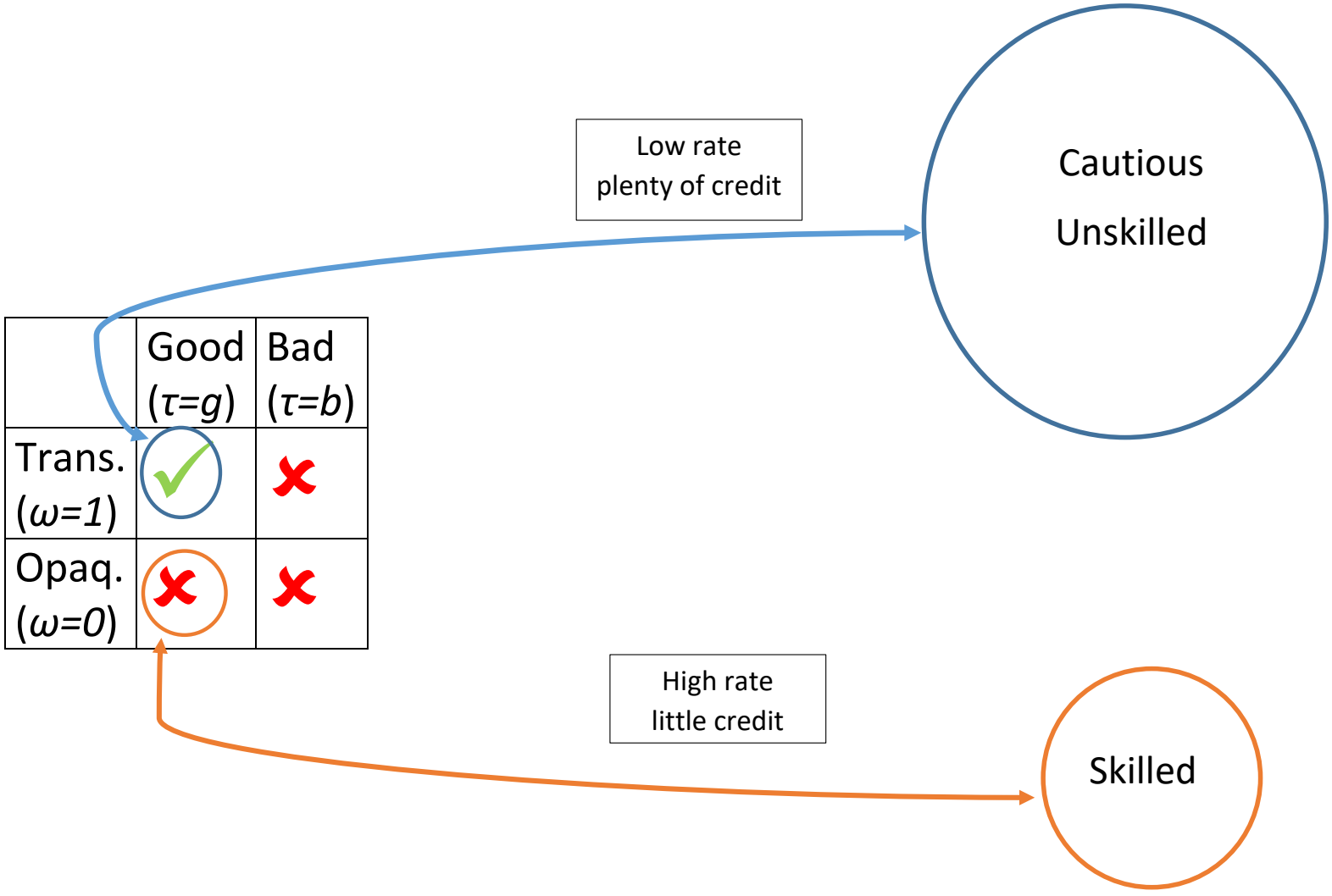
CREDIT MARKET

sampling and market clearing

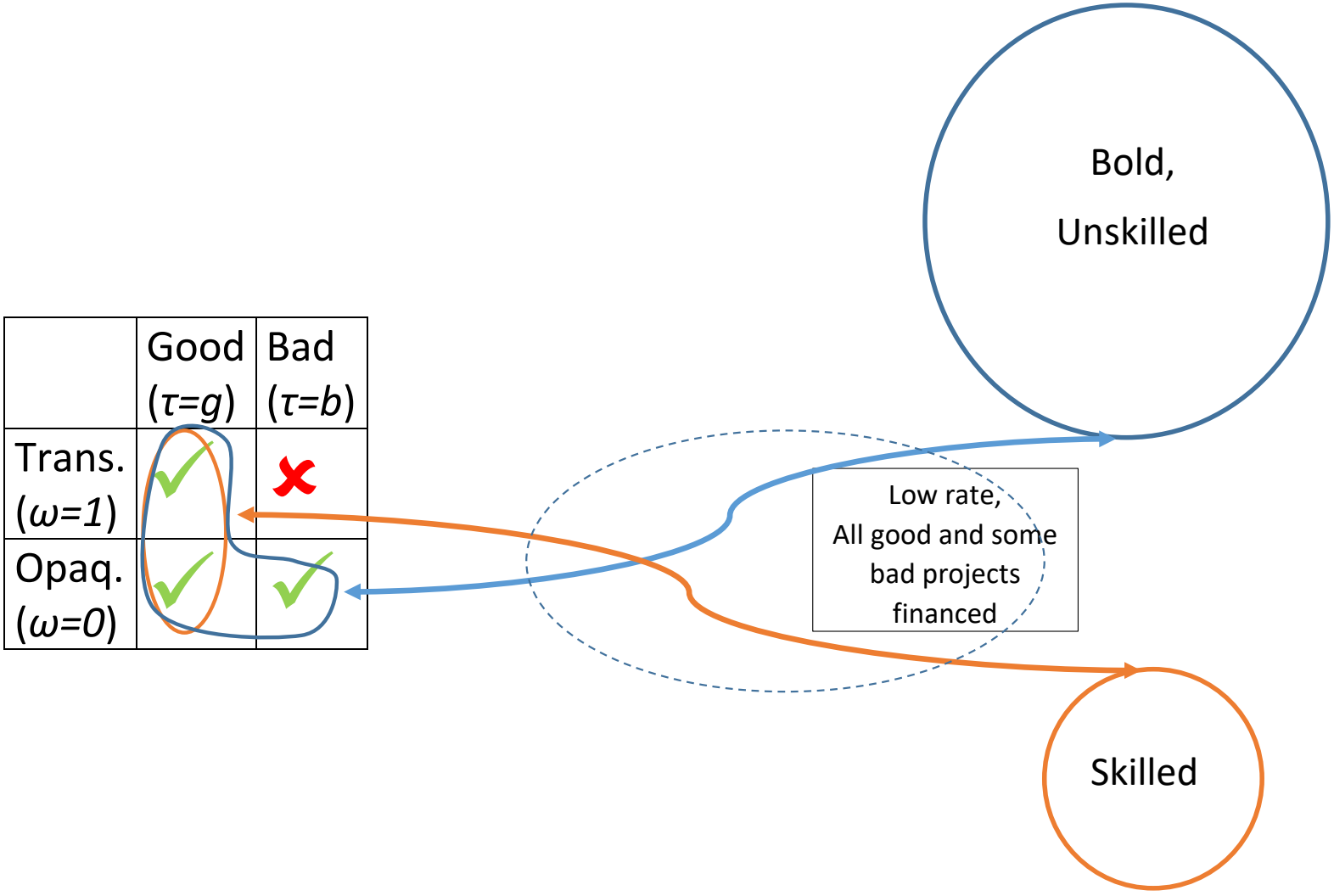
- start at the smallest advertised rate, r_0
  1. each entrepreneur with $\sigma(r_0, \tau, \omega) > 0$ has posted r_0 down-payment per application
  2. unskilled investors who advertised r_0
     - 2.1 sample applications pro-rata up to capacity by endowment and run test
     - 2.2 grant credit to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

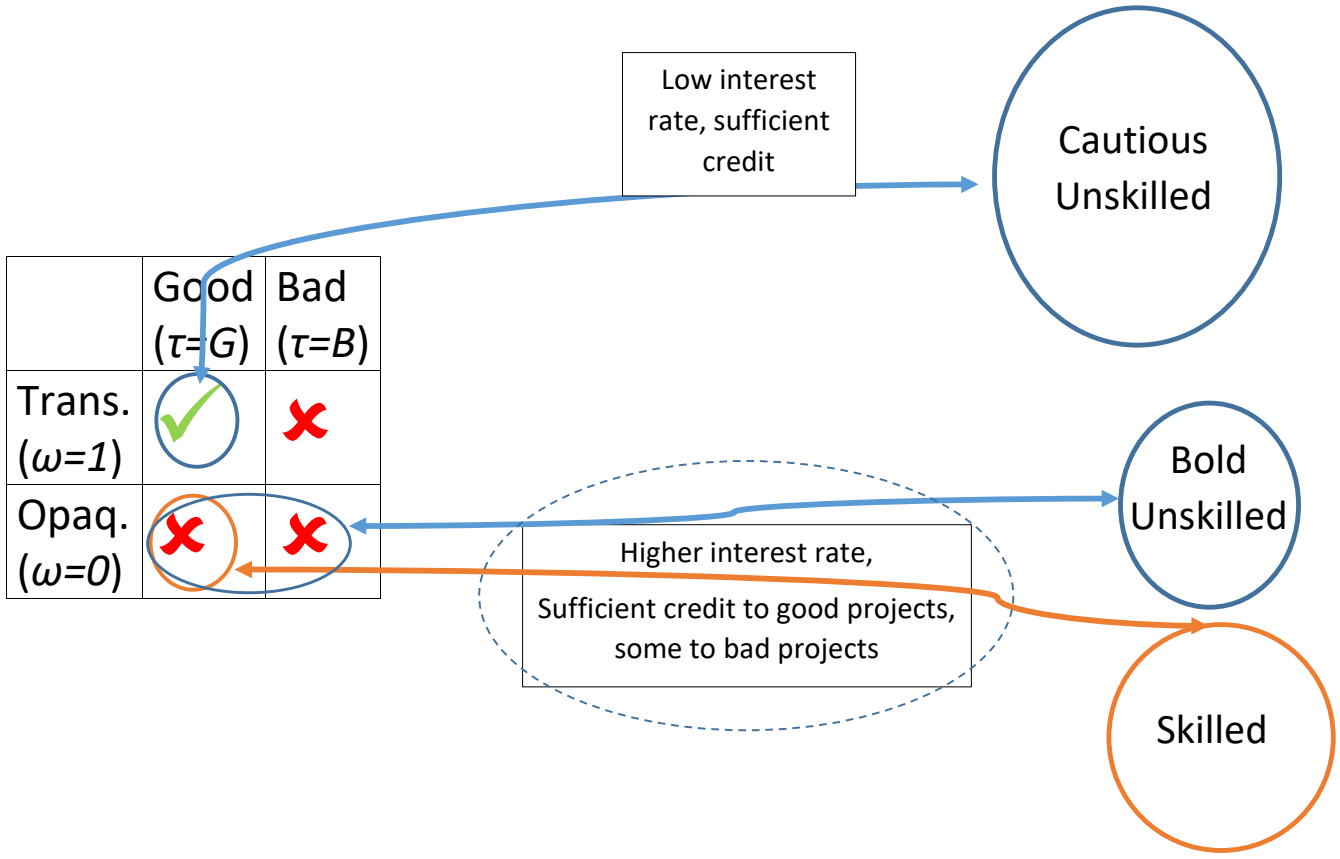


return

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



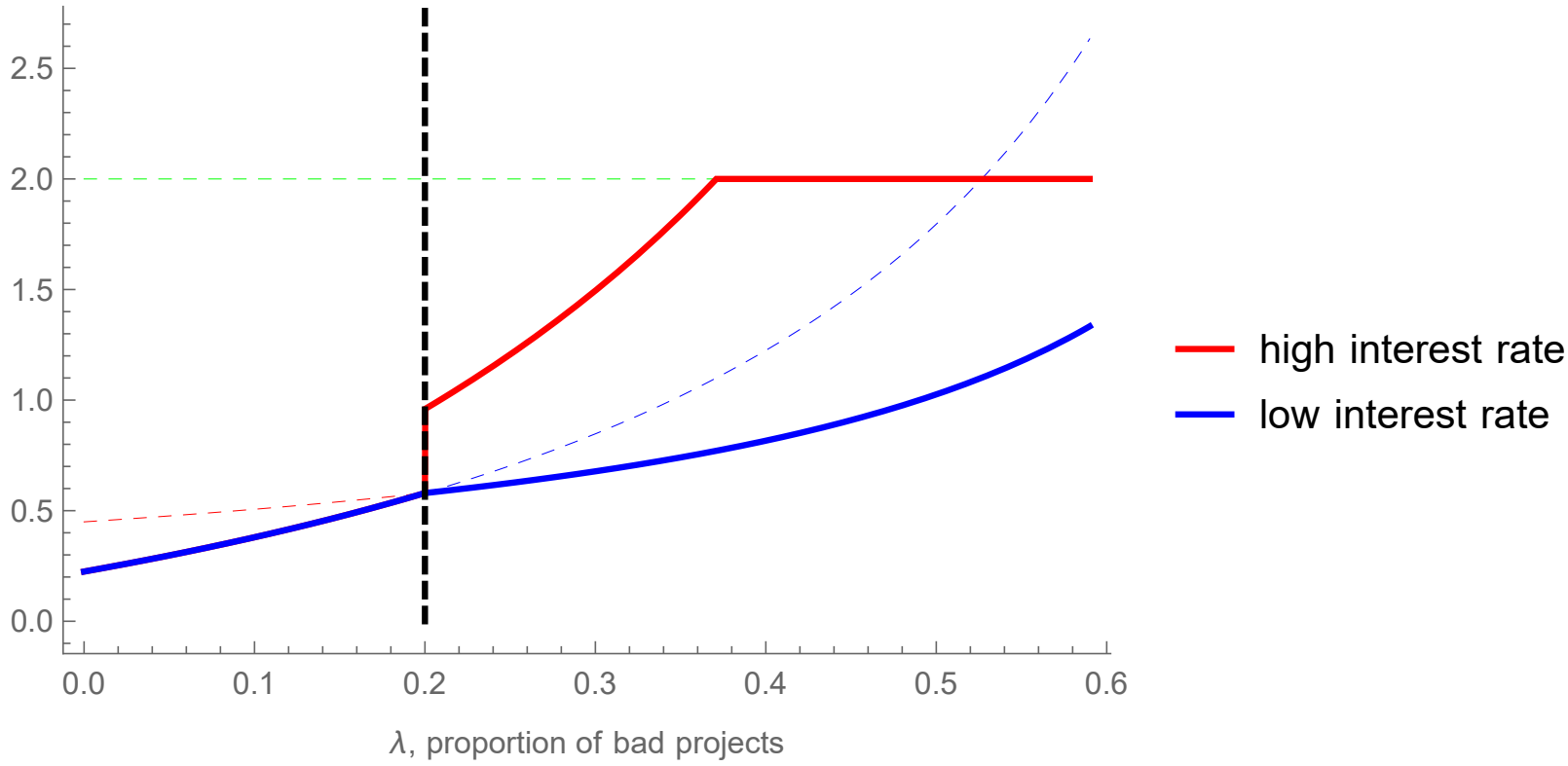
Mix equilibrium structure

3-STAGE ECONOMY: INTEREST RATE SCHEDULE

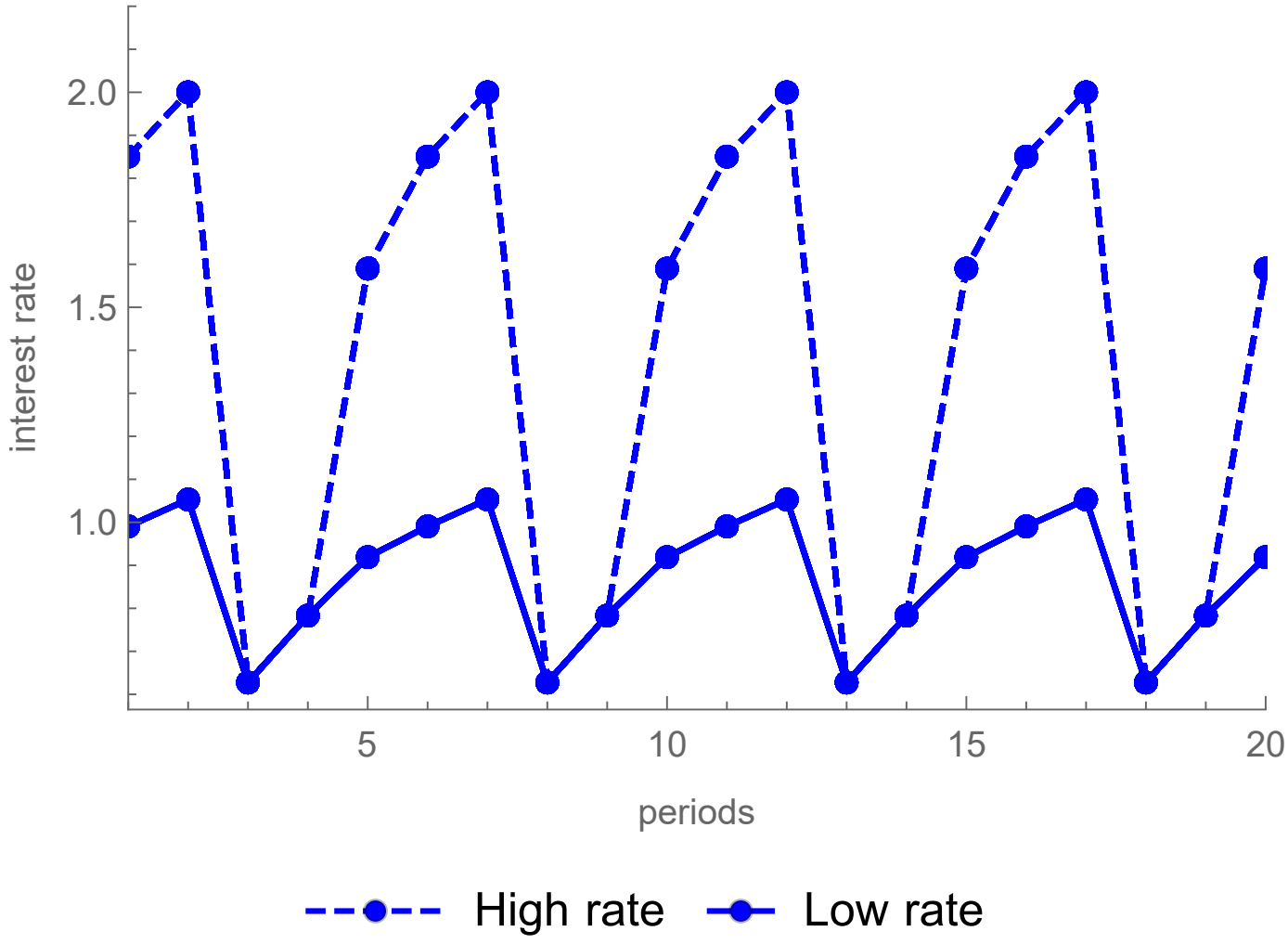
let $\tilde{\mu}_0(\mu_1) \equiv \frac{\bar{r}-r_f-c-\mu_1(\bar{r}+c-r_f)}{2+c+\bar{r}+r_f}$

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

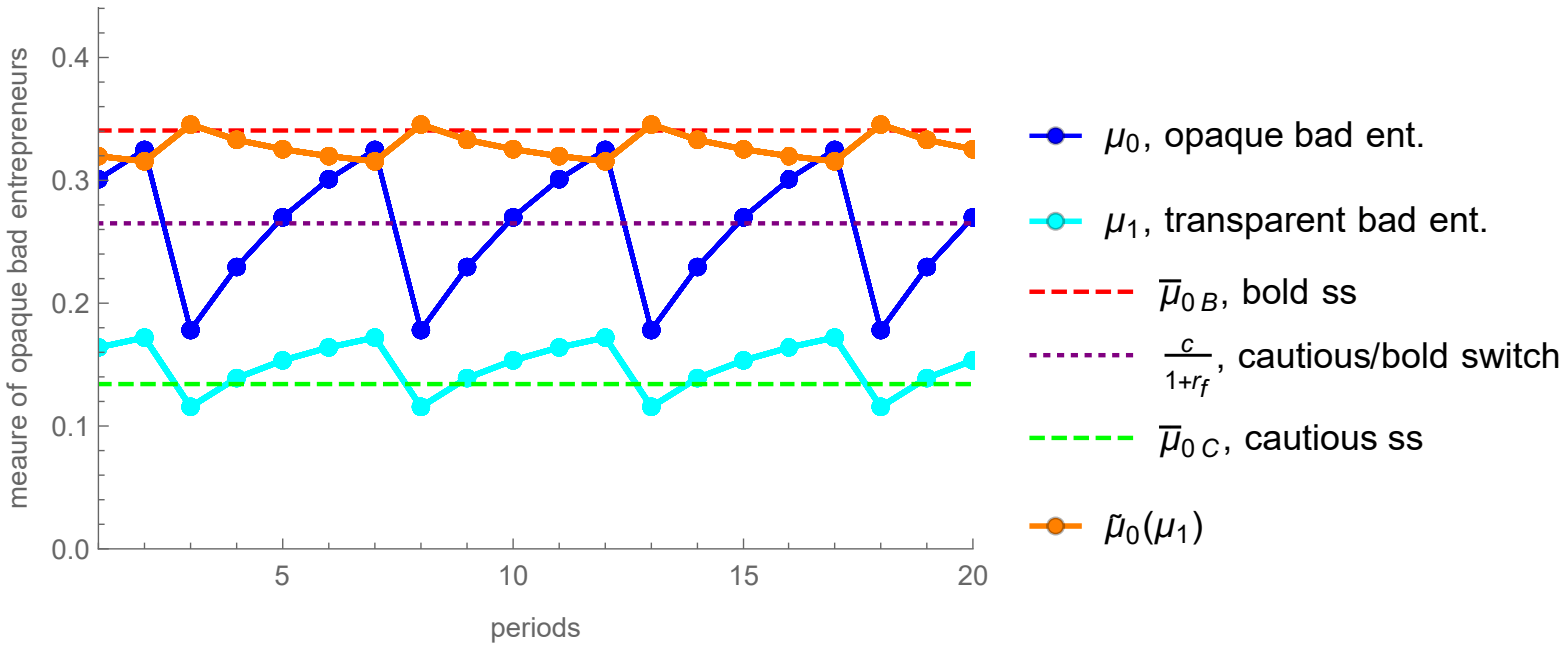


3-STAGE ECONOMY: INTEREST RATE



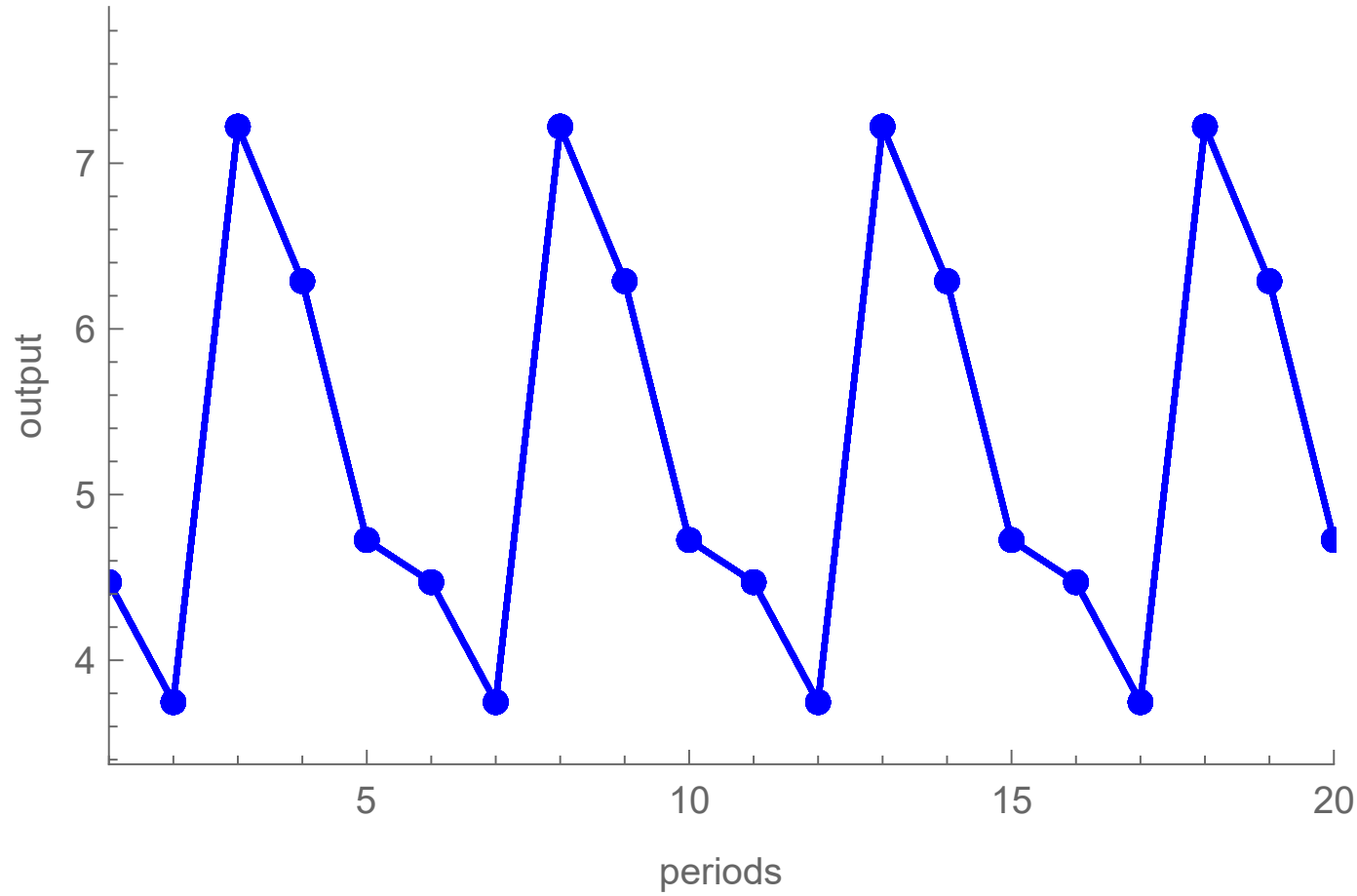
Return

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