# Adverse Selection, Slow Moving Capital and Misallocation

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# Motivation

To maximize efficiency, resources need to be allocated efficiently. Yet,

- Resource misallocation is costly and widespread
  - → especially during recessions and in developing countries.
- "Capital" moves slowly in response to shocks.

*What inhibits the efficient allocation of resources and generates slow movements in capital flows?*

- Literature typically assumes exogenous adjustment cost.
  - → Recent work argues these costs vary over time and the business cycle.

*What do these costs represent? Why do they vary over time?*

# This paper

**Main Idea**

- A theory of misallocation and slow movements in capital reallocation based on adverse selection.

**How it Works?**

- Starting point: "capital" reallocation requires market transactions.
  - → Physical, human, financial or existing matches (e.g., firm division)
- The equilibrium involves inefficient delays in these transactions.
  - → Capital is heterogeneous.
  - → Capital owners are better informed.
  - → Will be more anxious to sell less profitable capital units.

# Our Contribution

Incorporate adverse selection into a dynamic GE model

- Leads to endogenous reallocation cost and persistence in aggregate quantities

**Our focus:** How does equilibrium reallocation depend on the economic environment?

- Lower interest rates slows down reallocation
- More volatile shocks mitigate consequences of adverse selection.
  → Speed up reallocation.
- Consumption smoothing motives also speed up reallocation
  → Larger downturns followed by faster recoveries
- Hedging motives can halt reallocation entirely
  → Capital remains persistently misallocated.

# Our Contribution

Also provides a micro-foundation for convex adjustment costs.

- Equilibrium dynamics resemble those in convex adjustment cost models.
- Dynamics are pinned down by economic primitives.
  - → resembles 'i-dot' models if innovations and quality are complements
  - → resembles 'k-dot' models if they are substitutes

**One advantage:** Link changes in adjustment costs to changes in the economic environment e.g.,

- Higher productivity dispersion exacerbates consequences of adverse selection and slows down reallocation
  - → corresponds to higher adjustment costs
  - → consistent with empirical evidence

# The environment

- Two distinct **locations** $\ell \in \{A, B\}$.
  - → Could represent sectors, industries, physical locations
- Mass $M > 1$ of **firms** in each location
  - → Firms can operate capital only in their own location
- Unit mass of "**capital**" of varying quality: $\theta \sim F$ on $[\underline{\theta}, \overline{\theta}]$
  - → Quality is privately observed by owner of capital
- **Output** depends on capital quality $\theta$ and location

$$dy_\ell(\theta) = \pi_\ell(\theta)dt, \qquad \text{where } \pi'_\ell > 0$$

  - → Sector $B$ is more productive, but capital initially **allocated** to sector $A$.
- Fixed discount rate, $r$ (for now)

# Reallocation via markets

- To reallocate capital, trade must occur.
- Firms can trade capital in a spot market.
- Market is open continuously.
  - → No search, transactions, or adjustment costs.
- The information friction
  - → Capital is heterogeneous in quality: $\underline{\theta} < \overline{\theta}$
  - → Quality is privately observed by owner.
  - → Lemons condition

$$\pi_A(\overline{\theta}) > \int \pi_B(\theta) dF(\theta)$$

# Equilibrium

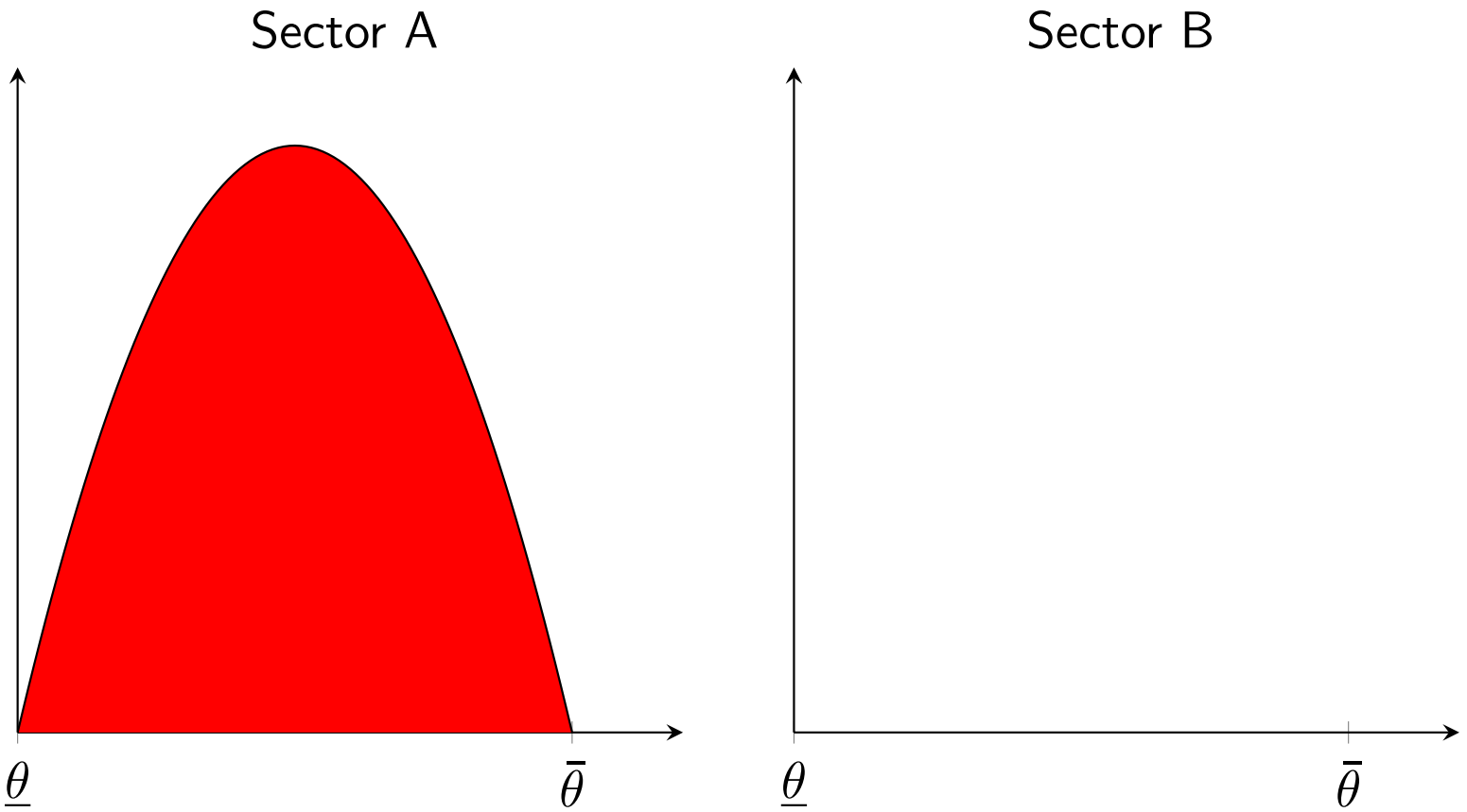
- Firms in A optimally choose when to sell capital. Their tradeoff
  - → Sell now: Capture productivity gains in new sector
  - → Sell later: Potentially get a better price
- Firms in B are competitive.
  - → Value capital at $V(\theta) = \pi_B(\theta)/r$ for $\theta$-unit
- Equilibrium
  1. Sector $A$ firms optimize given prices
  2. Sector $B$ firms break even given $A$ firms' policy
  3. Market clearing

# Equilibrium properties

- First-best reallocation is not an equilibrium.
  - → Sector $A$ firms with highest quality capital prefer not to trade.
- No atoms at $t = 0$.
  - → Prices would jump...also not an equilibrium.
- Equilibria must satisfy the **skimming property**:
  - → If it is optimal for $\theta$ to trade at time $t$, then strictly optimal for all $\theta' < \theta$ to trade at (or before) time $t$.
- Therefore, the lowest type of capital remaining in $A$ at time $t$, denoted by $\chi_t$, must weakly be increase over time.
  - → We construct an equilibrium in which it is strictly increasing.
  - → Type is "revealed" at the time of sale

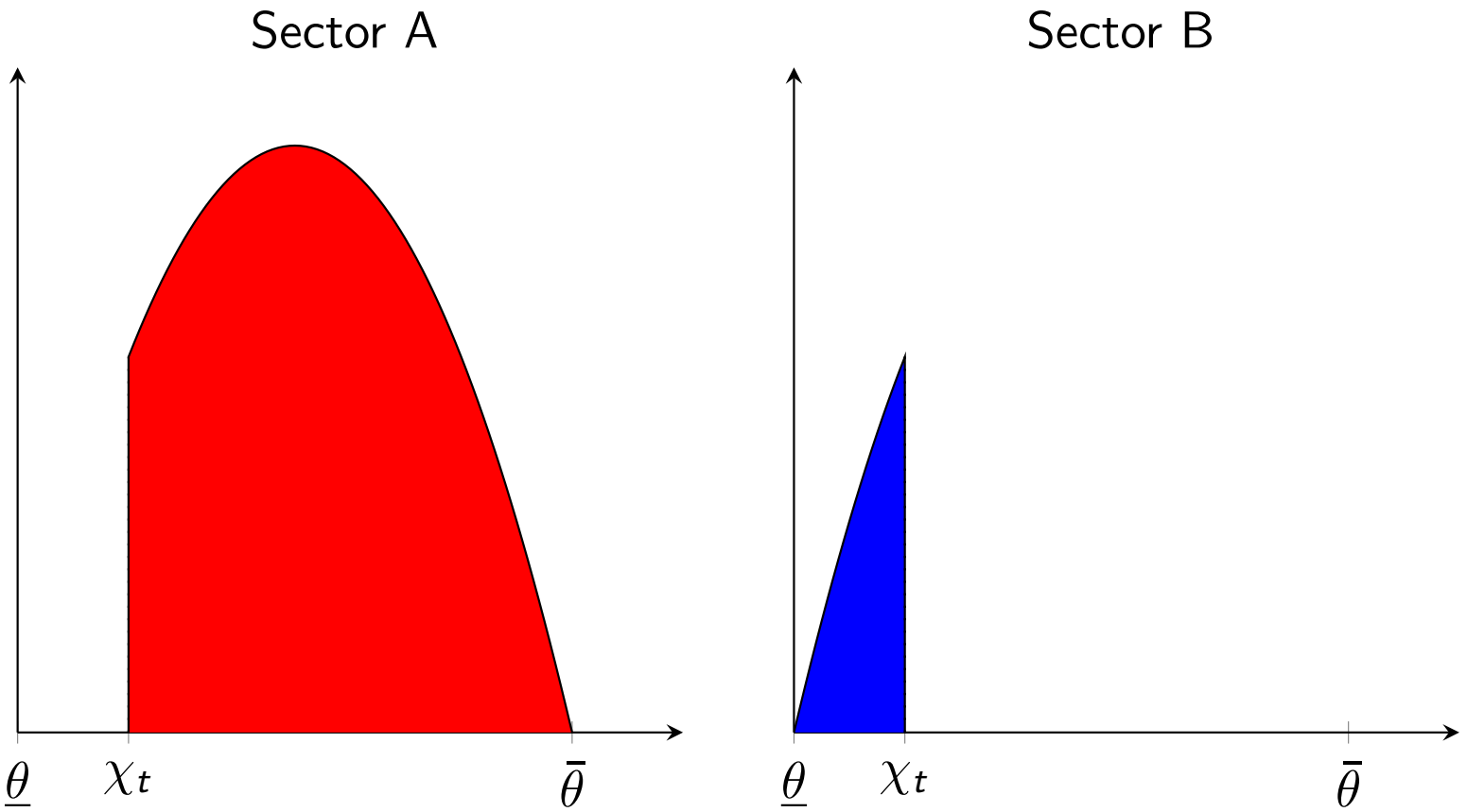
# Equilibrium dynamics

At $t = 0$:



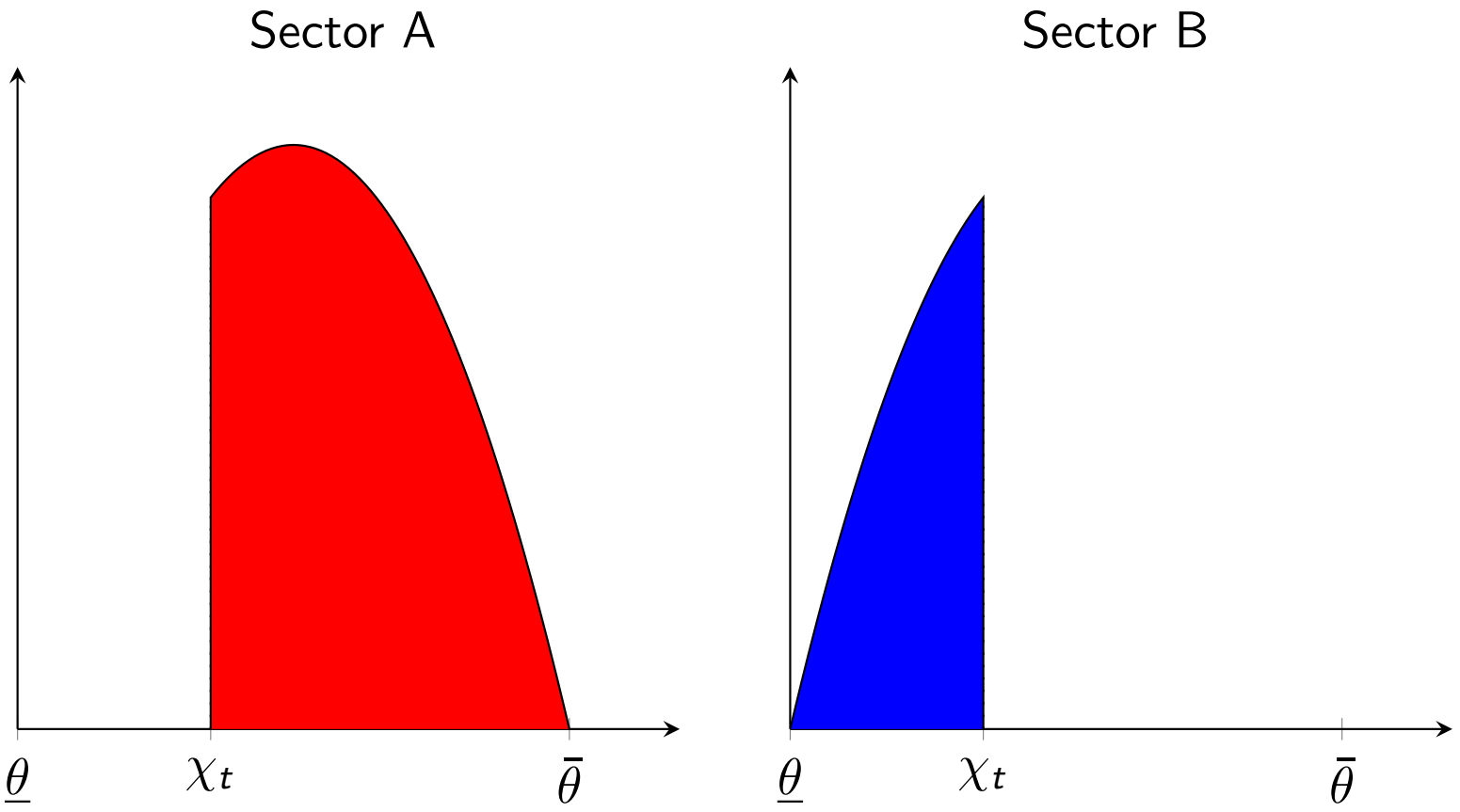
# Equilibrium dynamics

As $t$ increases:



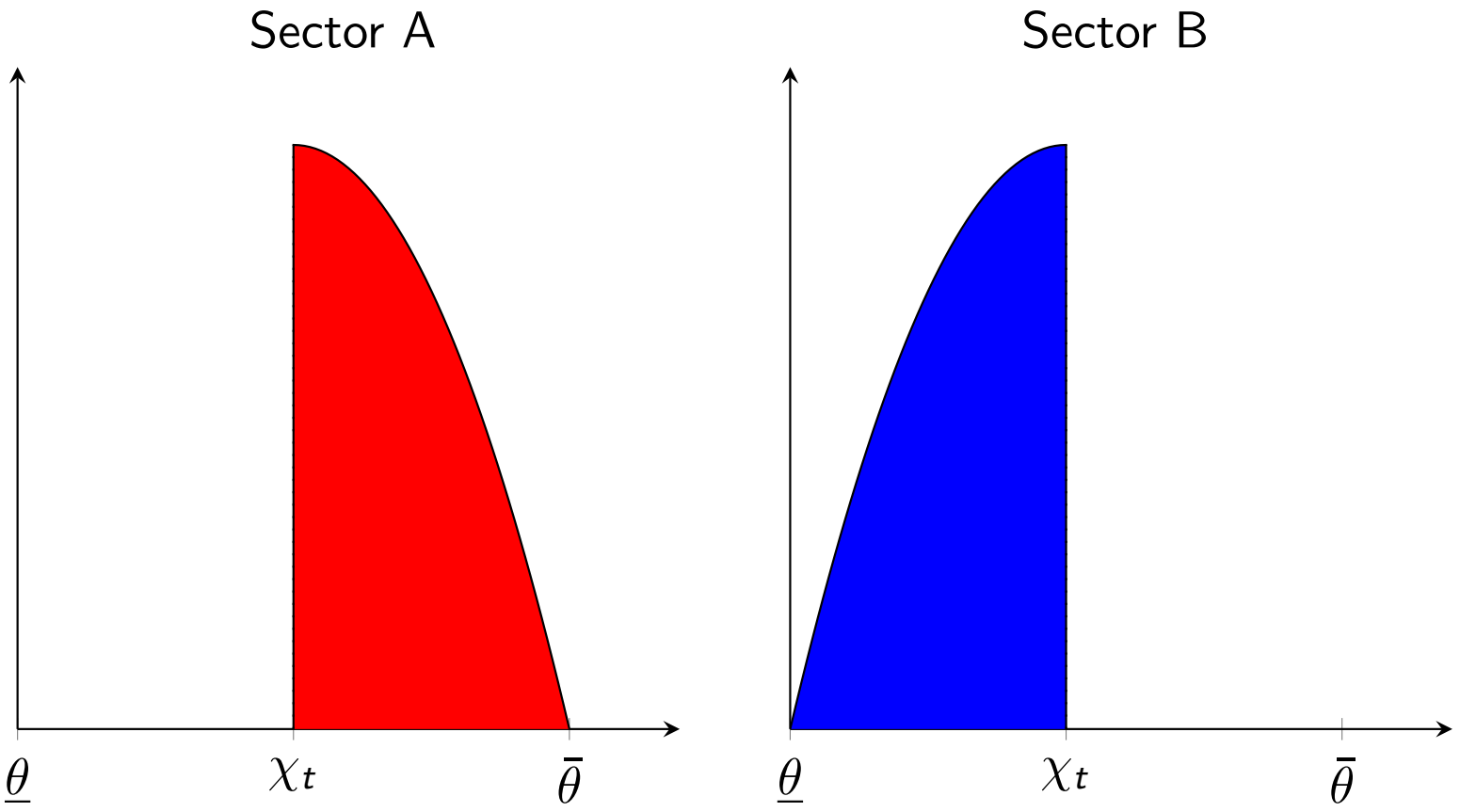
# Equilibrium dynamics

As $t$ increases:



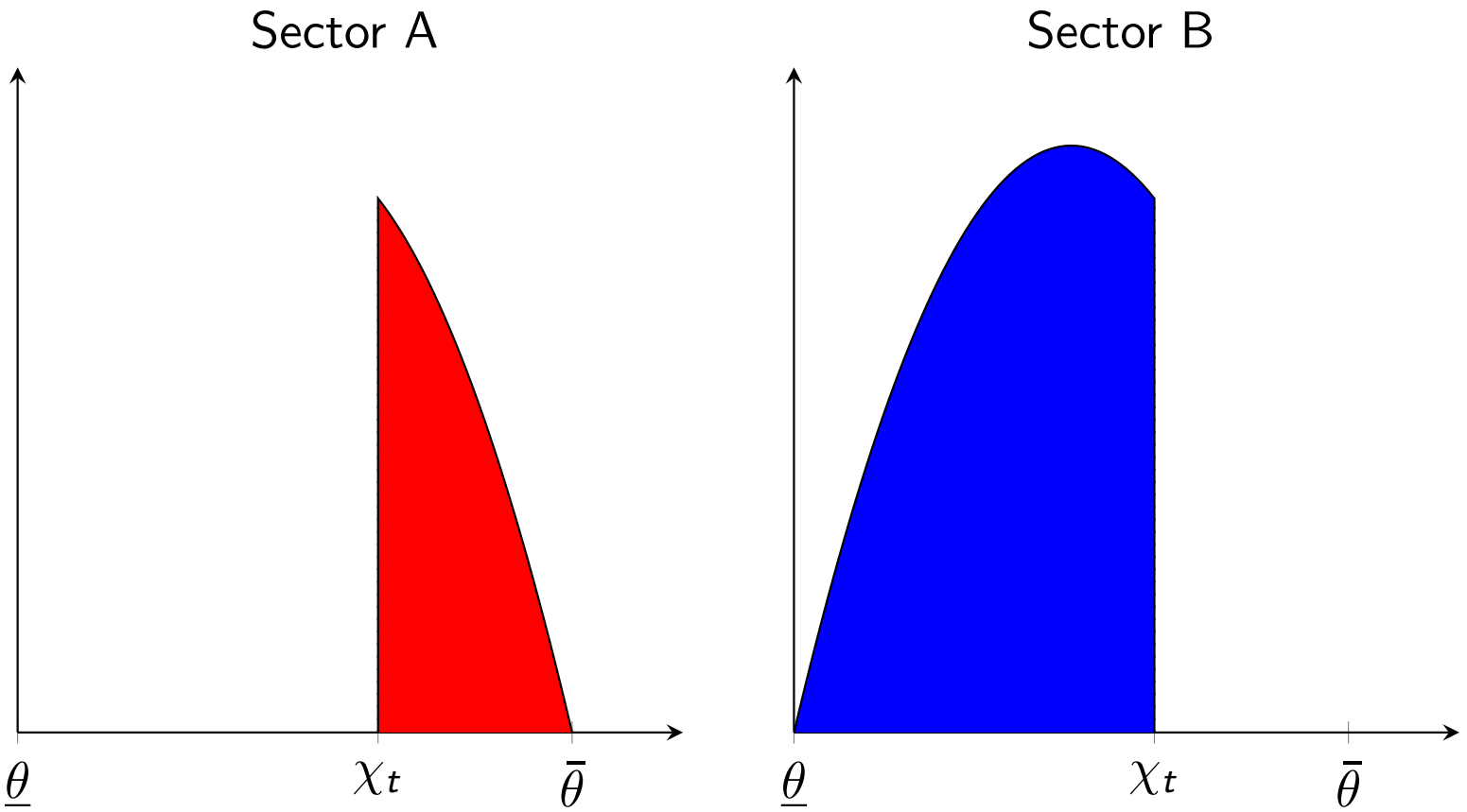
# Equilibrium dynamics

As $t$ increases:



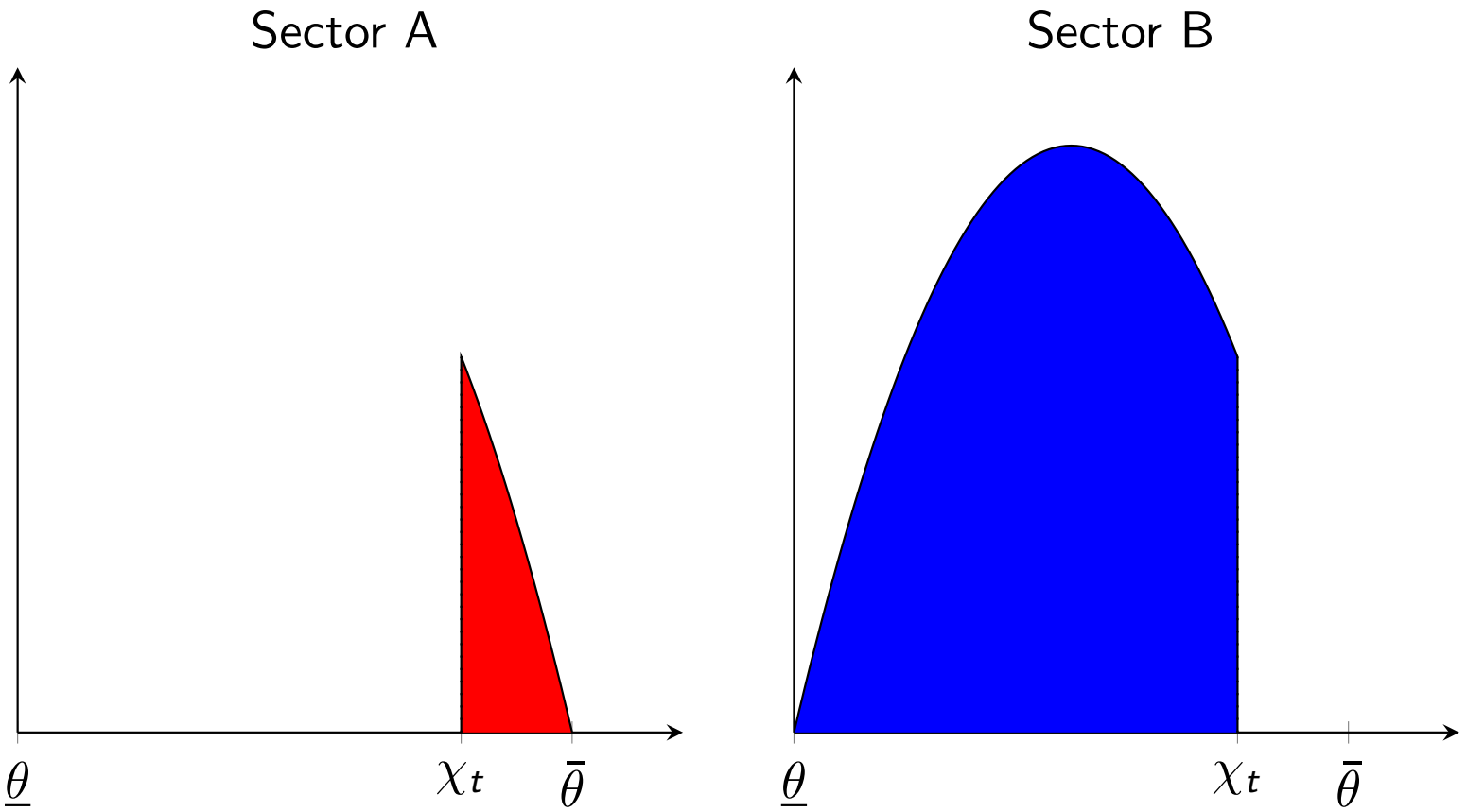
# Equilibrium dynamics

As $t$ increases:



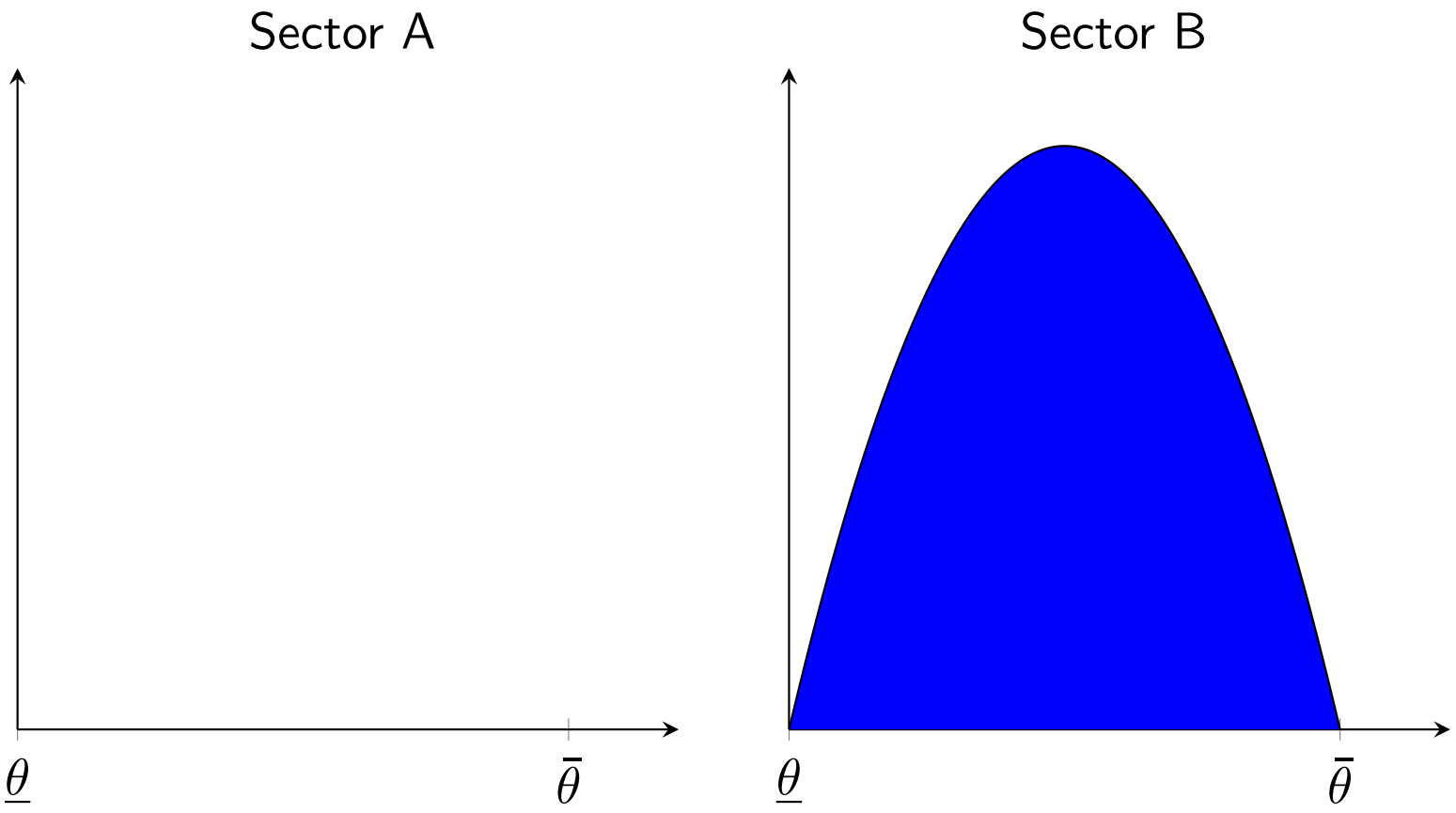
# Equilibrium dynamics

As $t$ increases:



# Equilibrium dynamics

For $t > \tau(\overline{\theta})$



# Equilibrium characterization

The equilibrium is characterized by

$$P_t = \frac{\pi_B(\chi_t)}{r} \qquad \text{(Break Even Condition)}$$

$$\underbrace{rP_t - \pi_A(\chi_t)}_{\text{Cost of Delay}} = \overbrace{\frac{d}{dt}P_t}^{\text{Benefit of Delay}} \qquad (\chi_t \text{ Local Indifference})$$

The equilibrium rate of skimming is

$$\dot{\chi}_t \equiv \frac{d\chi_t}{dt} = r\left(\frac{\pi_B(\chi_t) - \pi_A(\chi_t)}{\pi_B'(\chi_t)}\right)$$

- The **rate of capital reallocation** is $k'(t) = \dot{\chi}_t dF(\chi_t)$

# Example

- Suppose that

$$\pi_B(\theta) = \alpha\theta + \beta > \pi_A(\theta) = \theta$$

  - → $\alpha$ captures the importance of quality
  - → $\beta$ is the level of the innovation/shock

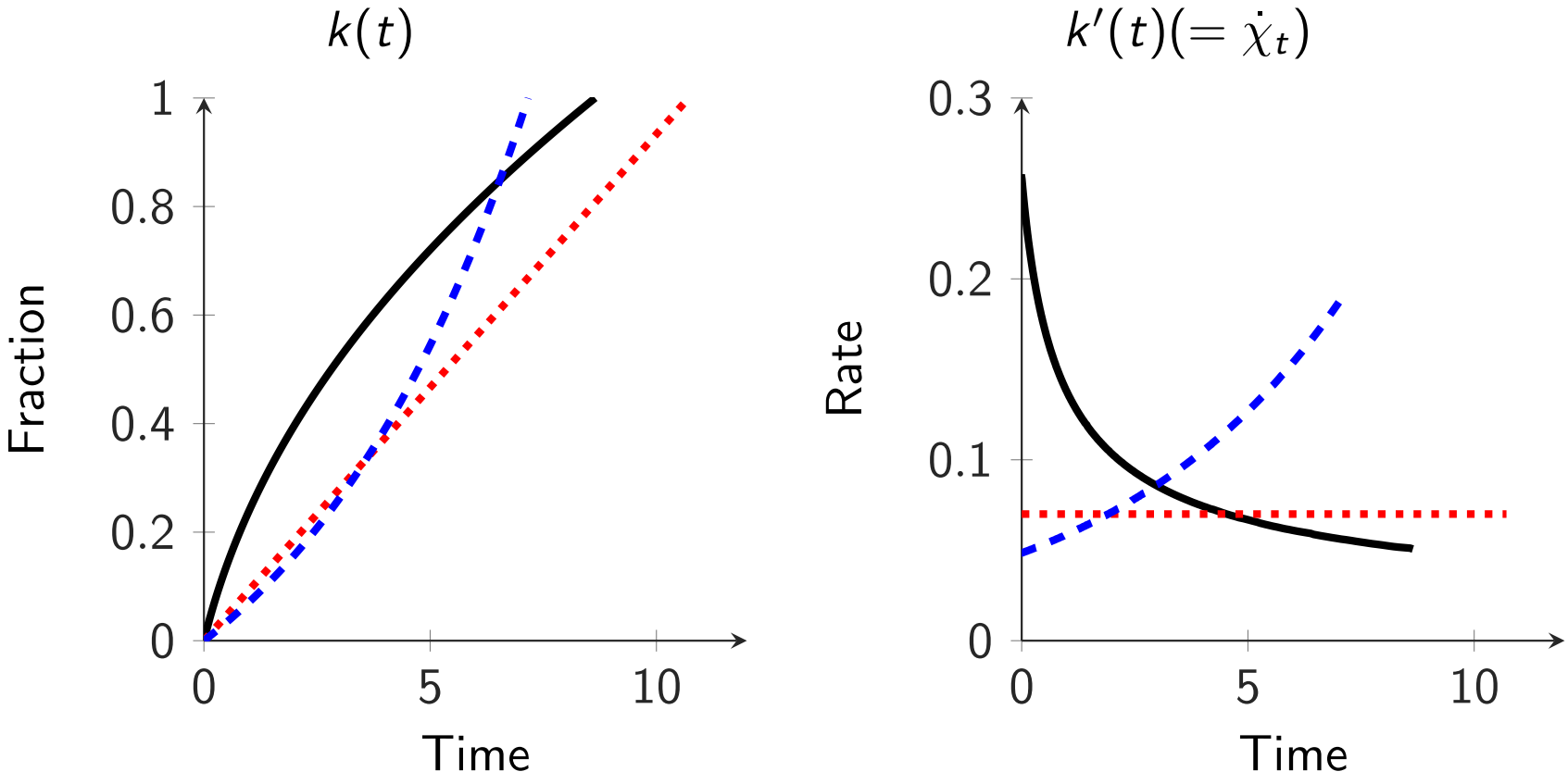
- The differential equation for the cutoff type is linear in $\chi$

$$\dot{\chi}_t = r \cdot \frac{(\alpha - 1)\chi_t + \beta}{\alpha},$$

- Therefore reallocation rate proportional to $e^{\left(\frac{\alpha-1}{\alpha}\right)rt}$
  - → Case 1. $\alpha = 1 \rightarrow \dot{\chi}_t$ constant over time as in to 'kdot' model
  - → Case 2. $\alpha > 1 \rightarrow \dot{\chi}_t$ increasing over time as in 'idot' model
  - → Case 3. $\alpha < 1 \rightarrow \dot{\chi}_t$ decreasing over time as in 'ik' model

# Example: reallocation dynamics

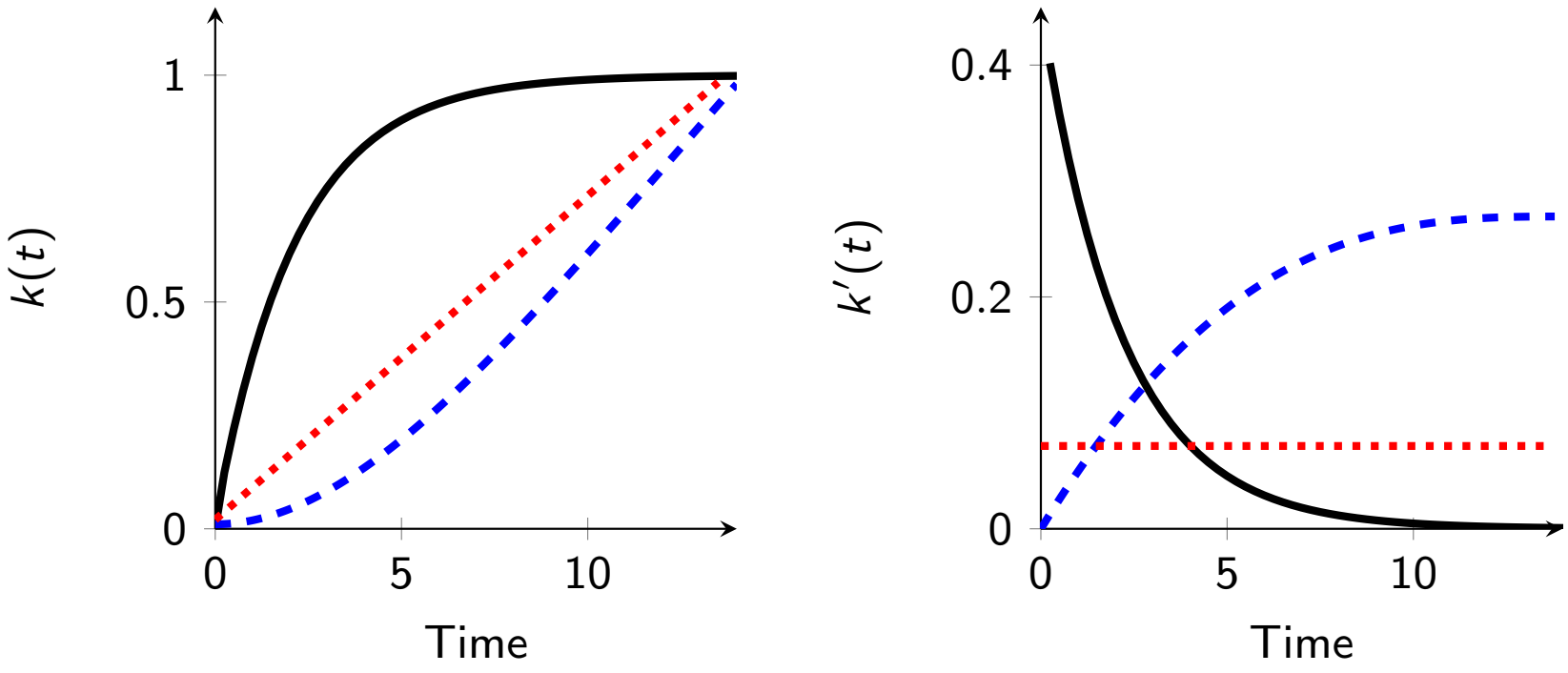
For $F$ uniform:




- Dynamics implied by $\alpha = 1$ (red), $\alpha < 1$ (black), $\alpha > 1$ (blue).

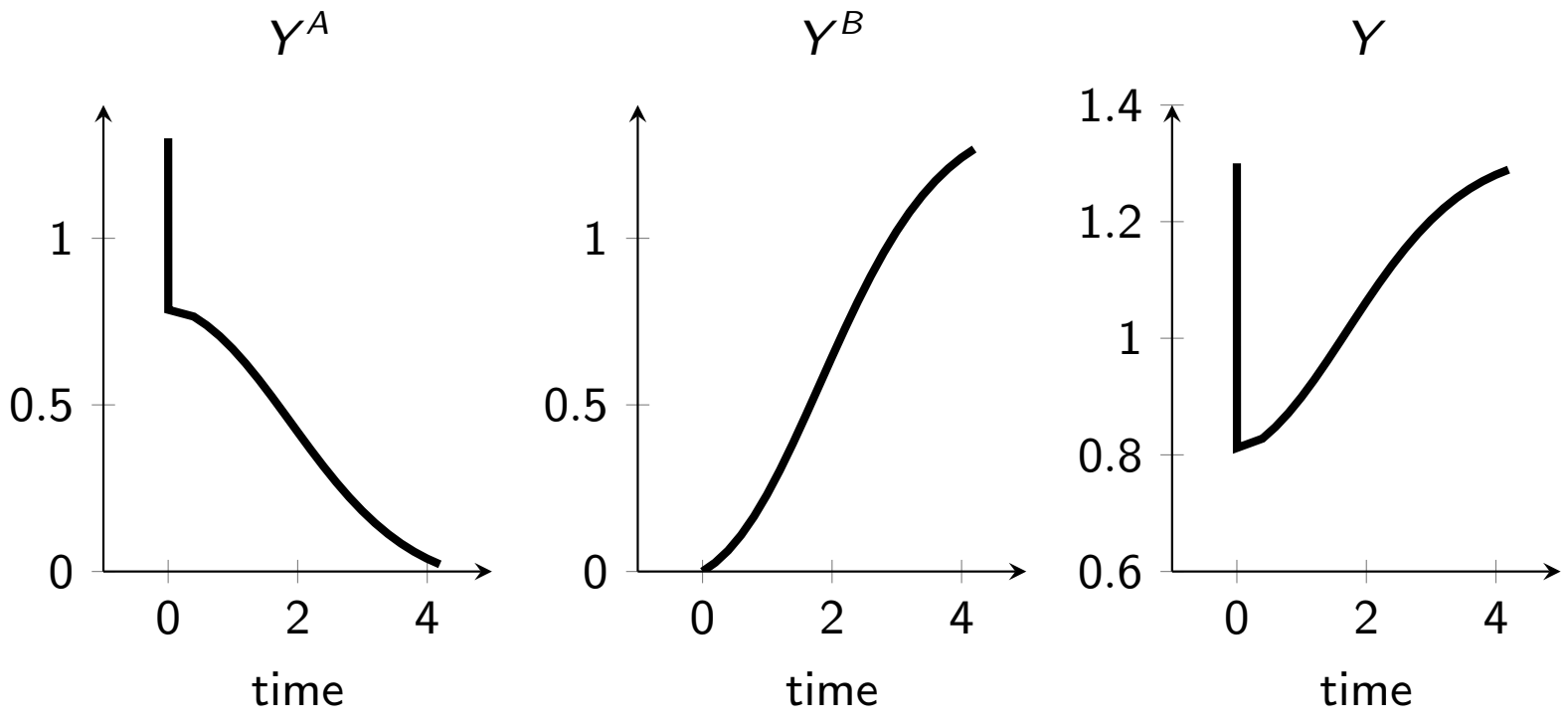
# Reallocation dynamics with exogenous adjustment costs

For comparison:




- Dynamics implied by ‘kdot’ (red), ‘ik’ (black) and ‘idot’ (blue) models.

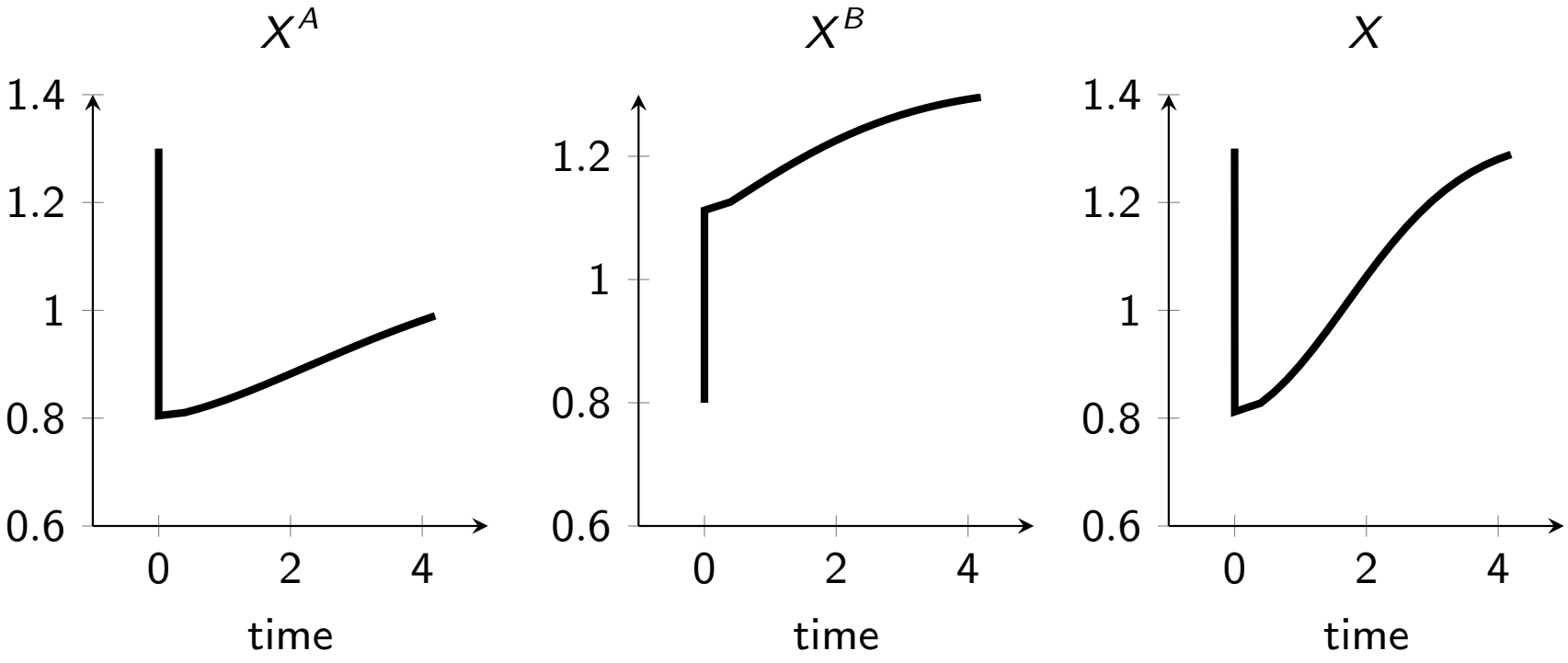
# Aggregate output




(a) output in sector A (b) output in sector B (c) total output

Figure: Response to a sectoral productivity shift, where at $t = 0$, sector B becomes the more productive sector. The economy recovers slowly from a productivity shift even though aggregate potential output is unchanged.

# Aggregate productivity




(a) productivity in sector A (b) productivity in sector B (c) total productivity

Figure: Productivity is increasing across *both* sectors.

# Key takeaway and next steps

- So far,
  - → Adverse selection as a mechanism for slow movements in capital flows
  - → An endogenous "adjustment cost"
- How does this "cost" and the equilibrium rate of reallocation depend on the underlying economic environment?
  - → Frequency of shocks
  - → Dispersion of capital productivity
  - → Interest rate
  - → Household's risk aversion and consumption smoothing motives

# Recurring shocks

Locations are symmetric:

- $\phi_t$ is a Markov process with transition probability $\lambda$
- Output per $\theta$-unit is given by

| | Location | |
|---|---|---|
| State | $\pi_A$ | $\pi_B$ |
| $\phi_A$ | $\pi_1(\theta)$ | $\pi_0(\theta)$ |
| $\phi_B$ | $\pi_0(\theta)$ | $\pi_1(\theta)$ |

  where $\pi_1(\theta) > \pi_0(\theta)$

- Existing capital depreciates and new capital flows in at rate $\delta$.
  - → New investment flows into most profitable sector
  - → Efficient sector maintains full support over $[\underline{\theta}, \overline{\theta}]$.

# Reallocation with recurring shocks

How does shock frequency affect equilibrium reallocation?

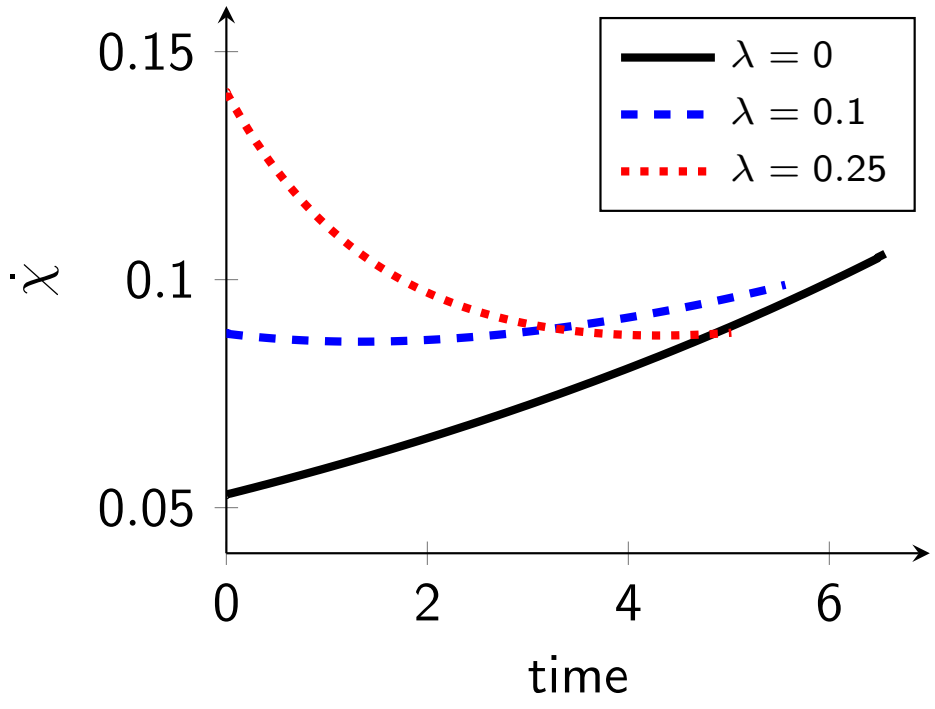
- With recurring shocks, prices account for expected future **costs of reallocation**.
- As a result, capital trades at a "discount" due to its illiquidity.
  - → Higher $\theta$ less liquid → trades at a larger discount.
  - → Influences reallocation decision, which in turn influences discount...
- As $\lambda$ increases there are two effects
  - → Level effect (cost of waiting): how much are prices depressed?
    - * Tends to slow down reallocation
  - → Slope effect (benefit of waiting): how much do prices flatten?
    - * Increasing illiquidity discount mitigates adverse selection!
    - * Tends to speed up reallocation

# Reallocation with recurring shocks

The slope effect dominates (at least initially)

$$\begin{aligned} \text{Higher } \lambda &\implies \text{larger discount for higher } \theta \\ &\implies \text{low types have less incentive to delay} \\ &\implies \text{so they reallocate faster} \end{aligned}$$

# Reallocation with recurring shocks




- More frequent shocks tend to mitigate the adverse selection problem.
  - → Market "adapts" with faster reallocation.
- However, reallocation costs are incurred more frequently so overall:
  - → prices and efficiency decrease with $\lambda$.

# Capital prices

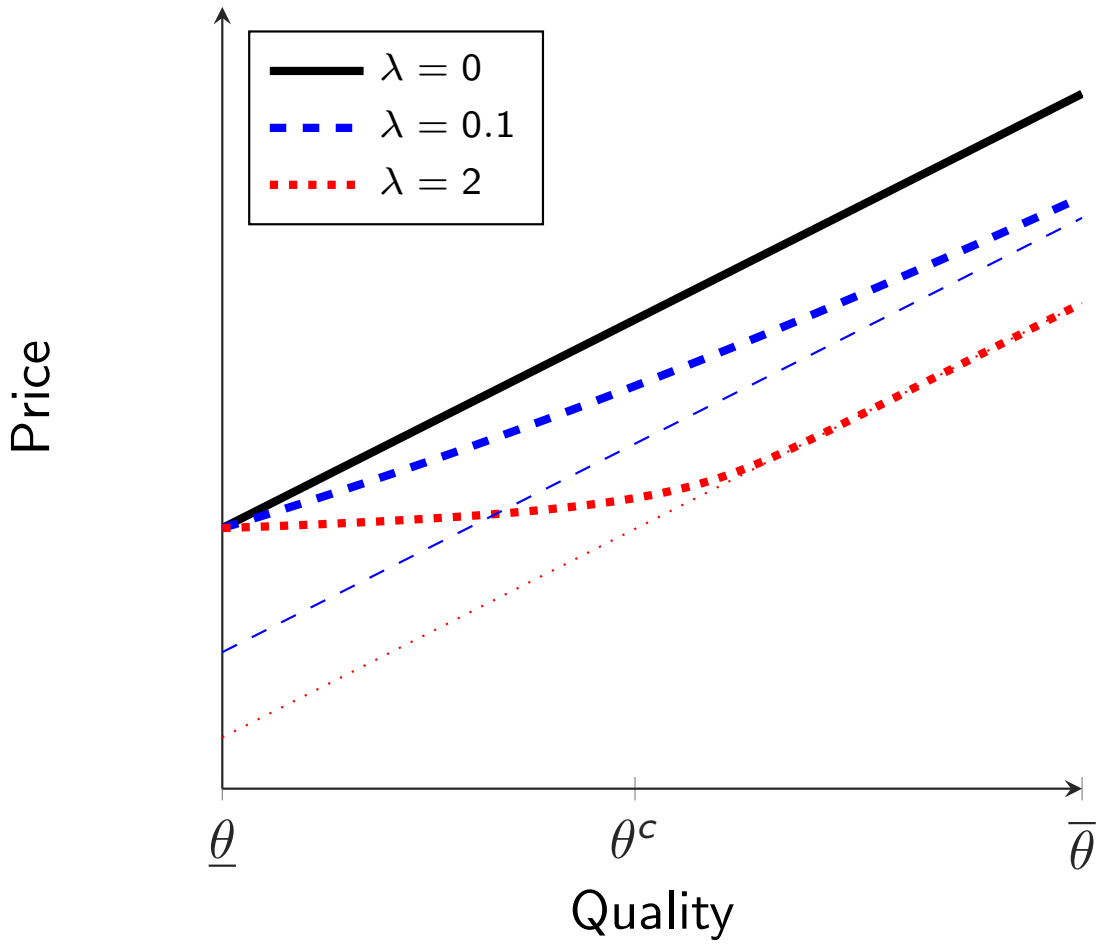



Figure: The effect of transitory shocks on the price of capital. Dotted line represent transaction price as function of quality. The faint dotted lines represent the hypothetical value of a unit of capital if it is never reallocated.

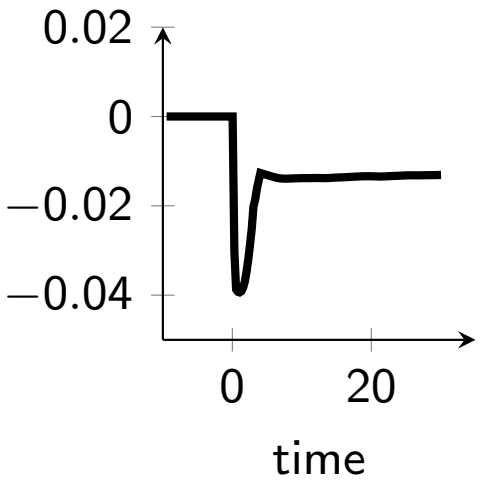
# Response to structural changes

- Time variation in adjustment costs as (reduced form) explanation of empirical patterns
  - → Eisfeldt and Rampini, 2006: Reallocation is procyclical even though benefits appear to be countercyclical
  - → Justiniano, Primiceri, Tambalotti, 2011: Shock to adjustment costs responsible for significant fraction of B-C fluctuations

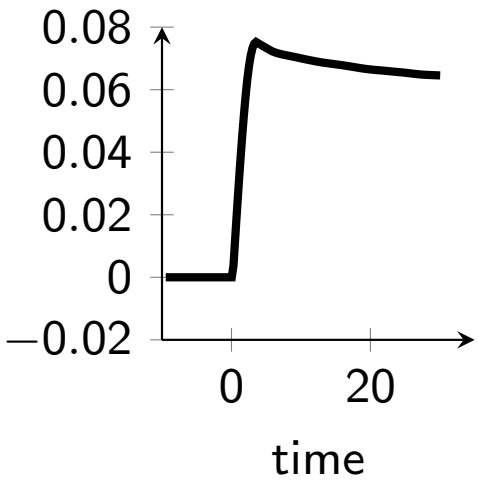
*How can we interpret these shocks?*

- Consider unanticipated changes to the model's structural parameters
  1. Increase in dispersion of capital quality $\overline{\theta} - \underline{\theta}$
  2. Reduction in the interest rate: $r$

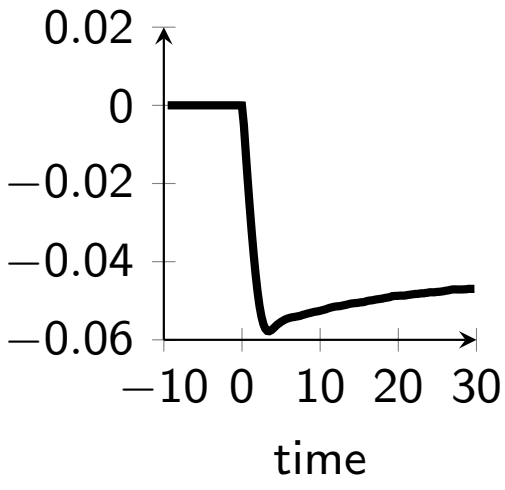
# Impulse response: capital dispersion




(a) Reallocation, $\Delta R_t$



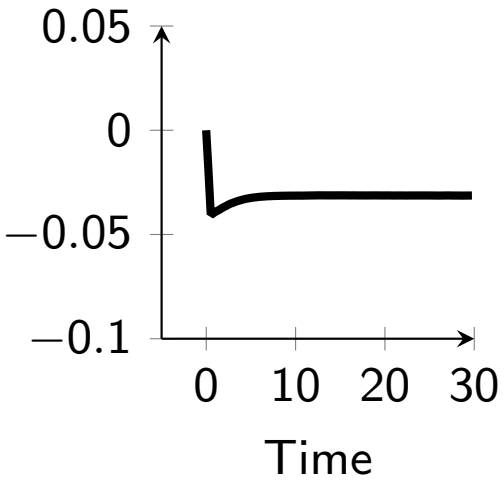

(b) Misallocation, $\Delta M_t$



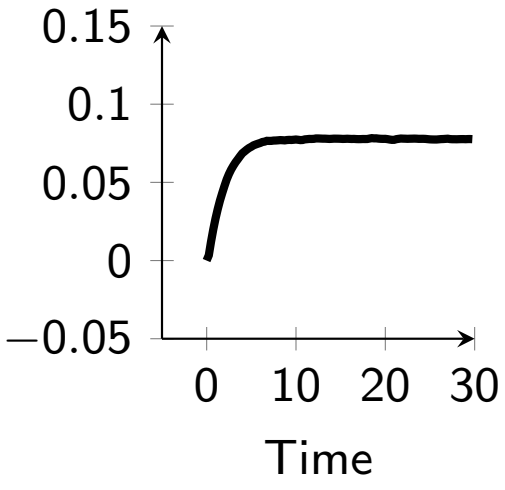

(c) Output, $\Delta \log(Y_t)$

- An increase in the dispersion of quality of *new* capital units exacerbates the adverse selection problem.
  - → Leads to lower reallocation, lower efficiency and reduced output.

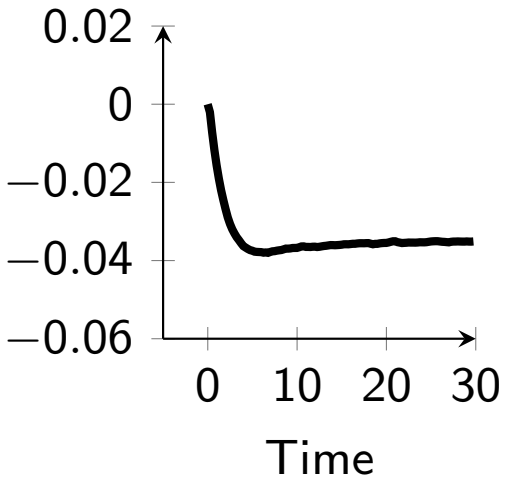
# Impulse response: reduction in interest rate




(d) Reallocation, $\Delta R_t$




(e) Misallocation, $\Delta M_t$




(f) Output, $\Delta \log(Y_t)$

- Standard adjustment cost model: lower $r$ increases benefits from reallocation
  - → **faster** reallocation
- Our model: lower $r$ decreases the cost of delaying
  - → **slows down** reallocation

# Risk averse households

- We also consider a closed economy with CRRA households
  - → Assume complete markets.

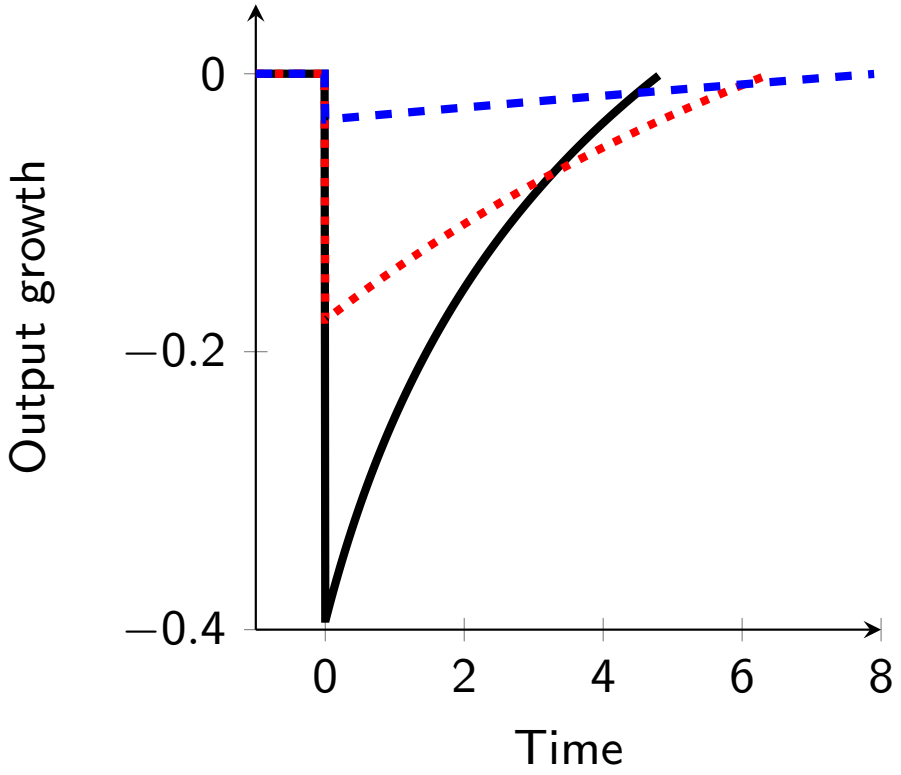
Additional Implications:

1. Due to consumption smoothing motives
   - → Interest rate rises upon arrival of sectoral shock
   - → Higher interest rates increase cost of delay $\Longrightarrow$ faster reallocation
   - → Larger downturns are followed by faster recoveries

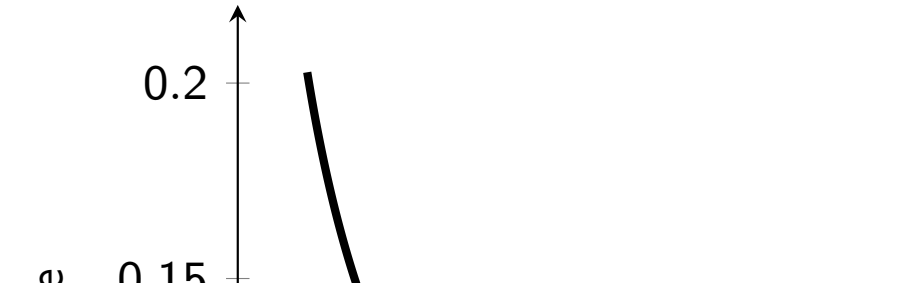
2. Risk aversion leads to a
   - → Motive for diversification, can halt reallocation process entirely

# Large downturns followed by sharp recoveries

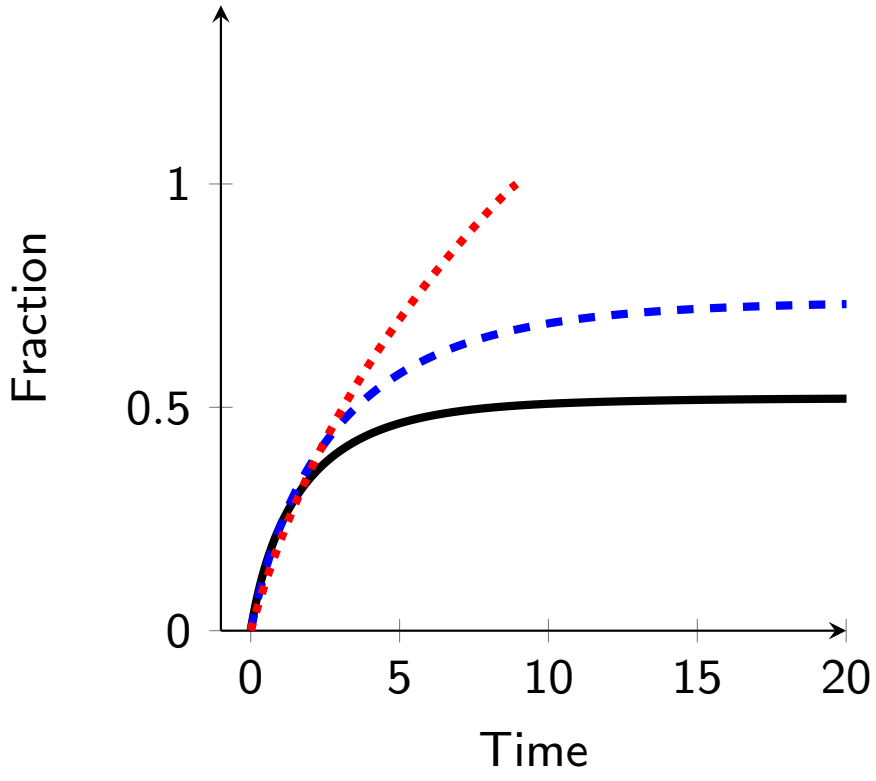
Recovery from a negative productivity shock to sector $A$.



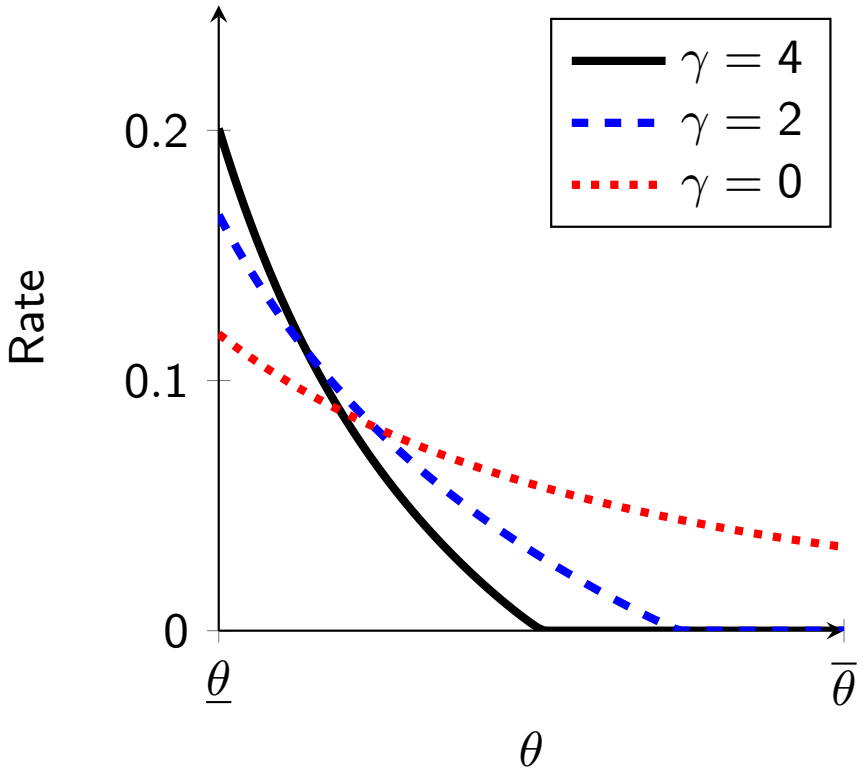

(g) Change in log output



# Reallocation dynamics in the presence of aggregate risk.




(a) fraction reallocated




(b) rate of reallocation

# Conclusion

- Proposed a mechanism for generating slow movements in capital flows based on adverse selection
  - → A micro-foundation for convex adjustment costs
  - → Particularly relevant for divestment decisions
- Reallocation "costs" intimately linked to economic environment
  - → Shock volatility → lower and flatter prices → faster reallocation
  - → Productivity dispersion → amplifies misallocation
  - → Reduction in interest rates → slows reallocation
  - → Sufficient risk aversion → can halt reallocation entirely
- A number of potential applications to explore
  - → Physical capital reallocation across firms
  - → Labor mobility
  - → New investment under financial constraints
  - → IPOs or merger waves

# Empirical evidence?

- Constructing test is difficult since mechanism relies on unobservables.
  - → High "types" may reallocate faster if type is observable.
- Need a setting where quality is unobservable to the market but observable to the econometrician. Perhaps ex-post...
- Testable Predictions:
  1. Higher types reallocate (sell) after longer delay.
  2. Price is fully revealing at time of sale.
- One possibility is the IPO market...
- Anecdotal evidence of strategic delay in the IPO market
  - → Business Week (May 27, 2009): *"If the stock market does not stabilize, many of the most promising companies can afford to sit on the sidelines."*