Adverse Selection, Slow Moving Capital and Misallocation

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Motivation

- Resource misallocation appears to be both 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?

- Standard models specify adjustment costs exogenously.
  - → e.g., convex adjustment costs
  - → need shocks to these costs to explain patterns in the data

What do these costs represent? Why do they vary with the underlying economic environment?

This paper

Main Idea

- A mechanism for slow movements in capital reallocation based on adverse selection.

What is "capital"?

- An asset whose quality or value cannot easily be verified or contracted upon.
  - → Physical, human, financial or existing matches (e.g., firm division)

How it works?

- Starting point: capital reallocation requires market transactions.
- The equilibrium involves inefficient delays in these transactions.
  - → Capital is heterogeneous and owners are better informed.
  - → Owners of less profitable capital units more eager to sell...do so earlier
  - → Prices rise over time as more profitable units are reallocated.

Our Contribution

Incorporate adverse selection in a dynamic GE model

- Leads to endogenous reallocation costs and persistence
  - → Equilibrium dynamics resemble those in adjustment costs models

Our focus: How do these "costs" depend on the economic environment?

- Productivity dispersion exacerbates adverse selection.
  - → Slows reallocation. Corresponds to higher adjustment costs.
- 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.

Related literature

Existing theories:

1. Convex Adjustment Cost and Time to Build Models:
   → Hall and Jorgenson (1967), Lucas and Prescott (1971), Hayashi (1982), Kydland and Prescott (1982), Pindyck (1982), Abel (1983), Abel and Eberly (1994), Ramey and Shapiro (1998), Eisfeldt and Rampini (2006), Lucca (2007), ...

2. Search and Capital/Labor Mobility:
   → Vayanos and Weil (2005), Duffie and Strulovici (2012), Gromb and Vayanos (2012)

3. Financial Constraints
   → Bernanke and Gertler (1989), Kiyotaki and Moore (1998), Banerjee and Newman (1993), Gilchrist, Sim, and Zakrajek (2013)

Related models:

- Adverse Selection and Delay
  → Hörner and Vielle (2009), Daley and Green (2012,2014), Fuchs and Skrzypacz (2013), Fuchs, Oëry and Skrzypacz (2013), Carmargo and Lester (2013), Chari, Shourideh, and Zetlin-Jones (2013)

- (Short-lived) Adverse Selection in Macro
  → Eisfeldt (2004), House and Leahy (2004), Kurlat (2013), Bigio (2013)

The environment

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

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

  - $\rightarrow$ 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
  - → Quality is privately observed by owner.
  - → Lemons condition

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

Equilibrium

Given an expected path of prices:

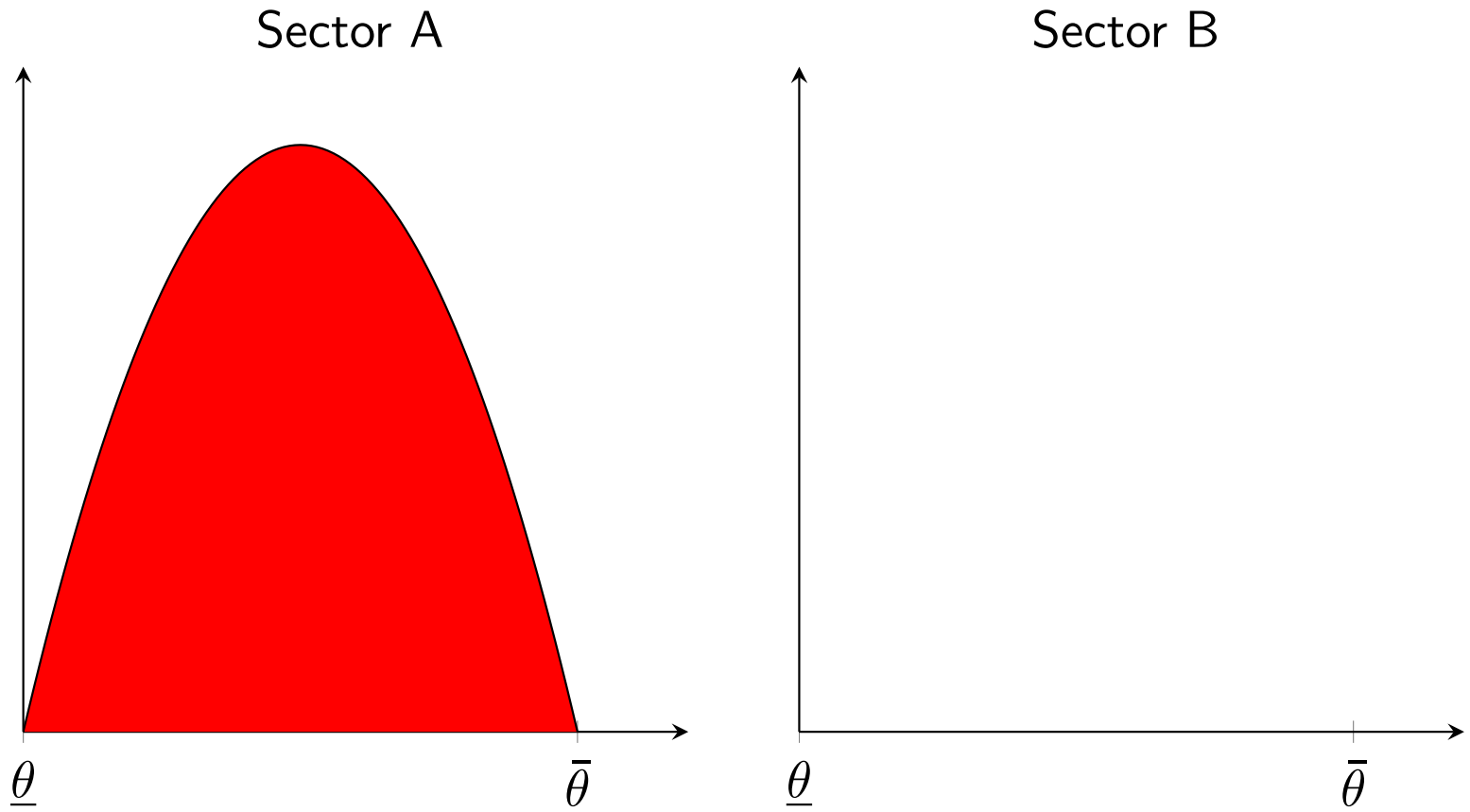
- Firms in A optimally choose when to sell capital. Their tradeoff
  - → Sell now: Capture productivity gains in new sector
  - → Sell later: Potentially get a better price
- Firms in B are competitive.
  - → Value capital at $V(\theta) = \pi_B(\theta)/r$ for θ-unit
- Equilibrium
  1. Sector A firms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

Observations

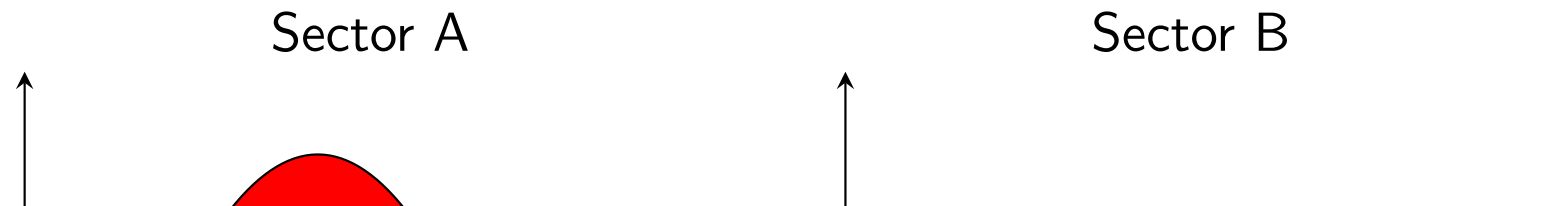
- First-best reallocation is not an equilibrium.
  - → Sector A firms with highest quality capital prefer not to trade.
- No atoms at $t = 0$.
  - → Prices would jump...also not an equilibrium.
- Equilibria must satisfy the **skimming property**:
  - → If it is optimal for θ to trade at time t, then 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 χ_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 $t = 0$:



As t increases:



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

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

  → α captures complementarities between quality and the shock
  → β is the level of the innovation/shock

- The differential equation for the cutoff type is linear in χ

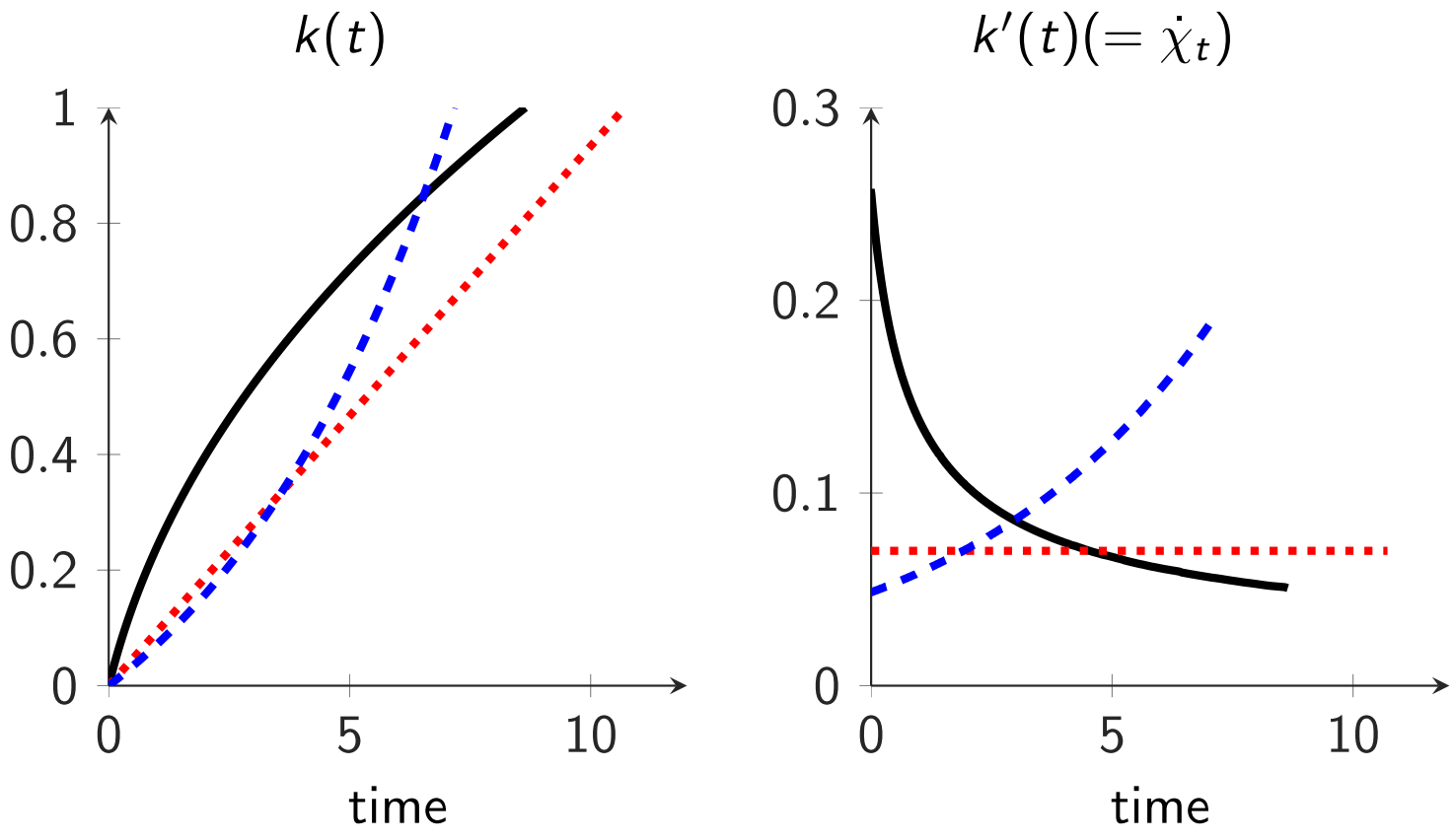
$$\dot{\chi}_t = r \cdot \frac{(\alpha - 1)\chi_t + \beta}{\alpha},$$

- 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

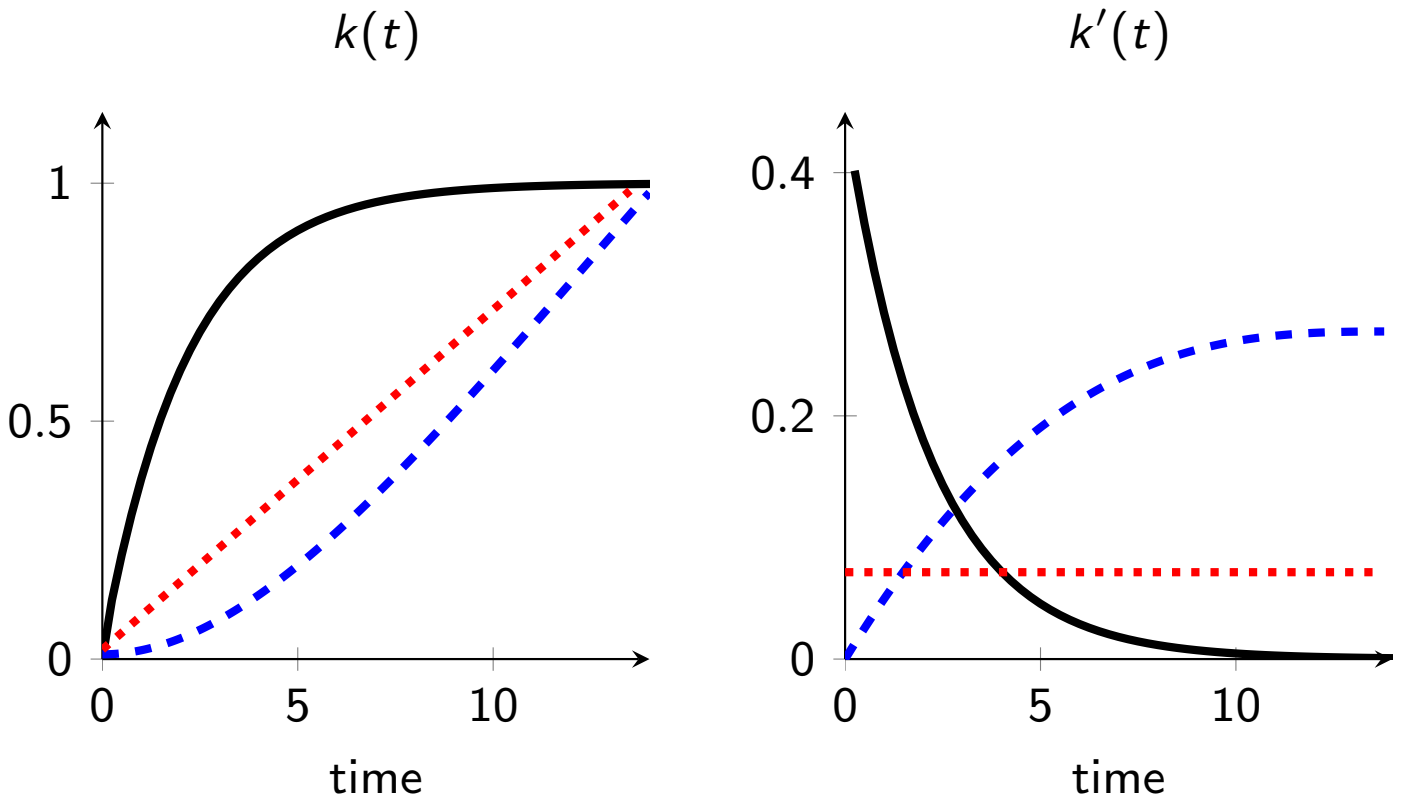
For F uniform:



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

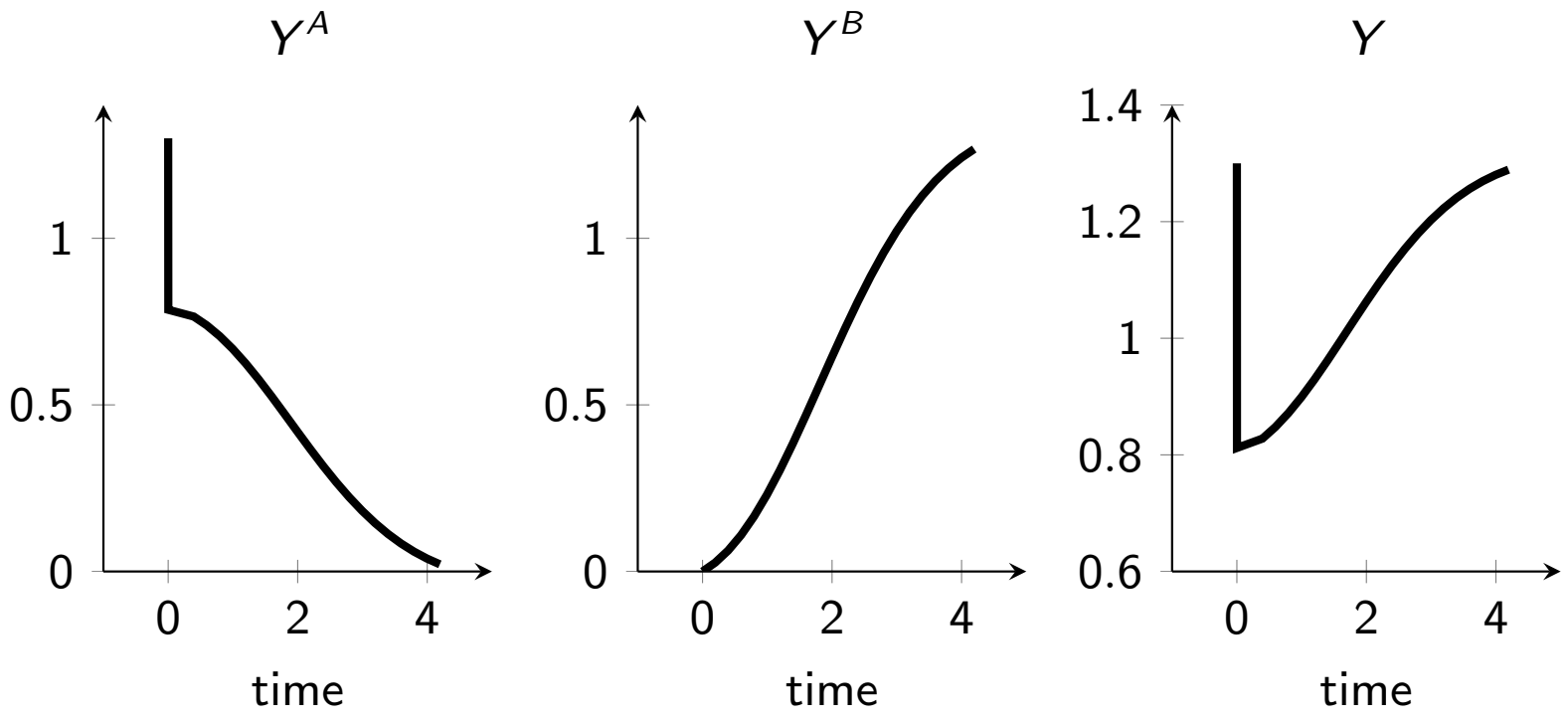
Reallocation dynamics with exogenous adjustment costs

For comparison:



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

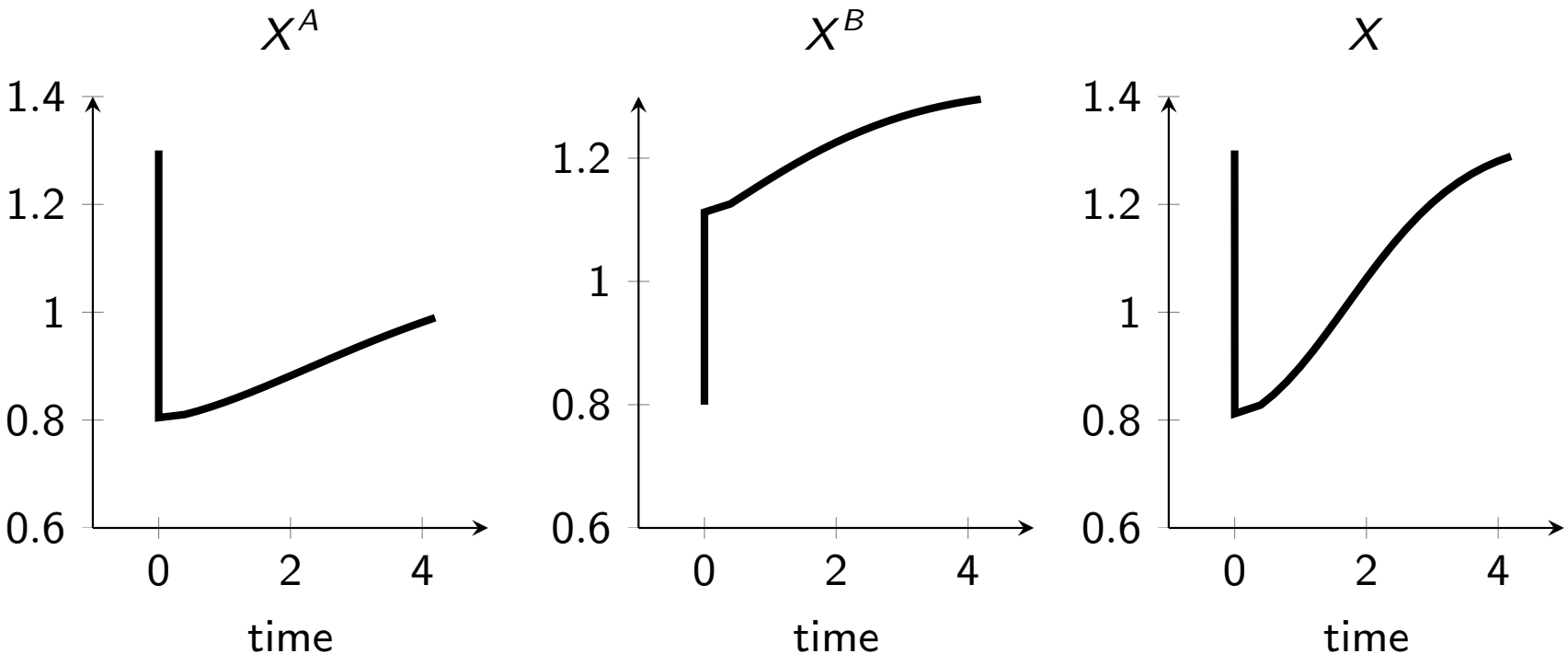
Aggregate output



(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:

- ϕ_t is a Markov process with transition probability λ
- Output per θ-unit is given by

	Location	
State	π_A	π_B
ϕ_A	$\pi_1(\theta)$	$\pi_0(\theta)$
ϕ_B	$\pi_0(\theta)$	$\pi_1(\theta)$

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

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

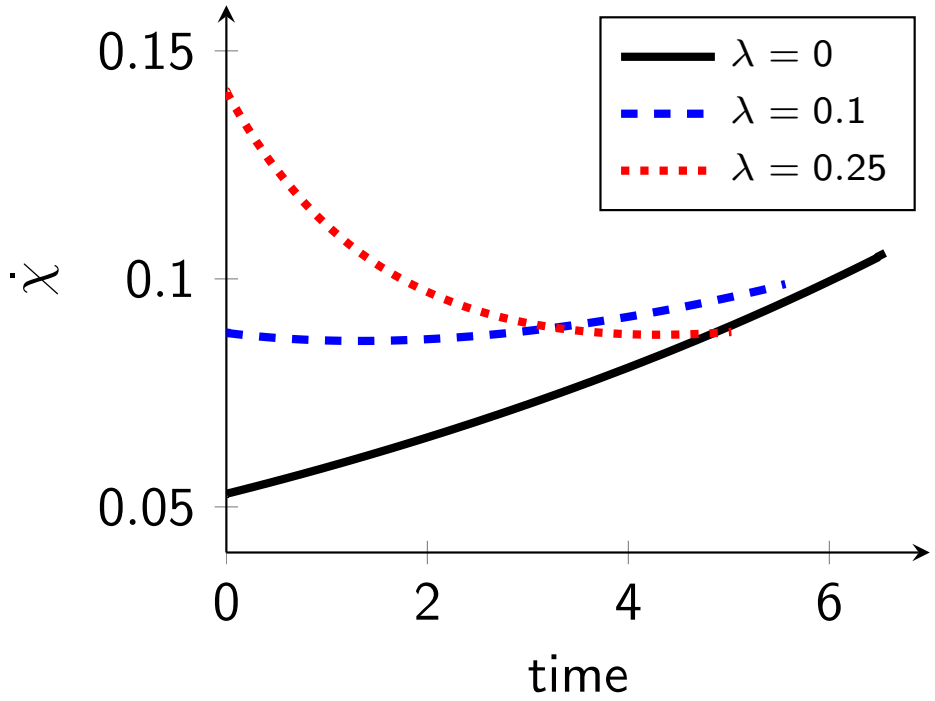
Reallocation with recurring shocks

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 θ less liquid $\rightarrow$ trades at a larger discount.
  - → Influences reallocation decision, which in turn influences discount...
- As λ 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)



- 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 λ.

Capital prices

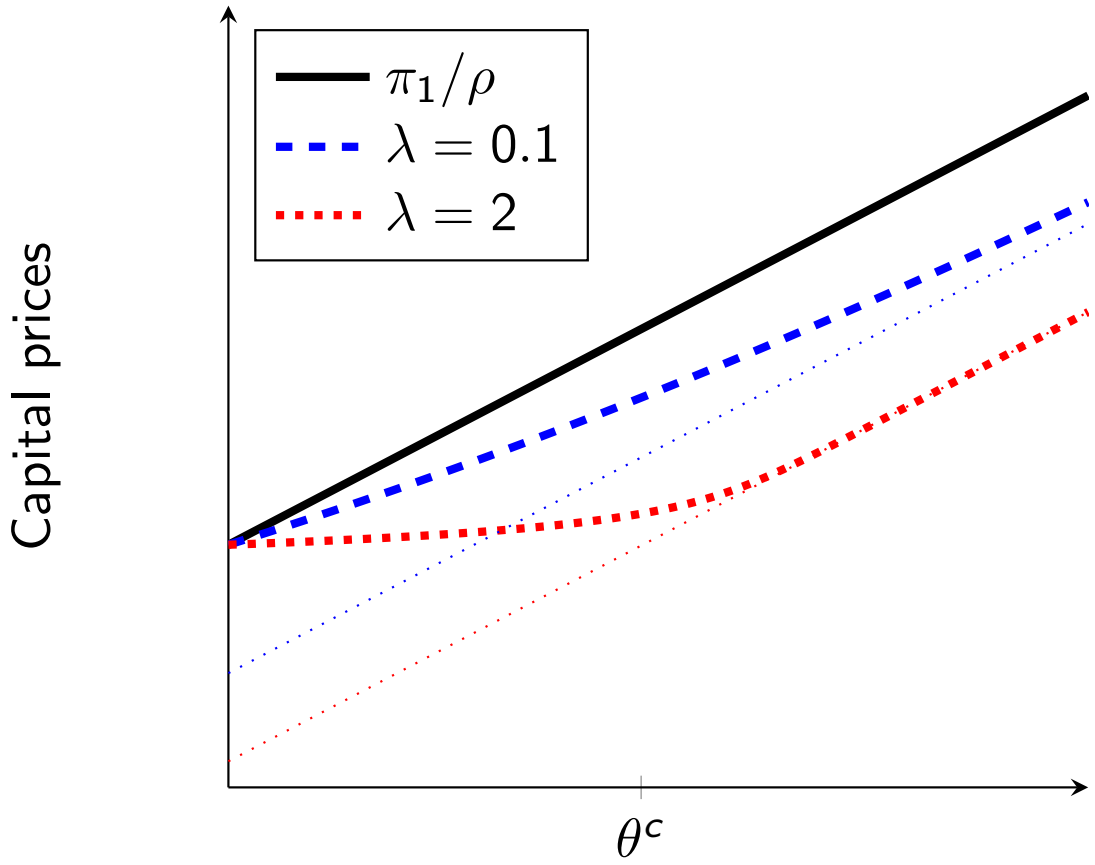


Figure: The effect of transitory shocks on the price of capital. Dotted line represent transaction price as function of quality. The faint dotted lines represent the hypothetical value of a unit of capital if it is never reallocated.

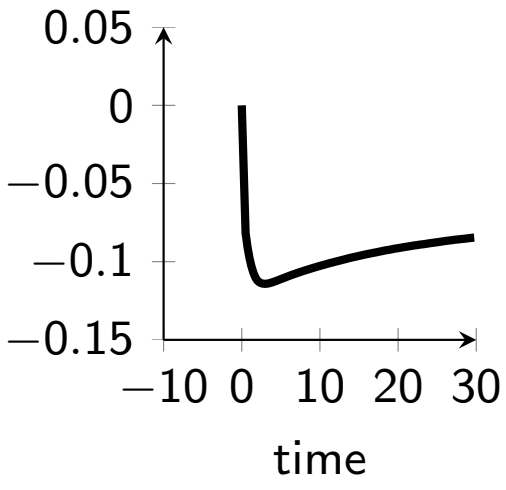
Response to structural changes

- Shocks to 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

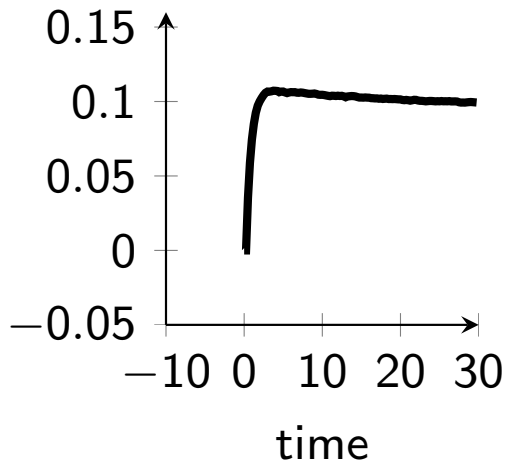
How can we interpret shocks to adjustment costs?

- 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

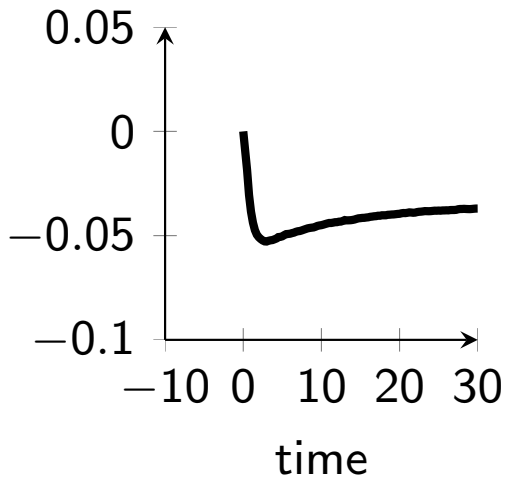
Impulse response: capital dispersion



(a) Reallocation, ΔR_t



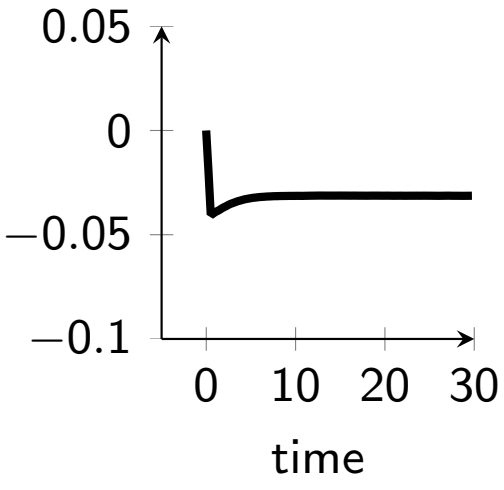
(b) Misallocation, ΔM_t



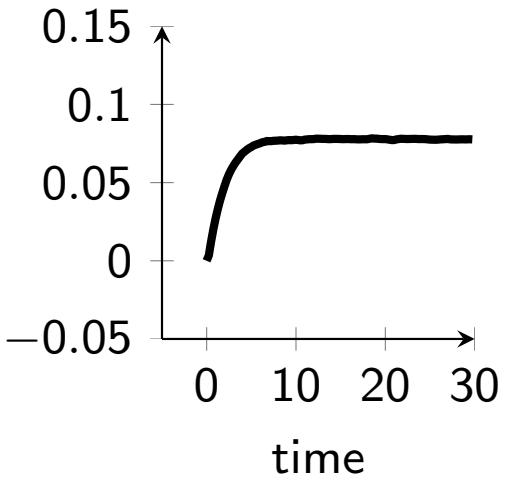
(c) Output, $\Delta \log(Y_t)$

- 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.

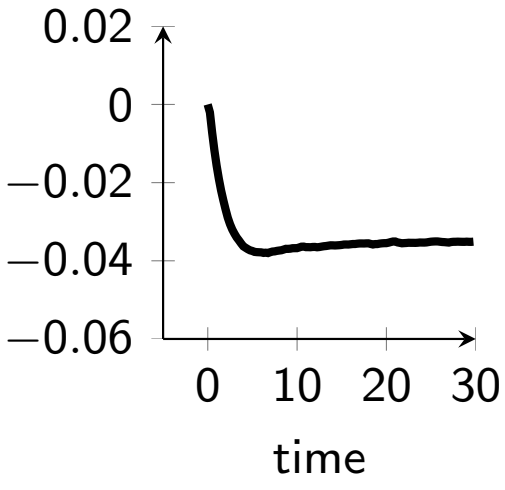
Impulse response: reduction in interest rate



(d) Reallocation, ΔR_t



(e) Misallocation, ΔM_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.

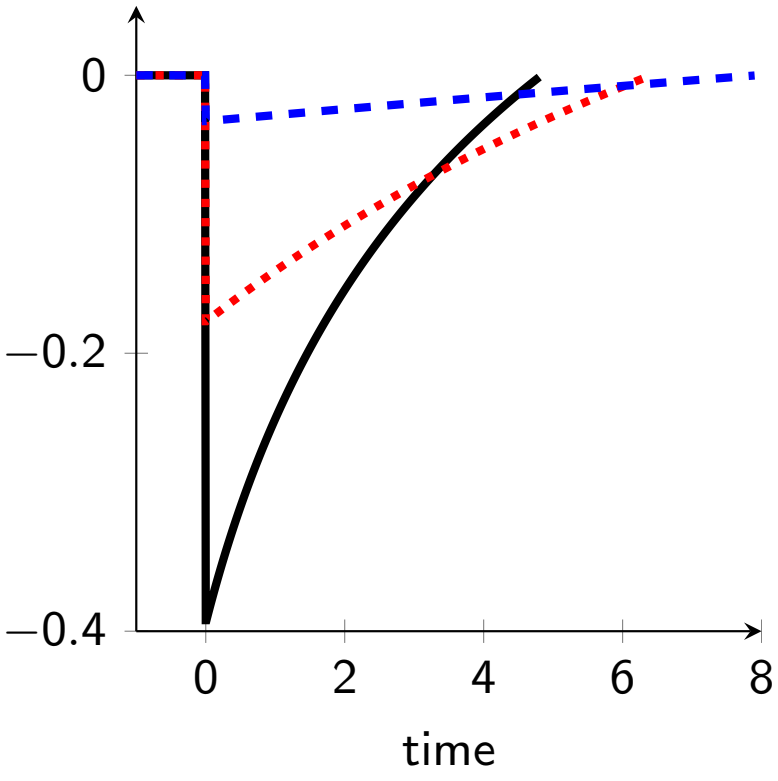
Additional Implications:

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

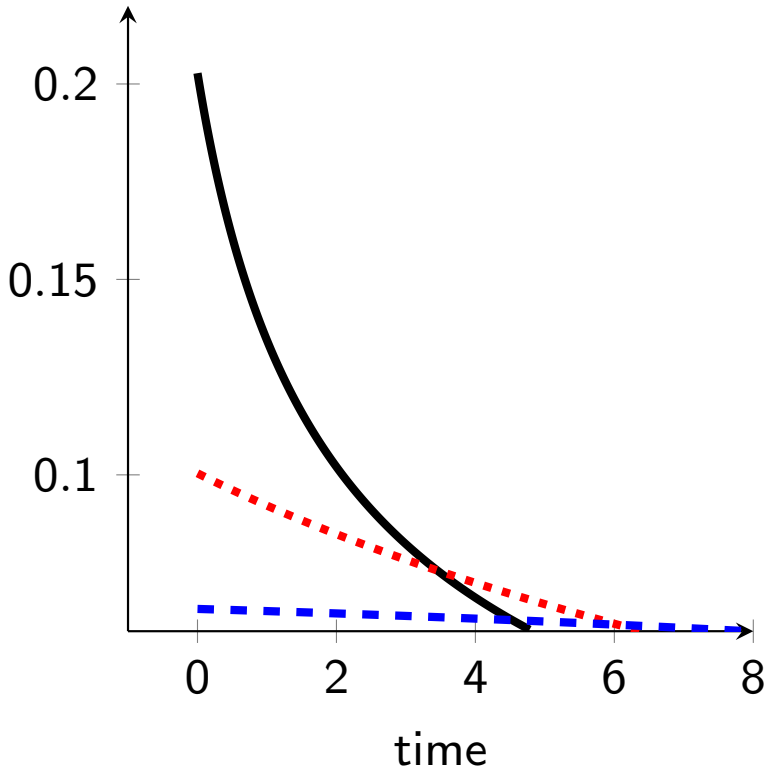
2. Risk aversion leads to a
   - → Motive for diversification, can halt reallocation process entirely

Large downturns followed by sharp recoveries

Recovery from a negative productivity shock to sector A.



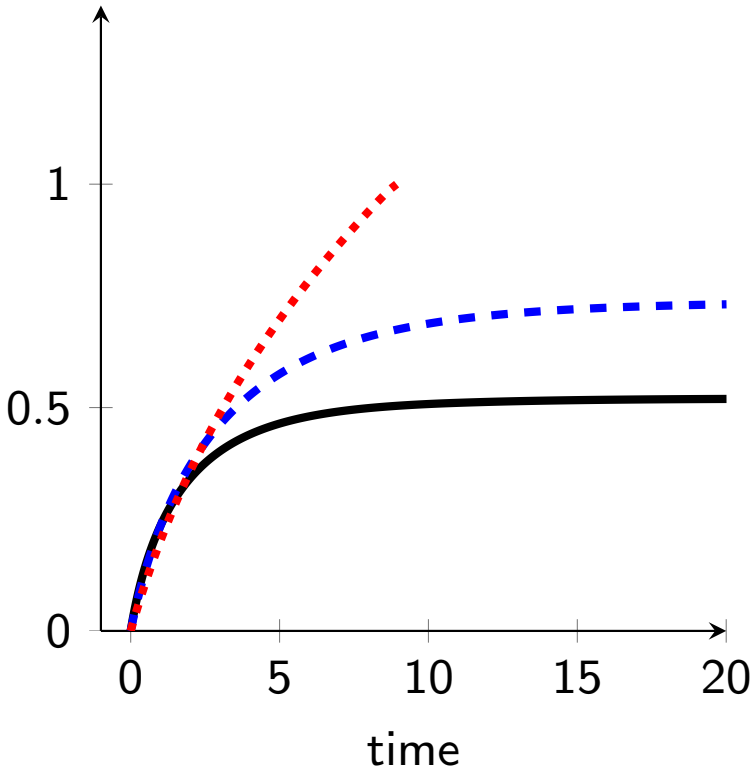
(g) Change in log output



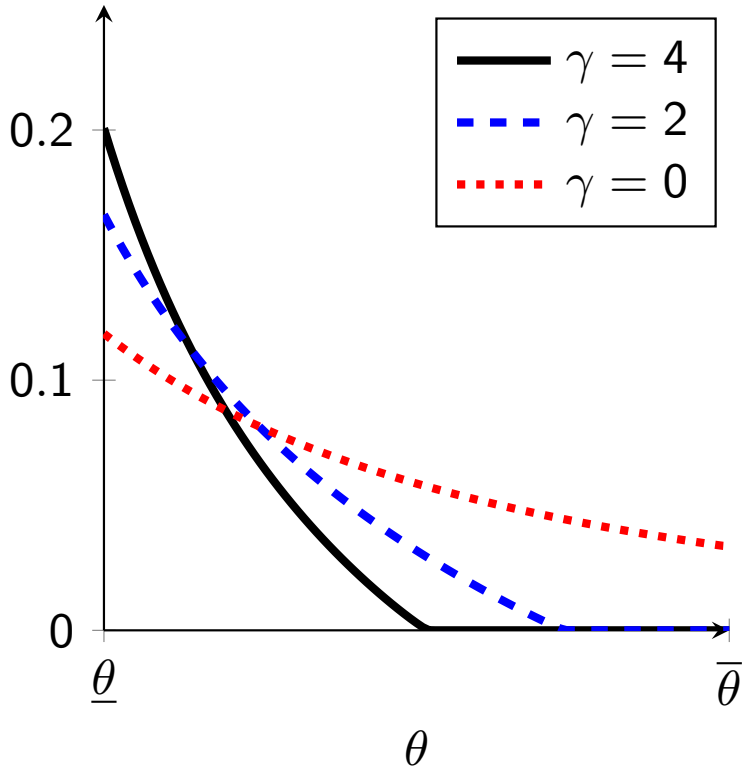
(h) Rate of reallocation

Figure: Black = 100%, red = 50%, dashed blue = 10% initially allocated in Sector A.

Reallocation dynamics in the presence of aggregate risk.



(a) fraction reallocated



(b) rate of reallocation

Conclusion

- Mechanism for generating slow movements in capital flows
  - → A micro-foundation for convex adjustment costs (especially cost of divesting)
- 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
  - → Reallocation across firms or industries
  - → Labor mobility across regions
  - → IPOs and merger waves
  - → Real estate

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."*

Firm age at IPO correlated with ex-post profitability

	ROA_{t+1}	ROA_{t+2}	ROA_{t+3}	ROA_{t+4}	ROA_{t+5}
$\log(1 + \text{Age at IPO})$	0.0183	0.0368	0.0391	0.0328	0.0333
	(2.51)	(4.06)	(6.85)	(4.39)	(4.88)
Observations	6004	5339	4655	4073	3532
Controls					
$Size_t$	Y	Y	Y	Y	Y
ROA_t	Y	Y	Y	Y	Y
Calendar Year FE	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y

Table: t-statistics in parenthesis; errors clustered by IPO year.

- Median profitability after 1 year is 2%.
- IQR: Profitability 24%, log 1+ firm age is 1.4.

Firm age at IPO not correlated with ex-post price changes

	R_t	R_{t+1}	R_{t+2}	R_{t+3}	R_{t+4}	R_{t+5}
$\log(1 + \text{Age at IPO})$	-0.0019	0.0021	0.0014	0.0014	-0.0002	0.0013
	(-1.06)	(1.73)	(1.46)	(1.18)	(-0.20)	(1.35)
Observations	5833	6033	5307	4535	3841	3211
Controls						
$Size_t$	Y	Y	Y	Y	Y	Y
ROA_t	Y	Y	Y	Y	Y	Y
Calendar Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y

Table: t-statistics in parenthesis; errors clustered by IPO year.

- Even though firm age at IPO predicts future profitability, price at IPO revealing.