Adverse Selection, Slow Moving Capital and Misallocation

William Fuchs*   Brett Green*   Dimitris Papanikolaou†

*Haas School of Business
University of California-Berkeley

†Kellogg School of Management
Northwestern University and NBER

NBER Asset Pricing Meetings, April 2015
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
  \[ dy_\ell(\theta) = \pi_\ell(\theta) dt, \quad \text{where } \pi'_\ell > 0 \]
  - 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: \( \theta < \bar{\theta} \)
  - Quality is privately observed by owner.
  - Lemons condition
    \[ \pi_A(\bar{\theta}) > \int \pi_B(\theta) dF(\theta) \]
Firms in A optimally choose \textit{when} to sell capital. Their tradeoff:

\begin{itemize}
  \item Sell now: Capture productivity gains in new sector
  \item Sell later: Potentially get a better price
\end{itemize}

Firms in B are \textit{competitive}.

\begin{itemize}
  \item Value capital at $V(\theta) = \frac{\pi_B(\theta)}{r}$ for $\theta$-unit
\end{itemize}

Equilibrium:

\begin{enumerate}
  \item Sector $A$ firms optimize given prices
  \item Sector $B$ firms break even given $A$ firms’ policy
  \item Market clearing
\end{enumerate}
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 $t = 0$:

**Sector A**

![Graph showing the distribution of Sector A]

**Sector B**

![Graph showing the distribution of Sector B]
Equilibrium dynamics

As $t$ increases:

Sector A

Sector B
Equilibrium dynamics

As $t$ increases:

- **Sector A**

- **Sector B**
Equilibrium dynamics

As $t$ increases:

Sector A

Sector B
As $t$ increases:

Sector A

Sector B
Equilibrium dynamics

As $t$ increases:

Sector A

Sector B
For $t > \tau(\bar{\theta})$
The equilibrium is characterized by

\[ P_t = \frac{\pi_B(\chi_t)}{r} \]  

(Break Even Condition)

\[ rP_t - \pi_A(\chi_t) = \frac{d}{dt} P_t \]  

(Cost of Delay vs. Benefit of Delay)

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 \( \chi \)
  \[ \dot{\chi}_t = r \cdot \left( \frac{\alpha - 1}{\alpha} \right) \chi_t + \beta, \]

- Therefore reallocation rate proportional to \( e^{(\alpha - \frac{1}{\alpha})rt} \)
  - 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

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

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

\[
\begin{array}{c|cc}
\text{Location} & \pi_A & \pi_B \\
\hline
\phi_A & \pi_1(\theta) & \pi_0(\theta) \\
\phi_B & \pi_0(\theta) & \pi_1(\theta) \\
\end{array}
\]

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 \([\theta, \overline{\theta}]\).
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 $\rightarrow$ 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)

Higher $\lambda \implies$ larger discount for higher $\theta$

$\implies$ low types have less incentive to delay

$\implies$ so they reallocate faster
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 $\lambda$. 

\[ \dot{\chi} = 0 \quad \lambda = 0 \]
\[ \dot{\chi} = 0.1 \quad \lambda = 0.1 \]
\[ \dot{\chi} = 0.25 \quad \lambda = 0.25 \]
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 $\bar{\theta} - \theta$
  2. Reduction in the interest rate: $r$
Impulse response: capital dispersion

- 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

- **Standard adjustment cost model:** lower $r$ increases benefits from reallocation
  - \textbf{faster} reallocation

- **Our model:** lower $r$ decreases the cost of delaying
  - \textbf{slows down} reallocation
We also consider a closed economy with CRRA households

1. Due to consumption smoothing motives
   - Interest rate rises upon arrival of sectoral shock
   - Higher interest rates increase cost of delay $\implies$ 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.

Figure:
(g) Change in log output
(h) Rate of reallocation

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

\[ \gamma = 4 \]
\[ \gamma = 2 \]
\[ \gamma = 0 \]
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.”