Adverse Selection, Slow Moving Capital and Misallocation.

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Motivation

- Economies respond sluggishly to aggregate shocks
- Capital misallocation matters.
  - e.g., Syverson (2004); Foster, Haltiwanger, and Syverson (2008)
- Especially in developing countries.
  - e.g., Hsieh and Klenow (2009)
Adjustment costs often used to explain these patterns:

- ‘k-dot’ adjustment cost generate slow changes in the capital stock
- ‘i-dot’ adjustment costs to generate slow changes in investment
  - Christiano, Eichenbaum and Evans (2005)
- Counter-cyclical adjustment costs generate pro-cyclical reallocation
  - Eisfeldt and Rampini (2006)

But what do these costs represent? Physical costs vs market frictions
A microfoundation for capital adjustment costs based on adverse selection
This Paper

- A microfoundation for capital adjustment costs based on adverse selection
  - Flexible model: generates rich reallocation dynamics

Applications
- Physical (or Human) Capital Reallocation.
- Technological Innovation and New Investment.
- Slow moving financial capital.
This Paper

- A microfoundation for capital adjustment costs based on adverse selection
  - Flexible model: generates rich reallocation dynamics
  - Misallocation increases with
    - productivity dispersion (degree of adverse selection)
    - frequency of productivity shifts
    - lower interest rate
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Convex Adjustment Cost and Time to Build Models

Search and Capital Mobility:

Financial Constraints:

Adverse Selection and Delay:
The Model

- Different locations \( l \in \{a, b\} \)
  - Sectors, industries, or physical locations
- Mass \( M > 1 \) of firms in each location
  - Firms can operate a unit of capital only in their own location
- Unit mass of capital of quality: \( \theta \in [\underline{\theta}, \overline{\theta}] \sim F(\theta) \) with \( dF(\theta) > 0 \)
  - Quality is privately observed by owner of capital
- The state \( \phi_t \in \{\phi_A, \phi_B\} \) is a Markov process with transition probability \( \lambda \).
- Output flow \( \pi_l(\theta, \phi_t) \) depends on capital quality, its location and the state:

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

where \( \pi_1(\theta) > \pi_0(\theta) \) and \( \pi'_i(\theta) > 0 \).
In order for capital to be reallocated it must be traded in a continuously open market.

Only friction adverse selection. (not adj costs, no search, deep pockets)

Firms can observe in which sector the capital is that they are buying but not its quality.

Existing capital depreciates and new capital flows in at rate $\delta$

- New capital flows into efficient sector (maintains full support).

Firms maximize the present expected profits discounted at $\rho = r + \delta$
If we have just one permanent transition then the value to the buyers of capital of type $\theta$ is simply $V_1(\theta) = \frac{\pi_1(\theta)}{\rho}$.

If the state is transitory then buyers will take into account the inefciencies they will face at the time of future sales when valuing capital. The problem is harder since $V_1(\theta)$ will be endogenous.

Different types of capital will have different illiquidity discounts.
Transitory vs Permanent

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- Different types of capital will have different illiquidity discounts.
Given $P_t$ sellers face a stopping problem:

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\sup_{\tau} \int_{0}^{\tau} e^{-\rho t} \pi_0 (\theta) \, dt + e^{-\rho \tau} P_t
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Permanent: Seller’s Problem

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- Skimming Property: If it is optimal for type $\theta$ to trade at time $t$, then strictly optimal for all $\theta' < \theta$ to trade at (or before) $t$. 

Let $\chi_t$ denote the lowest quality asset that has not been traded by time $t$:

$$\chi_t = \inf_{\theta} \tau_i = t : \tau_i \geq F$$
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Definition

A path for prices $P$ and stopping rules $\tau(\theta)$ is a **Competitive Decentralized Equilibrium** if:

(i) **Sellers Optimize:** Given $P$, $\tau(\theta)$ solves the Seller’s Problem

(ii) **Zero Profit:** Let $\Theta_t \neq \emptyset$ denote the set of types that trades at $t$, then:

$$P_t = E \left[ V_1(\theta) \mid \theta \in \Theta_t \right]$$

(iii) **Market Clearing:** $P_t \geq V_1(\chi_t)$
We will focus our analysis on the separating equilibrium where $\chi_t$ is strictly increasing and continuous.

Other equilibria can be ruled out with additional assumptions.
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- Seller’s Optimality:

\[ \rho P_t = \frac{dP_t}{dt} + \pi_0(\chi_t) \]

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- Together:

\[ \rho V_1(\chi_t) = \frac{d\chi_t}{dt} \frac{dV_1(\chi_t)}{d\chi} + \pi_0(\chi_t) \]
Letting $\dot{\chi}_t = \frac{d\chi_t}{dt}$ and rearranging:

$$\dot{\chi}_t = \frac{\pi_1(\chi_t) - \pi_0(\chi_t)}{\frac{\pi_1'(\chi_t)}{\rho}}$$
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This differential equation + boundary condition pin down the equilibrium. Note that $F(\theta)$ only plays a role via its support, shape does not matter.
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$F(\theta)$ would still matter when calculating aggregates.
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.
Permanent: Aggregate Productivity

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

Figure: Productivity is increasing across both sectors.
Permanent: Example:

Let \( \pi_1 (\theta) = c\theta + d \) and \( \pi_0 (\theta) = \theta \)

\[
\dot{\chi}_t = \frac{(c - 1)\chi_t + d}{\frac{c}{\rho}}
\]

\( c = 1 \rightarrow \dot{\chi}_t \) is constant over time
\( c > 1 \rightarrow \dot{\chi}_t \) is increasing over time
\( c < 1 \rightarrow \dot{\chi}_t \) is decreasing over time
Under full information we would have type specific prices $P(\theta)$ and all capital instantaneously reallocating.
Permanent: Example Benchmarks:

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Convex adjustment cost model:
- For simplicity assume capital is homogenous.
- Specify costs in terms of how capital is reallocated between sectors:

\[
c(k, \dot{k}, \ddot{k}) = \begin{cases} 
  c(k)^2 & ('kdot') \\
  c\left(\frac{k}{1-k}\right)^2 (1-k) & ('ik') \\
  c(\ddot{k})^2 & ('idot')
\end{cases}
\]

Focus on the planner’s problem:

\[
\max \int_0^\infty e^{-\rho t} (1 - k_t) \pi_0 + k_t \pi_1 - c(k_t)
\]
Permanent: Costly Adjustment Cost Dynamics:

Adverse selection can deliver similar dynamics to those of the costly adjustment cost models!!
Focus on stationary separating equilibria (only time since last shock matters).

Let $V_0(\theta, \chi)$ denote the value of a unit of capital ineffectively allocated.

The seller's Bellman equation is:

$$
\rho V_0(\theta, \chi) = \pi_0(\theta) + \lambda (V_1(\theta) - V_0(\theta, \chi)) + \frac{\partial V_0(\theta, \chi)}{\partial \chi} \dot{\chi}_t
$$

The cut-off type ($\theta = \chi$) must be locally indifferent:

$$
P_0(\chi) = \frac{\partial V_0(\theta, \chi)}{\partial \chi} \bigg|_{\theta = \chi}
$$

Combining we get:

$$
\dot{\chi}_t = \rho V_1(\chi_t) - \pi_0(\chi_t) V_1(\chi_t), \chi_0 = \theta
$$

Before we were done but now we must determine $V_1(\theta)$ which is now endogenous.
Transitory: Seller’s Problem

- Focus on stationary separating equilibria (only time since last shock matters).
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Determining $V_1(\theta)$ from $\chi_t$

$$V_1(\theta) = \frac{\rho}{\rho + \lambda} \pi_1(\theta) + \frac{\lambda}{\rho + \lambda} V_0(\theta, \theta)$$

Also,

$$V_0(\theta, \theta) = f(\tau(\theta)) \frac{\pi_0(\theta)}{\rho} + (1 - f(\tau(\theta))) V_1(\theta)$$

$\tau(\theta)$ is the time from that it takes to type $\theta$ to trade once the state switches.

$f(\tau(\theta))$ in addition takes into account discounting and the state switching.
Transitory: Characterization:

Combining both we get:

\[ V_1(\theta) = g(\tau(\theta)) \frac{\pi_0(\theta)}{\rho} + (1 - g(\tau(\theta))) \frac{\pi_1(\theta)}{\rho} \]
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- Using the seller’s indifference condition we can then obtain:

\[ \dot{\chi}_t = \rho \left( 1 - g(t) + \frac{g'(t)}{\rho} \right) \left( \pi_1(\chi_t) - \pi_0(\chi_t) \right) \]

\[ \frac{\rho \left( 1 - g(t) + \frac{g'(t)}{\rho} \right) \left( \pi_1(\chi_t) - \pi_0(\chi_t) \right)}{g(t) \pi_0'(\chi_t) + (1 - g(t)) \pi_1'(\chi_t)} \]

which (under mild regularity conditions) has a unique solution.
Existence and Uniqueness of Separating Equilibria

**Theorem**

There exists a unique \((\tau^*, V_1^*)\) such that the strategies consistent with \((\tau^*, V_1^*)\) constitute a fully separating equilibrium.

**Remark:** If other equilibria exist they are basically characterized by a continuous flow of trade, a pause and one atom in which all remaining types trade. If the adverse selection problem is mild enough then the atom would take place at time zero. A sufficient condition to rule such equilibria out is that \(\pi_0(\bar{\theta}) = \pi_1(\bar{\theta})\).
What happens when shocks are more frequent?

- Initial guess: The state will switch back soon $\Rightarrow$ less incentive to trade $\Rightarrow$ slower reallocation.
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- Not correct!!

![Graphs showing constant and increasing gains over time](image-url)
What happens when shocks are more frequent?

**Result**

Consider any two symmetric economies \( \Gamma_x \) and \( \Gamma_y \), which are identical except that \( \lambda_x < \lambda_y \). There exists a \( \bar{t} > 0 \) such that the rate of reallocation is strictly higher in \( \Gamma_y \) than in \( \Gamma_x \) prior to \( \bar{t} \), i.e., \( \chi'_y(t) > \chi'_x(t) \) for all \( t \in [0, \bar{t}] \).
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Explanation:

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- Reallocation must "speed up" at the bottom in equilibrium.
What happens when shocks are more frequent?

\[ \frac{\pi_1}{\rho} \]

- \( \lambda = 0.1 \)
- \( \lambda = 2 \)
Empirical Evidence: Productivity dispersion correlated with misallocation.
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- Capable of generating rich dynamics/predictions.

Delayed response to shocks. Productivity dispersion amplifies misallocation. TFP slowdowns in response to innovation.

Several possible applications:

- Physical capital reallocation.
- Human capital reallocation.
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