FINANCIAL RISK AND UNEMPLOYMENT

Zvi Eckstein, Ofer Setty, David Weiss

Tel Aviv U. and IDC, Tel Aviv U., Tel Aviv U.

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Volatility in labor market – unemployment $u$, vacancies $v$, and market tightness $\theta = \frac{v}{u}$
Introduction

- Volatility in labor market – unemployment $u$, vacancies $v$, and market tightness $\theta = \frac{v}{u}$

- Firms experience a large volatility in financial risk:
  - Interest rate (BAA)
  - Spread (BAA-Treasury)
Introduction

- Volatility in labor market – unemployment $u$, vacancies $v$, and market tightness $\theta = \frac{v}{u}$

- Firms experience a large volatility in financial risk:
  - Interest rate (BAA)
  - Spread (BAA-Treasury)

- How much labor market volatility can be accounted for by financial shocks?
  - A search-and-matching (DMP) model with capital
  - A simple model goes a long way
Mechanisms DMP

Productivity shock $\downarrow \rightarrow$ surplus/profits $\downarrow \rightarrow v \downarrow \rightarrow u \uparrow$
Mechanisms DMP

Productivity shock $\downarrow \rightarrow$ surplus/profits $\downarrow \rightarrow u \uparrow$

Interest rate rises:

- *Profits*: capital costs $\uparrow \rightarrow$ profits $\downarrow \rightarrow v \downarrow$

- *Vacancy cost*: vacancy cost $\uparrow \rightarrow$ return on vacancies $\downarrow \rightarrow v \downarrow$
Mechanisms DMP

Productivity shock ↓ → surplus/profits ↓ → v ↓ → u ↑

Interest rate rises:

- **Profits**: capital costs ↑ → profits ↓→ v ↓

- **Vacancy cost**: vacancy cost ↑→ return on vacancies ↓ → v↓

Spread rises - related to rising default:

- **Ownership**: claim to future profits ↓ → v ↓
## Why Financial Shocks?

<table>
<thead>
<tr>
<th></th>
<th>(u)</th>
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- Quarterly moments: 1982 – 2012
- All stochastic processes in HP-log deviations

More... Contemporaneous...
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**Figure**: US time-series data 1982-2012
Spread and productivity are lagged by 2 quarters
Unemployment, Spread, Productivity

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- DMP with productivity shocks:
  - Puzzle: Shimer (2005)
  - Solutions: Hall (2005), Hagedorn & Manovskii (2008)....
  - Fundamental surplus: Ljungqvist and Sargent (2014)

- DMP with financial shocks:
  - Petrosky-Nadeau (2014)
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Methodology

- Use a search-and-matching (DMP) model with capital

Calibrate Model to US economy- NOT including volatility

Use exogenous financial shocks

A default risk

A financial intermediation cost

Model delivers $\sim 80\%$ of volatility

Interest rate mechanisms important

A large-shock model, not a small-surplus one

$\sim 50\%$ of increase in $u$ during the Great Recession
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Key Features

- Risk-neutral workers, $E_0 \sum_{t=0}^{\infty} \beta^t i_t$
  - Employed: $i_t = w_s + r_f k_s$
  - Unemployed: $i_t = b + r_f k_s$
  - Make consumption/savings choice w.r.t. risk free $r_f$
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  - Perceive financial intermediation costs & default risk ($\rightarrow r_s$)
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  - Matched: produce, pay labor & capital costs: $w_s, (r_s + \delta)k$
    - $\delta$ is the depreciation rate, $r_s$ is state dependent
  - Unmatched: post vacancies $v$ at a cost $c_s(r_s)$
  - Face state-dependent default
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- Wages - Nash Bargaining
Banks

- Borrow from workers at $r_f = \frac{1-\beta}{\beta}$
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  - Default rate $d_s$ (recovery rate $\zeta$)
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  - Default rate $d_s$ (recovery rate $\zeta$)
  - Intermediation costs $x_s$
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- Lend to firms at rate \( r_s \), to maximize per-unit profits:

\[
\pi_b = (1 - d_s)(1 + r_s - x_s) + d_s \zeta (1 + r_s - x_s) - (1 + r_f)
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- Timing: \( d_s, x_s \) realized; \( r_s \) set by profit maximization
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- Free entry
Matching

- A C.R.S. matching function $M(u, v)$: new matches

- Define *market tightness* as: $\theta = \frac{v}{u}$
  - Job finding rate for worker: $\frac{M(u,v)}{u} = \lambda^w(\theta)$
  - Job filling rate for firm: $\frac{M(u,v)}{v} = \lambda^f(\theta)$

- Use: $M(u, v) = \frac{uv}{(u^l+v^l)^{\frac{1}{r}}}$ (Ramey, den Haan, and Watson)
Firms and Production

- Matched firms: output $p$ using capital $K$ and labor $L$

$$Q(L, K) = \min \left( pL, \frac{K}{\phi} \right)$$

- Capital per worker is $k = \frac{K}{\phi p}$

- Allows constant productivity

- Look at business cycle frequencies

- Flow profits per match: $\pi = p - w_s - (r_s + \delta)k$
Firms and workers face state-independent separations $\bar{\sigma}$

In addition firms separate at $d$, due to default

Separation rate for firms: $\sigma_s^f = \bar{\sigma} + (1 - \bar{\sigma})d$

Separation rate for workers: $\sigma_w^w = \bar{\sigma}$
**Value Functions – Workers**

Employed worker:

\[ W_s = w_s + r_f k + \beta((1 - \sigma^w)E_sW_{s'} + \sigma^w E_sU_{s'}) \]

Unemployed worker:

\[ U_s = b + r_f k + \beta(\lambda^w(\theta)E_sW_{s'} + (1 - \lambda^w(\theta)) E_sU_{s'}) \]
**Value Functions – Firms**

The value of a matched firm is:

\[ J_s = p - w_s - (r_s + \delta)k + \beta \left( (1 - \sigma^f_s)E_s J_{s'} + \sigma^f_s E_s V_{s'} \right) \]

Vacancy posting firm:

\[ V_s = -c_s(r_s) + \beta \left( \lambda^f(\theta)E_s J_{s'} + \left( 1 - \lambda^f(\theta) \right)E_s V_{s'} \right), \]

with vacancy cost: \( c_s(r_s) = c_r r_s + c_\delta + c_l \) (conservative!)
Wages – Nash Bargaining

- Wages solve: \( \max_{w_s} (W_s - U_s)^\gamma (J_s - V_s)^{1-\gamma} \)
  - where \( \gamma \) is the worker’s bargaining weight

- The solution is: \( W_s - U_s = \gamma S_s; \quad J_s = (1 - \gamma) S_s \)
  - where \( S_s = (W_s - U_s) + (J_s - V_s) \)

Equilibrium
Calibration

- Time period is a week
- Abstract from default
- Normalize \( p - (\bar{r} + \delta)k = 1 \)
  - Flow surplus is \( 1 - b - k \Delta r \), where \( \Delta r \) is deviation from mean
  - Compared with \( 1 - b + \Delta p \) in productivity shocks literature
- Exogenous shocks to the financial intermediation cost \( x_s \)
- Set some parameters a priori
- Set some parameters to match data moments
Financial shocks

- Without default the free entry condition for banks becomes:

$$r_s = r_f + x_s$$
**FINANCIAL SHOCKS**

- Without default the free entry condition for banks becomes:
  
  \[ r_s = r_f + x_s \]

- Reminder: banks

- Guess & verify a weekly AR(1) process that matches quarterly data on \( r_s \)

<table>
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<th>Parameter</th>
<th>Model</th>
<th>Data</th>
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<tbody>
<tr>
<td>Frequency</td>
<td>Weekly</td>
<td>Quarterly</td>
<td>Quarterly</td>
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<td>Persistence</td>
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### A-Priori Parameter Values

<table>
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<th>Symbol</th>
<th>Meaning</th>
<th>Value</th>
<th>Identification</th>
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<tr>
<td>(\sigma)</td>
<td>Job separation</td>
<td>0.0081</td>
<td>CPS-Shimer (2005)</td>
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<tr>
<td>(\beta)</td>
<td>Discount rate</td>
<td>0.99(\frac{1}{12})</td>
<td>4% annual</td>
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<tr>
<td>(c)</td>
<td>Vacancy Costs</td>
<td>0.584</td>
<td>(K &amp; w) – HM (2008)</td>
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<td>(\gamma)</td>
<td>Worker Bargaining Weight</td>
<td>0.50</td>
<td>Literature</td>
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<tr>
<td>(\delta)</td>
<td>Depreciation Rate</td>
<td>0.0012</td>
<td>6% annual (NIPA)</td>
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▶ Calibration of vacancy cost
Calibration – Matching Moments

Parameter values and identification:

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<td>$b$</td>
<td>Flow utility when $u$</td>
<td>0.60</td>
<td>Job finding rate</td>
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<td>$l$</td>
<td>Matching elasticity</td>
<td>0.41</td>
<td>Market Tightness</td>
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Model fit:

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Table: Quarterly moments: data: 1982–2012 versus Model

In correlations with the $r$, the interest rate is lagged by two quarters. This is with Results without lag.
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- **Vacancy cost**: vacancy cost $\uparrow \rightarrow$ return on vacancies $\downarrow \rightarrow v \downarrow$

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Breakdown of Mechanisms

Interest rate rises:

- **Profits:** capital costs $\uparrow \rightarrow$ profits $\downarrow \rightarrow v \downarrow$

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<td>Vacancy cost</td>
<td>0.03</td>
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**Table:** Breakdown- Just Standard Deviation
A small surplus or a large shock?

- The elasticity of market tightness ($\theta$) w.r.t. the shock:

In Shimer (2005):
$$\frac{\partial \log \theta}{\partial \log p} = 1.67.$$  

In our model:
$$\frac{\partial \log \theta}{\partial \log r_k} = 0.83 \text{ (only the profit channel)}.$$  

But...

$$\sigma_p = 0.01.$$  

$$\sigma_r = 0.14.$$  

...our model produces $0.83 \times 0.67 \times 0.14 = 7$ times more volatility.
A small surplus or a large shock?

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  - In Shimer (2005): $\frac{\partial \log \theta}{\partial \log p} = 1.67$
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...our model produces more volatility:

- $\sigma_p = 0.01$
- $\sigma_r = 0.14$
- $\sigma = 0.831670.01 = 7$ times more volatility
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# Robustness

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<tr>
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Robustness – Cobb Douglas

Now suppose:

- Cobb-Douglas: \( y(k) = Ak^\alpha: \alpha = 1/3 \)
- Solution: \( k = \left( \frac{\alpha A}{r+\delta} \right)^{\frac{1}{1-\alpha}} \)
- Flow Surplus: \( y(k) - b - rk \)
Robustness – Cobb Douglas

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Robustness – Cobb Douglas

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- Cobb-Douglas: $y(k) = A k^\alpha$: $\alpha = 1/3$
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What About the Great Recession?

![Graph showing the percent of a given year]

- **Percent**: 4, 6, 8, 10, 12, 14, 16
Simulate the *benchmark* model for 2008Q2-2012Q4
What About the Great Recession?

- Simulate the benchmark model for 2008Q2-2012Q4
- Simulate a counterfactual if the Fed had not intervened:

\[ r_c = r_t + (f_{2008Q2} - f_t) \]
CONCLUSION

We studied:

- Mechanisms for *financial risk* affecting unemployment
- The quantitative effect of those shocks using DMP literature
Conclusion

We studied:

▶ Mechanisms for *financial risk* affecting unemployment
▶ The quantitative effect of those shocks using DMP literature

We found:

▶ Financial conditions matter a lot
▶ The main driving force is the interest rate
Calibration of vacancy cost

- Vacancy cost is $c_s(r_s) = c_r r_s + c_\delta + c_l$

- Capital component: $c_r r_s + c_\delta$
  - Assume capital required one period in advance
  - Capital share = $\frac{1}{3}$
  - Labor productivity is 1 → capital cost $\sim 0.5$
  - Correct for capital in vacancies: $c_r r_s + c_\delta = 0.474$

- Labor component: $c_l$
  - 11% of average labor productivity based on micro evidence

- Total vacancy cost = $0.474 + 0.11 = 0.584$
Hires from JOLTS, Inv. is real gross private domestic
Correlation = 0.73
St dev of log is 0.11 for investment, 0.10 for hires
**UNEMPLOYMENT, INTEREST, PRODUCTIVITY**

**Figure:** US time-series data 1982-2012

Interest rate and productivity are lagged by 2 quarters
Unemployment, Interest rate and Spread

Figure: US time-series data 1982-2012
No lag

Spread HP filtered
EQUILIBRIUM

Given free entry for banks \( r = f(x, d|r_f, \zeta) \), solve \( S_s, \theta_s \) using:

- Free entry condition \( (V = 0) \):
  \[
  \frac{c_s}{\lambda f(\theta)} = \beta(1 - \gamma)E_sS'_s(= \beta E_s J'_s)
  \]

- Evolution of surplus:
  \[
  S_s = p - b - (r_s + \delta)k + \beta \left\{ \left(1 - \sigma_s^f\right)E_sS'_s - \frac{(\theta q(\theta) - (1 - \bar{\sigma})d)\gamma c_s}{(1 - \gamma) q(\theta)} \right\}
  \]

The aggregate resource constraint is \( C + I = Y \), where:

\[
Y = (1 - u)p
\]
\[
I = vc_s + (1 - \sigma^w)(\delta + x + d(1 - \zeta))(1 - u)k.
\]
Abstracting from Default

- Default is a shock to ownership (continuation value)
- How big is it?
  - Separation rate is on average 2% a month (Shimer, 2005)
  - Default rate is on average 1% a year (Elton, 2001)
- Formalize that this is small using Ljungqvist and Sargent (2014) *Fundamental Surplus* approach
# Results - Data versus Model

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**Table:** Quarterly moments: data: 1982-2012 versus Model

In correlations with the $r$, the interest rate is contemporaneous.
**Interest Rate vs. Productivity Shocks**

Comparison by looking at only data:

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**Table:** Quarterly moments: data: 1982-2012
Correlations: $r$ or $p$ are lagged by two quarters

Note: exact value for $\sigma_p$ is 0.0095.
Comparison by looking at only data:

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**Table**: Quarterly moments: data: 1982-2012 Contemporaneous correlations

Note: exact value for $\sigma_p$ is 0.0095.
Why Financial Shocks?

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<tr>
<td>St Dev</td>
<td>0.11</td>
<td>0.12</td>
<td>0.22</td>
<td>0.14</td>
<td>0.35</td>
<td>0.01</td>
</tr>
<tr>
<td>Corr with $u$</td>
<td></td>
<td></td>
<td></td>
<td>0.26</td>
<td>0.71</td>
<td>-0.32</td>
</tr>
<tr>
<td></td>
<td>2 quarters lags</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.32</td>
<td>0.62</td>
<td>0.05</td>
</tr>
</tbody>
</table>

- Quarterly moments: 1982 – 2012
- All stochastic processes in HP-log deviations
Elasticity of tightness w.r.t. the shock

Example: profits channel

- A continuous time model w/ only profits mechanism \((r_s k)\)

\[
\frac{\partial \log \theta}{\partial \log p} = \frac{p}{p - b} \quad * \Upsilon \quad \text{productivity shocks}
\]

fundamental surplus

\[
\frac{\partial \log \theta}{\partial \log rk} = \frac{-\bar{r}k}{p - \bar{r}k - \delta k - b} \quad * \Upsilon \quad \text{interest – rate shocks}
\]

fundamental surplus

- \(\Upsilon = \frac{(r+\sigma)+\gamma \theta q(\theta)}{\alpha(r+\sigma)+\gamma \theta q(\theta)}\) where \(\alpha\) is the elasticity of matching w.r.t. \(u\)
Elasticity of tightness w.r.t. the shock

Example: profits channel

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\[
\text{fundamental surplus}
\]

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\frac{\partial \log \theta}{\partial \log rk} = \frac{-\bar{r}k}{p - \bar{r}k - \delta k - b} \ast \Upsilon \quad \text{interest-rate shocks}
\]

\[
\text{fundamental surplus}
\]

\[
\Upsilon = \frac{(r+\sigma)+\gamma\theta q(\theta)}{\alpha(r+\sigma)+\gamma\theta q(\theta)} \quad \text{where } \alpha \text{ is the elasticity of matching w.r.t. } u
\]

- In Shimer-based calibration: \(\frac{p}{p-z} = 1.67, \frac{\bar{r}k}{p-\bar{r}k-\delta k-z} = 0.83\)

- Conclusion: elasticity is about 2 times smaller in our model, But:

- \((r,\text{spread})\) are \(\sim 14\) times more volatile than labor productivity

\[
\frac{\partial \log \theta}{\partial \log rk} \ast \sigma_r = 0.12
\]
Banks

- Borrow from workers at \( r_f = \frac{1-\beta}{\beta} \)
- Face:
  - Default rate \( d_s \) (recovery rate \( \zeta \))
  - Intermediation costs \( x_s \)
- Lend to firms at rate \( r_s \), to maximize per-unit profits:

\[
\pi_b = (1 - d_s)(1 + r_s - x_s) + d_s \zeta(1 + r_s - x_s) - (1 + r_f)
\]
- Timing: \( d_s, x_s \) realized; \( r_s \) set by profit maximization
- Free entry