# Financial Risk and Unemployment
## Work in progress

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# Introduction

- Volatility in unemployment $u$, vacancies $v$, tightness $\frac{v}{u}$
- Firms experience a large volatility in financial risk:
  - Interest rate fluctuations (BAA)
  - Spread ($\Rightarrow$ default) fluctuations (BAA-Treasury)
- Relationship? $\rightarrow$

# Unemployment, Interest rate and Spread

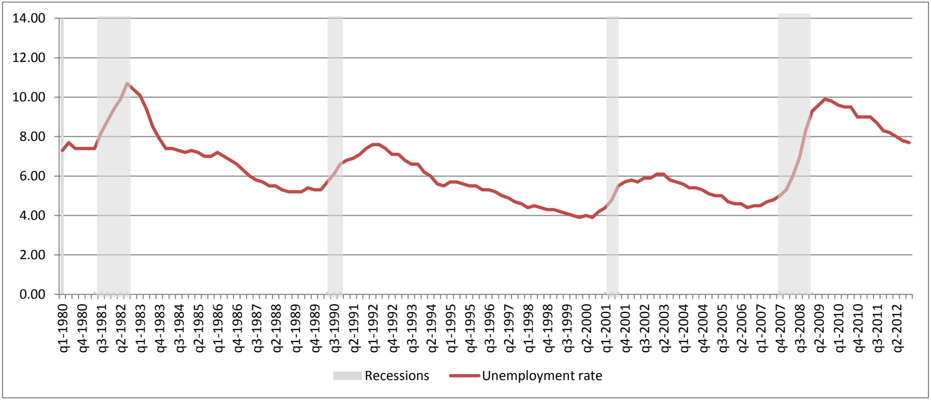


Figure: US time-series data 1980-2012

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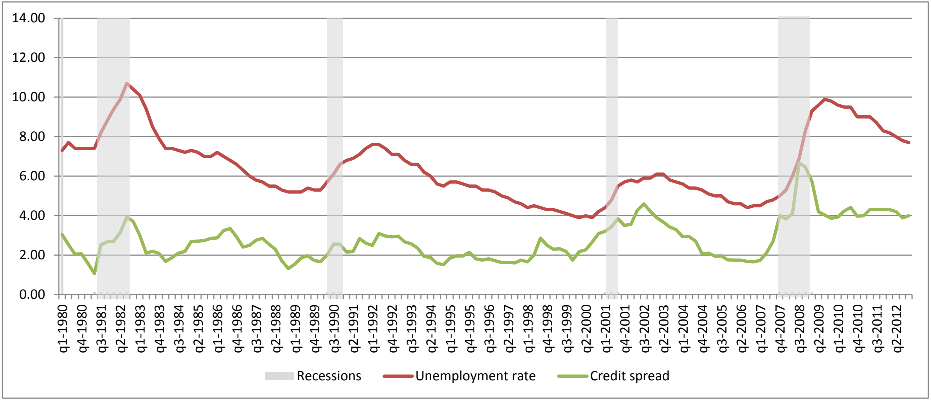


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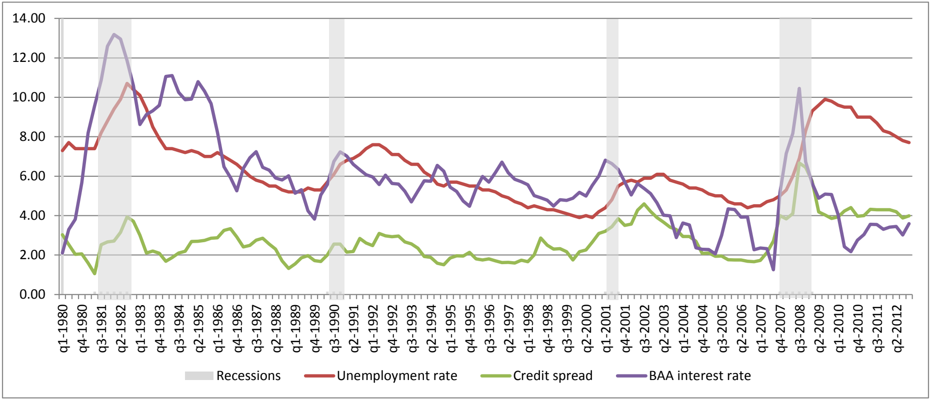


Figure: US time-series data 1980-2012

Spread & interest rate Granger cause $u$ with lag 2.

# Research question & Methodology

*How does financial risk (interest rate and credit spread) affect unemployment, vacancies, and market tightness?*

- What are the mechanisms?
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Methodology:

- Use a search-and-matching (DMP) model with capital
- Use exogenous interest rate and spread shocks
- Outline mechanisms for interest rate and spread
- Calibrate model to US economy (w/o targeting volatility)

# Literature

- Productivity shocks: p $\downarrow \rightarrow$ profits $\downarrow \rightarrow$ v $\downarrow \rightarrow$ u $\uparrow \quad \Rightarrow \theta \downarrow$
  - Puzzle: Shimer (2005)
  - Wage stickiness: Hall (2005)
  - Calibration: Hagedorn and Manovskii (2008)
  - Amplification: Petrosky-Nadau (2014)...
  - *Fundamental surplus*: Ljungqvist and Sargent (2014)

# Literature

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  - Calibration: Hagedorn and Manovskii (2008)
  - Amplification: Petrosky-Nadau (2014)...
  - *Fundamental surplus*: Ljungqvist and Sargent (2014)
- Alternative shocks:
  - Credit: Monacelli, Quadrini and Trigari (2012)
  - Discount rate: Hall (2014)

# Mechanisms

Interest rate rises:

- higher capital costs lead to a lower profits (*Profits*)
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Spread (default) rises:

- increase in chances of losing claim to profits (*Ownership*)
- some defaults end in separation with worker (*Closure*)

Back to Breakdown

# Model

## Key Features

- Risk-neutral workers, $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t i_t$
  - Employed: $i_t = w_t$
  - Unemployed: $i_t = b$
- Firms:
  - Matched: produce, pay labor & capital costs: $w_s$ & $r_s k + \delta k$
  - Unmatched: post vacancies $v$ at a cost $c_s(r_s)$
- Workers and firms match in a *frictional* labor market
- Wages - Nash Bargaining
- State-dependent default and separations

# Matching

- A C.R.S. matching function $M(v,u)$: 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: $M(u,v) = \frac{uv}{(u^l + v^l)^{\frac{1}{l}}}$

# Firms and Production

- Firms produce output $p$ using capital $K$ and labor $L$:

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

  - Allows constant productivity
  - Treat the data accordingly

# Inferring default from the spread

- Risk neutral competitive financial intermediaries borrow at rate $r_f$ and lend to *risky* firms at rate $r_e$
  - Risk: default at rate $\psi_n$ with recovery rate $\Omega$

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$$1 + r_f = (1 - \psi_n)(1 + r_e) + \psi_n \Omega (1 + r_e)$$

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- But, only a fraction $\eta_1$ of spread is due to default:

$$\Rightarrow \psi_d = \frac{\eta_1 * (r_e - r_f)}{1 + r_e} \frac{1}{1 - \Omega}$$

# Separations

- *Firms*: default at rate $\psi_d$
- *Workers:* only a fraction $\eta_2$ of defaults end in separation
- In addition firms and workers face state-independent $\bar{\sigma}$

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- *Firms*: default at rate $\psi_d$
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- In addition firms and workers face state-independent $\bar{\sigma}$
- Separation rate for *firms*: $\sigma_s^f = \bar{\sigma} + (1 - \bar{\sigma})\psi_d$
- Separation rate for *workers*: $\sigma_s^w = \bar{\sigma} + (1 - \bar{\sigma})\psi_d \eta_2$

# Value Functions - Workers

Employed worker:

$$W_s = w_s + \beta((1 - \sigma_s^w) E_s W_{s'} + \sigma_s^w E_s U_{s'})$$

Unemployed worker:

$$U_s = b + \beta(\lambda^w(\theta) E_s W_{s'} + (1 - \lambda^w(\theta)) E_s U_{s'})$$

# Value Functions - Firms

The value of a matched firm is:

$$J_s = \underbrace{p - w_s - r_s k - \delta k}_{\text{Flow profit}} + \beta \left( \left(1 - \sigma_s^f\right) E_s J_{s'} + \sigma_s^f E_s V_{s'} \right)$$

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: $c_s(r_s) = c_r r_s + c_\delta + c_l$

# 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

Solve for $S_s, \theta_s$ using:

- Free entry condition ($V = 0$):

$$\frac{c_s}{\lambda^f(\theta)} = \beta(1-\gamma)E_s S_{s'} (= \beta E_s J_{s'})$$

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- Free entry condition ($V = 0$):

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- Evolution of surplus:

$$S_s = p - b - (r_s + \delta)k + \beta \left\{ \left(1 - \sigma_s^f\right) E_s S_{s'} - \frac{\left(\theta q(\theta) - \sigma_s^f + \sigma_s^w\right)\gamma}{(1-\gamma)\, q(\theta)} \frac{c_s}{\beta} \right\}$$

# Calibration strategy

- Normalize labor productivity to 1
- Use a priori calibration as Hagedorn and Manovskii (2008)
  - including their matching function & parameter
- Target job finding rate and market tightness
- VAR(1) data estimation for $\{r, spread\}$
  - simplifying (conservative) assumption: uncorrelated

▸ Details

# Calibration

## Labor productivity normalization

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$$p - (\bar{r} + \delta)k - \Delta r k - b$$

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- Define labor productivity $= p - (\bar{r} + \delta)k$ and normalize to 1

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- Flow surplus is now: $1 - \Delta r k - b$

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- Define $r_s = \bar{r} + \Delta r$ and rearrange:

$$p - (\bar{r} + \delta)k - \Delta r k - b$$

- Define labor productivity $= p - (\bar{r} + \delta)k$ and normalize to 1
- Flow surplus is now: $1 - \Delta r k - b$
- Flow surplus in the model without capital is: $p - b$

# Calibration - A priori

Time period = 1 week

| Parameter | Meaning | Value | Identification |
|---|---|---|---|
| $\beta$ | Discount rate | $0.99^{1/12}$ | Literature |
| $\delta$ | Depreciation rate | 0.0016 | Literature (8%) |
| $\bar{\sigma}$ | Job separation | 0.0081 | Shimer/ HM |
| $c$ | Mean vacancy cost | 0.584 | HM ▸ Show |
| $l$ | Matching parameter | 0.407 | HM |
| $\rho_r$ | Persistence r | 0.971 | Authors |
| $\sigma_r$ | St. dev. r | 0.084 | calculation |
| $\rho_{sp}$ | Persistence spread | 0.991 | Authors |
| $\sigma_{sp}$ | St. dev. spread | 0.051 | calculation |
| $\Omega$ | Recovery Rate | 0.51 | Acharya et al ('07) |
| $\eta_1$ | Spread due default | 1 | Aggressive |
| $\eta_2$ | Defaults that separate | 1 | Aggressive |

# Calibration -Matching Moments

Parameter values and identification:

| Parameter | Meaning | Value | Jointly Identified |
|---|---|---|---|
| $b$ | Flow utility when $u$ | 0.60 | Job finding rate |
| $\gamma$ | Bargaining weight | 0.48 | Market Tightness |

Model fit:

| Moment | Data | Model |
|---|---|---|
| Job Finding Rate | 0.139 | 0.137 |
| Market Tightness | 0.634 | 0.642 |

# Results - Data

| | | $u$ | $v$ | $\theta$ | $r$ | Spread |
|---|---|---|---|---|---|---|
| St Dev | Data | 0.11 | 0.12 | 0.22 | | |
| Pers | Data | 0.94 | 0.91 | 0.93 | | |
| Corr $U$ | Data | 1 | -0.89 | -0.97 | | |
| Corr $V$ | Data | - | 1 | 0.98 | | |
| Corr $\theta$ | Data | - | - | 1 | | |

Table: Quarterly moments: data: 1980- 2012

This is without. To Results with lag

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| Corr $\theta$ | Data | - | - | 1 | -0.15 | -0.51 |

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# Results - Data versus Model

| | | $u$ | $v$ | $\theta$ | $r$ | Spread |
|---|---|---|---|---|---|---|
| St Dev | Data | 0.11 | 0.12 | 0.22 | 0.26 | 0.29 |
| | Model | 0.11 | 0.14 | 0.23 | | |
| Pers | Data | 0.94 | 0.91 | 0.93 | 0.71 | 0.91 |
| | Model | 0.77 | 0.47 | 0.66 | | |
| Corr $U$ | Data | 1 | -0.89 | -0.97 | 0.10 | 0.45 |
| | Model | 1 | -0.65 | -0.89 | 0.86 | 0.11 |
| Corr $V$ | Data | - | 1 | 0.98 | -0.20 | -0.54 |
| | Model | - | 1 | 0.93 | -0.90 | 0.05 |
| Corr $\theta$ | Data | - | - | 1 | -0.15 | -0.51 |
| | Model | - | - | 1 | -0.96 | -0.02 |

Table: Quarterly moments: data: 1980- 2012 versus Model

This is without. To Results with lag

# Understanding the results

- What is the role of each shock? each mechanism?
  - breakdown by mechanism + intuition
- What is the importance of the calibration?
  - Alternative calibration following Shimer
- What makes the model successful?
  - Analyze the elasticity of $\theta$ w.r.t. $r$
- Why financial risk shocks?
  - Comparison between *financial risk* and *productivity* shocks

# Break Down of Mechanisms

| Mechanisms | $u$ | $v$ | $\theta$ |
|---|---|---|---|
| Data | 0.11 | 0.12 | 0.22 |
| All mechanisms | 0.11 | 0.14 | 0.23 |
| Profit | 0.06 | 0.08 | 0.13 |
| Vacancy cost | 0.05 | 0.06 | 0.10 |
| Ownership | 0.00 | 0.00 | 0.00 |
| Spread (ownership & closure) | 0.02 | 0.02 | 0.00 |

Table: Breakdown- Just Standard Deviation

▸ Reminder of mechanisms ▸ Results spread only

# Break Down of Mechanisms

## Intuition

- Profit and vacancy cost channels:
  - Large effect of deviation in $r$ on cost
- How come default matters so little?
  - Relative to stateinvariant separations ($\bar{\sigma}$), default is small
- Does it mean that firms don't care about default?
  - Direct effect is not very big, BUT....
  - Indirect effect thru interest rate is VERY important

# Robustness - Shimer (2005) calibration

- Follow Shimer (2005)
- Main differences
  - **b=0.4**, $\gamma = 0.72$
  - Lower vacancy cost
  - Different matching function
  - No capital (add as above)
- Produces very weak volatility with *productivity* shocks
- What about financial shocks?

# Shimer-based calibration

| | | $u$ | $v$ | $\theta$ | $r$ | Spread |
|---|---|---|---|---|---|---|
| St Dev | Data | 0.11 | 0.12 | 0.22 | 0.26 | 0.29 |
| | Model | 0.08 | 0.10 | 0.17 | | |
| Pers | Data | 0.94 | 0.91 | 0.93 | 0.71 | 0.91 |
| | Model | 0.75 | 0.54 | 0.68 | | |
| Corr $U$ | Data | 1 | -0.89 | -0.97 | 0.10 | 0.45 |
| | Model | 1 | -0.71 | -0.90 | 0.86 | 0.16 |
| Corr $V$ | Data | - | 1 | 0.98 | -0.20 | -0.54 |
| | Model | - | 1 | 0.94 | -0.92 | 0.09 |
| Corr $\theta$ | Data | - | - | 1 | -0.15 | -0.51 |
| | Model | - | - | 1 | -0.97 | -0.02 |

Table: Quarterly moments: data: 1980- 2012 versus Model

This is without. To Results with lag Results breakdown

# Elasticity of tightness w.r.t. the shock

## Example: profits channel

- Ljungqvist and Sargent (2014): all reconfigured models are based on a small *fundamental surplus* in the steady state:

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$$\frac{\partial log\theta}{\partial \log rk} = \underbrace{\frac{-\bar{r}k}{p-\bar{r}k-\delta k-z}}_{\text{fundamental surplus}=0.6} * \Upsilon(\gamma\lambda^w)$$

▸ Show $\Upsilon$

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Show $\Upsilon$

- In Shimer-based calibration: $\frac{p}{p-z} = 1.67$, $\frac{r_s k}{p - r_s k - \delta k - z} = 0.28 \Rightarrow$ the elasticity in our model is 6 times **smaller**

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Show $\Upsilon$

- In Shimer-based calibration: $\frac{p}{p-z} = 1.67$, $\frac{r_s k}{p-r_s k-\delta k-z} = 0.28 \Rightarrow$ the elasticity in our model is 6 times **smaller**
- But! $r$ is $\sim$ 26 times **more** volatile than labor productivity

# Interest Rate vs. Productivity Shocks

Comparison by looking at (only) data (*lagged correlations*):

| | $u$ | $v$ | $\theta$ | $r$ | spread | $p$ |
|---|---|---|---|---|---|---|
| St Dev | 0.11 | 0.12 | 0.22 | 0.26 | 0.29 | 0.01 |
| Pers | 0.94 | 0.91 | 0.93 | 0.71 | 0.91 | 0.77 |
| Corr $U$ | 1 | -0.89 | -0.97 | 0.42 | 0.63 | -0.32 |
| Corr $V$ | - | 1 | 0.98 | -0.47 | -0.61 | 0.48 |
| Corr $\theta$ | - | - | 1 | -0.46 | -0.64 | 0.41 |

Table: Data

Note: exact value for $\sigma_P$ is 0.0095. Go to comparison without lag

# Next steps

Importance of spread

- Allow the default parameters $(\eta_1, \eta_2, \Omega)$ to change over time
- New mechanisms for default
- The role of liquidity

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Heterogeneous firms (SMEs)

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- The role of liquidity

Robustness

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Heterogeneous firms (SMEs)

Endogenous prices ($r$): Yes, but:

- Insist on importance of large fluctuations
- Try keeping the simple framework and clear comparison

# Conclusion

We studied:

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

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- 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
- Spread (default and liquidity) should be further explored

# Unemployment, Vacancies and Tightness

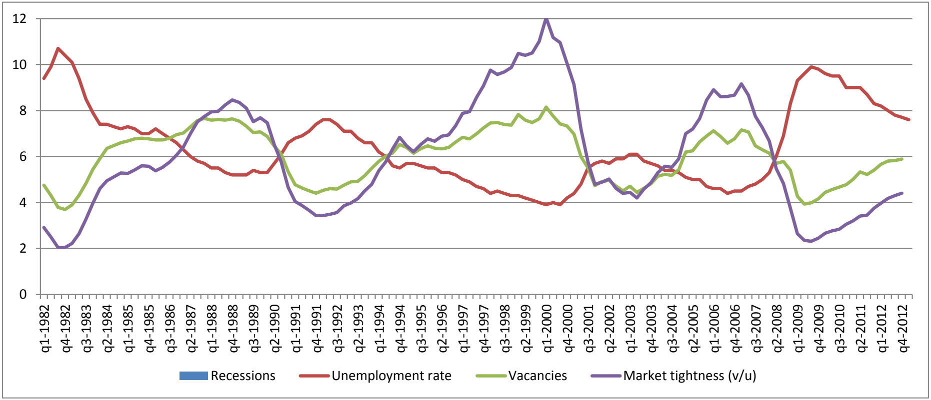


Figure: US time-series data 1980-2012

▸ Back to Motivation

# Break Down of Mechanisms - a la Shimer

| Mechanisms | $u$ | $v$ | $\theta$ |
|---|---|---|---|
| Data | 0.11 | 0.12 | 0.22 |
| All mechanisms | 0.08 | 0.10 | 0.17 |
| Profit | 0.03 | 0.05 | 0.08 |
| Vacancy cost | 0.04 | 0.05 | 0.09 |
| Ownership | 0.00 | 0.00 | 0.00 |
| Spread | 0.02 | 0.02 | 0.00 |

Table: Breakdown- Just Standard Deviation

Back to "Shimer" results

# Interest Rate vs. Productivity Shocks

Comparison by looking at (only) data (*without lags*):

| | $u$ | $v$ | $\theta$ | $r$ | spread | $p$ |
|---|---|---|---|---|---|---|
| St Dev | 0.11 | 0.12 | 0.22 | 0.26 | 0.29 | 0.01 |
| Pers | 0.94 | 0.91 | 0.93 | 0.71 | 0.91 | 0.77 |
| Corr $U$ | 1 | -0.89 | -0.97 | 0.10 | 0.45 | 0.05 |
| Corr $V$ | - | 1 | 0.98 | -0.20 | -0.54 | 0.17 |
| Corr $\theta$ | - | - | 1 | -0.15 | -0.51 | 0.06 |

Table: Data

Note: exact value for $\sigma_P$ is 0.0095. Back to comparison with lag

# 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 $1 \rightarrow$ capital cost $\sim 0.5$
  - Correct for capital in vacancies: $c_r r_s + c_\delta = 0.464$
- Labor component: $c_l$
  - 11% of average labor productivity based on micro evidence
- Total vacancy cost $= 0.474 + 0.11 = 0.574$

Back to Calibration

# Results - Data -lag

| | | $u$ | $v$ | $\theta$ | $r$ | Spread |
|---|---|---|---|---|---|---|
| St Dev | Data | 0.11 | 0.12 | 0.22 | 0.26 | 0.29 |
| Pers | Data | 0.94 | 0.91 | 0.93 | 0.71 | 0.91 |
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| Corr $\theta$ | Data | - | - | 1 | **-0.46** | **-0.64** |

Table: Quarterly moments: data: 1980- 2012

Back to results without lag

# Results - Data vs Model -lag

| | | $u$ | $v$ | $\theta$ | $r$ | Spread |
|---|---|---|---|---|---|---|
| St Dev | Data | 0.11 | 0.12 | 0.22 | 0.26 | 0.29 |
| | Model | 0.11 | 0.14 | 0.23 | | |
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| | Model | 0.77 | 0.47 | 0.66 | | |
| Corr $U$ | Data | 1 | -0.89 | -0.97 | **0.42** | **0.63** |
| | Model | 1 | -0.65 | -0.89 | **0.55** | **0.12** |
| Corr $V$ | Data | - | 1 | 0.98 | **-0.47** | **-0.61** |
| | Model | - | 1 | 0.93 | **-0.12** | **0.05** |
| Corr $\theta$ | Data | - | - | 1 | **-0.46** | **-0.64** |
| | Model | - | - | 1 | **-0.46** | **-0.03** |

Table: Quarterly moments: data: 1980- 2012 versus Model

Back to results without lag

# Shimer-based calibration -lag

| | | $u$ | $v$ | $\theta$ | $r$ | Spread |
|---|---|---|---|---|---|---|
| St Dev | Data | 0.11 | 0.12 | 0.22 | 0.26 | 0.29 |
| | Model | 0.08 | 0.10 | 0.17 | | |
| Pers | Data | 0.94 | 0.91 | 0.93 | 0.71 | 0.91 |
| | Model | 0.75 | 0.54 | 0.68 | | |
| Corr $U$ | Data | 1 | -0.89 | -0.97 | 0.42 | 0.63 |
| | Model | 1 | -0.71 | -0.90 | 0.55 | 0.12 |
| Corr $V$ | Data | - | 1 | 0.98 | -0.47 | -0.61 |
| | Model | - | 1 | 0.94 | -0.12 | 0.05 |
| Corr $\theta$ | Data | - | - | 1 | -0.46 | -0.64 |
| | Model | - | - | 1 | -0.46 | -0.03 |

Table: Quarterly moments: data: 1980- 2012 versus Model

▸ Back to results without lag

# Results - Only Spread

| | | $u$ | $v$ | $\theta$ | $r$ | Spread |
|---|---|---|---|---|---|---|
| St Dev | Data | 0.11 | 0.12 | 0.22 | 0.26 | 0.29 |
| | Model | 0.02 | 0.02 | 0.00 | | |
| Pers | Data | 0.94 | 0.91 | 0.93 | 0.71 | 0.91 |
| | Model | 0.76 | 0.76 | 0.75 | | |
| Corr $U$ | Data | 1 | -0.89 | -0.97 | 0.10 | 0.45 |
| | Model | 1 | 1.00 | -0.93 | -0.01 | 0.46 |
| Corr $V$ | Data | - | 1 | 0.98 | -0.20 | -0.54 |
| | Model | - | 1 | -0.92 | -0.01 | 0.47 |
| Corr $\theta$ | Data | - | - | 1 | -0.15 | -0.51 |
| | Model | - | - | 1 | 0.00 | -0.36 |

Table: Quarterly moments: data: 1980- 2012 versus Model

Back to Breakdown

# Elasticity of tightness w.r.t. the shock

## Example: profits channel

- Ljungqvist and Sargent (2014): all reconfigured models are based on a small *fundamental surplus* in the steady state:

$$\frac{\partial log\theta}{\partial \log p} = \underbrace{\frac{p}{p-z}}_{\text{fundamental surplus}} * \Upsilon(\gamma\lambda^w)$$

$$\frac{\partial log\theta}{\partial \log rk} = \underbrace{\frac{-\bar{r}k}{p-\bar{r}k-\delta k-z}}_{\text{fundamental surplus}} * \Upsilon(\gamma\lambda^w)$$

$$\Upsilon = \frac{r_s+\bar{\sigma}+\gamma\lambda^w}{(1-\eta)(r_s+\bar{\sigma})+\gamma\lambda^w}$$

- In Shimer-based calibration: $\frac{p}{p-z} = 1.67$, $\frac{r_s k}{p-r_s k-\delta k-z} = 0.28$
- Conclusion: the elasticity is 6 times **smaller** in our model, But:
- (r,spread) are $\sim$ 26 times **more** volatile than labor productivity

Back to elasticity

# Financial Risk

- State: $s = \{r, spread\}$
- Shock follows VAR(1):

$$
\begin{aligned}
s_t &= \mu + \eta_t \\
\eta_t &= \rho \eta_{t-1} + \epsilon_t \\
\epsilon_t &\sim N\left(0, \begin{bmatrix} \sigma_r^2 & \rho_{r,sp} \\ \rho_{r,sp} & \sigma_{sp}^2 \end{bmatrix}\right)
\end{aligned}
$$

Back to calibration strategy

## Unemployment, Productivity and Interest rate

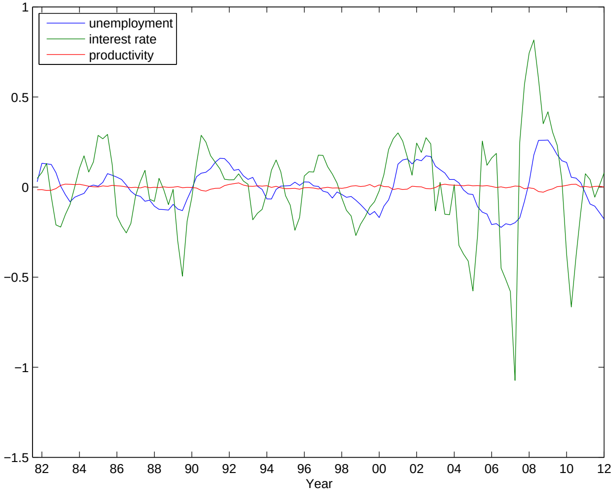


**Figure:** Quarterly US time-series data 1982-2012, HP filtered with a coefficient of 1600. Unemployment is 2 quarters lagged.

## Unemployment, Productivity and Spread

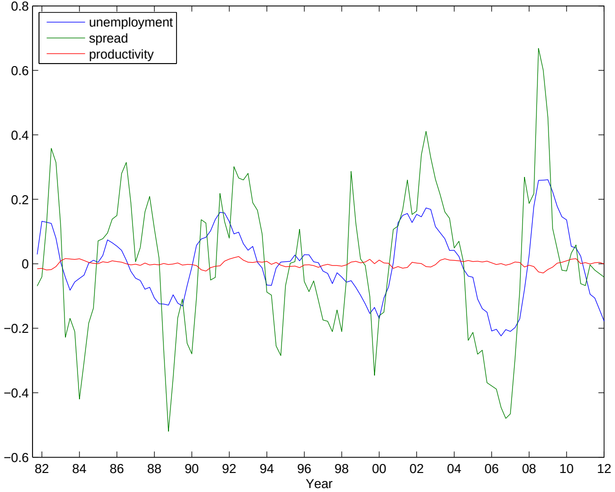


**Figure:** Quarterly US time-series data 1982-2012, HP filtered with a coefficient of 1600. Unemployment is 2 quarters lagged.

# Phelps & Zoega on interest rate shocks

Phelps and Zoega (JET, 1998):

*A firm has to invest in customers or in employee training or in labour-intensive capital goods when it hires new workers. So if it is to hire it must expect to cover the interest and depreciation. A rise of real interest rates raises this hurdle.*