# Unemployment Crises


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# The key messages

## Search and matching models of the labor market:

1 - Matching function with congestion effects a good description of aggregate relationship between unemployment and vacancies going back to the 1920s

2 - Model calibrated to the mean and volatility of unemployment in the postwar sample will generate unemployment rates seen during the Great Depression

# Summary of Results

## A matching function with congestion effects

Matching identity: $G = \underbrace{q \times V}_{\text{Filled vacancies}} = \underbrace{f \times U}_{\text{Hired Unemployed}}$

- $f$ and $q$ are necessarily linked through the ratio $\theta = V/U$

Matching function G(U,V): increasing and concave

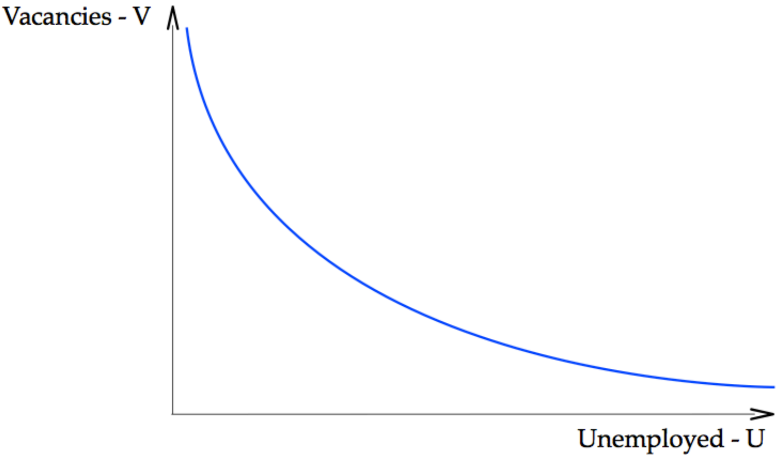
- Increasingly difficult to recruit workers when job seekers become scarce

Unemployment dynamics: $U_{t+1} - U_t = \underbrace{s(1 - U_t)}_{\text{Inflows}} - \underbrace{G(U_t, V_t)}_{\text{Outflows}}$

- Greater impact of vacancies on outflows when unemployment is high $\frac{\partial G(U_t, V_t)}{\partial V_t}$ increasing in $U_t$

# Matching, Congestion and a Beveridge Curve

Steady state : $s(1-U) = G(U,V)$



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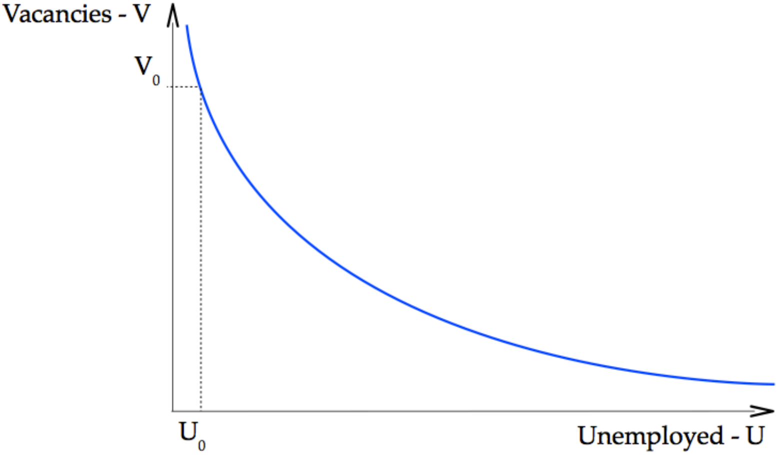

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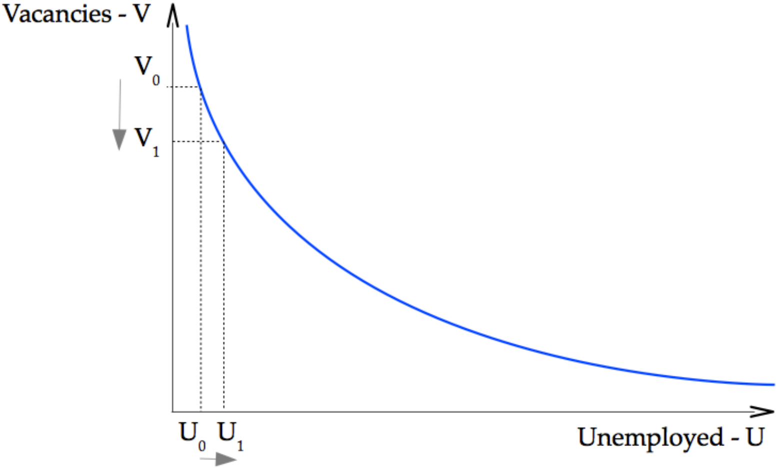

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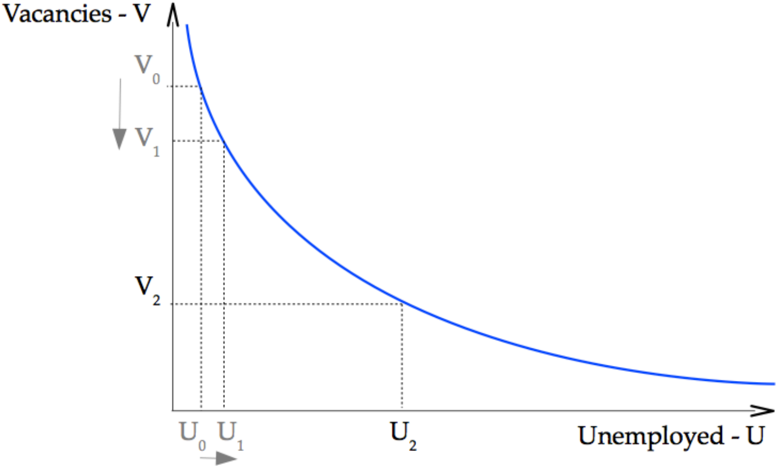

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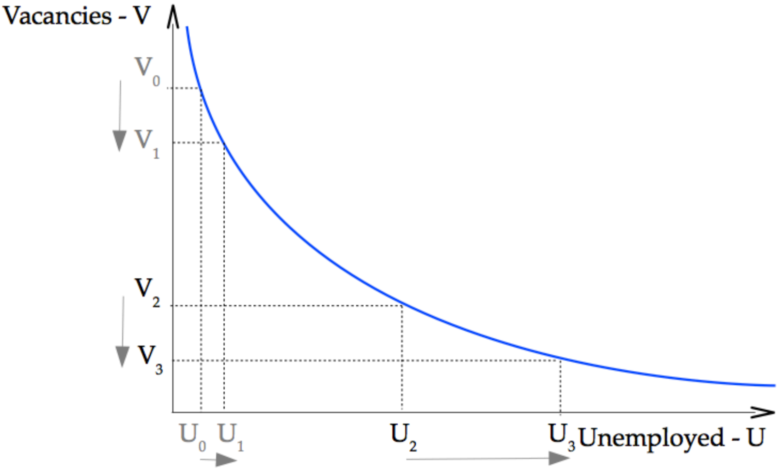
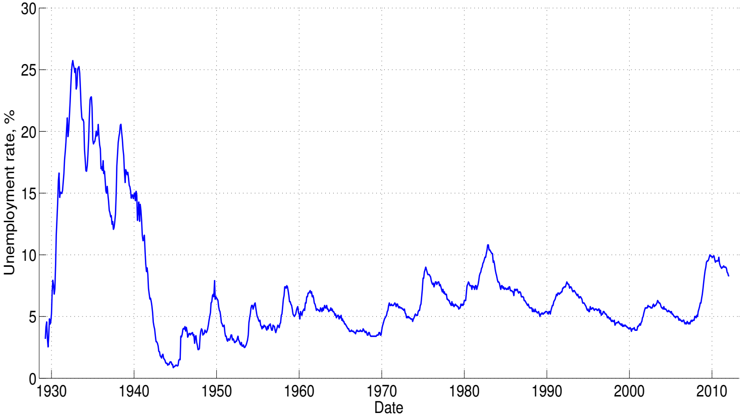


# Facts

## The monthly U.S. unemployment rate, 1929:4–2012:12




Data sources: NBER macro history files and B.L.S. U data details

# Facts

## Job vacancies and unemployment, 1929:04–2012:12

Construct a monthly job vacancy rate for U.S. starting 1929:04

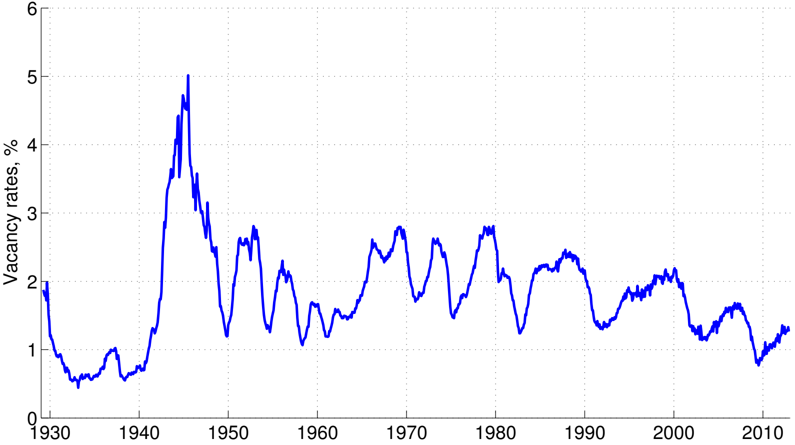
- Metropolitan Life Help-Wanted Index: 1919:01–1960:08
- Conference Board Help-Wanted Index: 1951:01–2006:07
- Barnichon's print and on-line Help-Wanted Index: 1995:01–2012:02
- Job Openings and Labor Turnover Survey: 2000:12–2012:12

Normalize by the size of the labor force and scale to a 2% average vacancy rate in 1965 (Abraham 1983, Zagorsky 1998)

HWI details

# Facts

## Monthly U.S. vacancy rate 1929:04–2012:12

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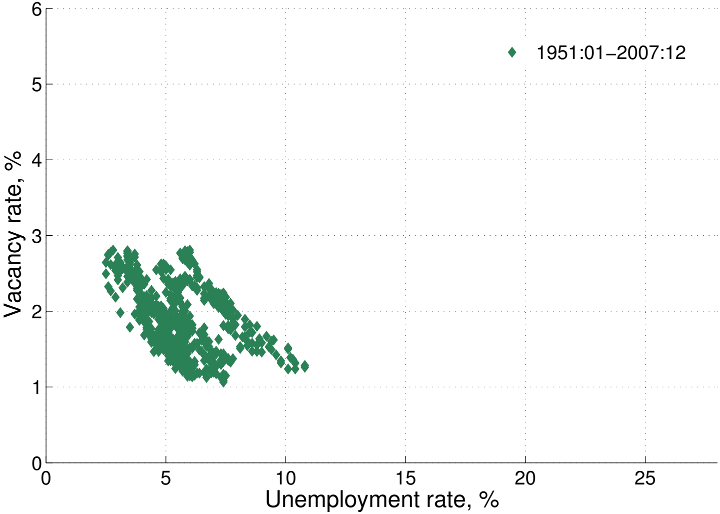
# Facts

## U.S. Beveridge curve, 1929:04–2012:12



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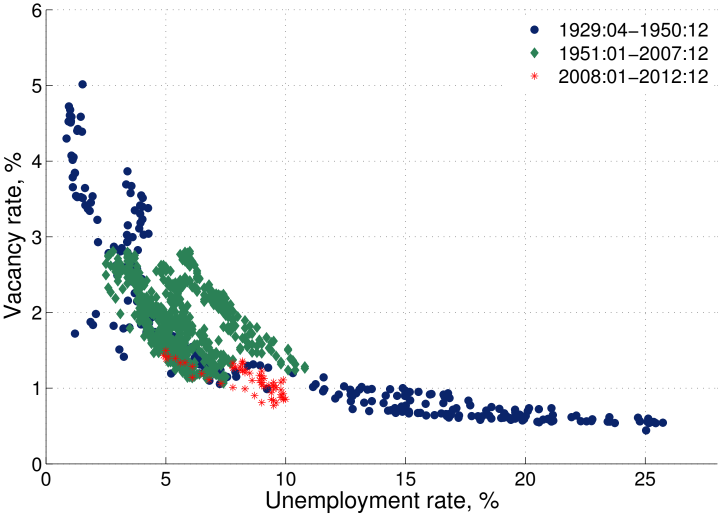


# Matching, Congestion and Unemployment Dynamics

Be agnostic on structural driving forces as first pass:

- Fit AR process on US labor market tightness $\theta_t$

$$\theta_t = \omega + \rho_\theta \theta_{t-1} + \upsilon_t$$

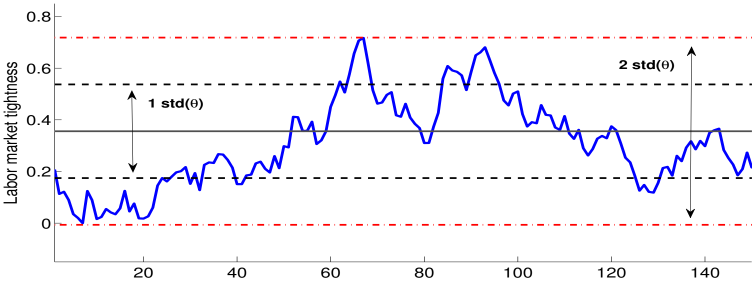
  - $\rho_\theta = 0.95$ ; $\omega = 0.016$

- Pass simulated $\theta_t$ through Cobb-Douglas matching function

$$U_{t+1} - U_t = s(1 - U_t) - \chi U_t^\eta V_t^{1-\eta}$$

  - $\chi$ such state average unemployment = 5.8%
  - $\eta = -0.65$: mid range of estimates

# Matching, Congestion and Unemployment Dynamics



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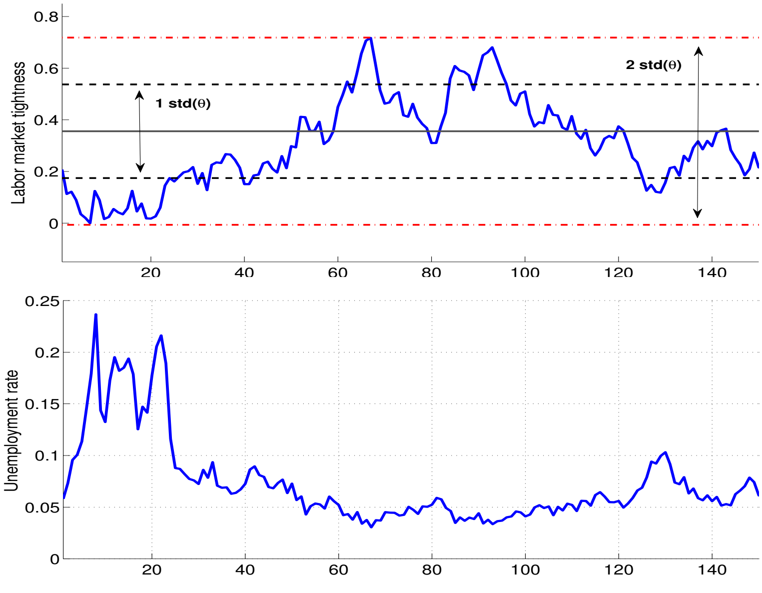

# Summary of Results

## Unemployment Crises

Model: Diamond-Mortensen-Pissarides with Hall-Milgrom wages

- 1 exogenous process: AR(1) labor productivity
- Calibrate to post-1951 mean and volatility of unemployment

| | | MODEL | | | | U.S. DATA | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $U$ | $V$ | $\theta$ | X | $U$ | $V$ | $\theta$ | $X$ |
| | | Non-crisis samples | | | | 1951:1–2012:12 | | | |
| Volatility | | 0.102 | 0.191 | 0.274 | 0.13 | 0.131 | 0.142 | 0.269 | 0.013 |
| Correlation | $U$ | | −0.732 | −0.880 | -0.742 | | −0.931 | −0.981 | −0.232 |
| | $V$ | | | 0.966 | 0.950 | | | 0.984 | 0.391 |
| | $\theta$ | | | | 0.938 | | | | 0.925 |

# Summary of Results
## Unemployment Crises

Congestion in matching generates important non-linear dynamics

- Skewness, differences in steady states and stochastic means
- Do not use local solution methods
- Larger impulse responses when labor market is slack

Unemployment crises

- Occasionally unemployment rate similar to Great Depression
- Large welfare costs of business cycle fluctuations

Conclusions

# Model

## Search and matching

Representative large firm

- Post job vacancies, $V_t$, to attract unemployed workers, $U_t$
- Matching function CRS:

$$G(U_t, V_t) = \frac{U_t V_t}{(U_t^{\iota} + V_t^{\iota})^{1/\iota}}$$

- Job filling rate:

$$q(\theta_t) \equiv \frac{G(U_t, V_t)}{V_t} = \frac{1}{(1 + \theta_t^{\iota})^{1/\iota}}$$

in which $\theta_t = V_t / U_t$ is labor market tightness: $q'(\theta_t) < 0$

# Model

## The costs of job creation

Two costs to job creation costs

- Flow posting cost $\kappa_0$
- Fixed cost paid after hiring $\kappa_1$

Average cost to hiring a worker:

$$\frac{\kappa_0}{q(\theta_t)} + \kappa_0$$

Per period resources devoted to job creation:

$$\left[\kappa_0 + q(\theta_t)\kappa_1\right] V_t = \kappa_t V_t$$

- $\kappa_t \equiv \kappa_0 + q(\theta_t)\kappa_1$

# Model

## Law of motion for employment and production

Once matched, jobs are destroyed at a constant rate $s$:

$$N_{t+1} = (1 - s)N_t + q(\theta_t)V_t$$

Production technology:

$$Y_t = X_t N_t \quad \text{in which} \quad \log(X_{t+1}) = \rho \log(X_t) + \sigma \epsilon_{t+1}$$

# Model

## The representative firm

The firm maximizes the market value of equity, $S_t$:

$$S_t = \max_{V_t} \{X_t N_t - W_t N_t - \kappa_t V_t + E_t [S_{t+1}]\}$$

Subject to
$$N_{t+1} = (1 - s) N_t + q(\theta_t) V_t$$
$$V_t \geq 0$$

in which $W_t$ is the wage rate

# Model

## The intertemporal job creation condition

Let $\lambda_t$ be the multiplier on the $q(\theta_t)V_t \geq 0$ constraint:

$$\underbrace{\frac{\kappa_t}{q(\theta_t)} - \lambda_t}_{\text{Average cost}} = \underbrace{E_t\left[\beta\left[X_{t+1} - W_{t+1} + (1-s)\left[\frac{\kappa_{t+1}}{q(\theta_{t+1})} - \lambda_{t+1}\right]\right]\right]}_{\text{Expected benefit}}$$

Response of equilibrium $\theta_t$ to productivity shocks:

- Benefit side: hinges on the equilibrium response of wage $W$
- Cost side: $\kappa_t/q(\theta_t) = \kappa_0/q(\theta_t) + \kappa_1$

The Kuhn-Tucker conditions: $V_t \geq 0, \lambda_t \geq 0, \lambda_t V_t = 0$

Value of employment at a wage $W_t$

$$J^W_{Nt} = W_t + \beta E_t \left[ (1-s) J^W_{Nt+1} + s J_{Ut+1} \right]$$

Value of unemployment:

$$J_{Ut} = b + \beta E_t \left[ f_t J^W_{Nt+1} + (1 - f_t) J_{Ut+1} \right]$$

- $b$: Unemployment flow value, forgone leisure
- $s$: Job separation rate
- $f_t$: Job finding rate

# Model

## Credible bargaining, Hall and Milgrom (2008)

Alternating wage offers leaving the other party just indifferent:

- Firm to worker: $W_t$

$$\underbrace{J_{Nt}^{W}}_{\text{Value of accepting offer}} = \underbrace{\delta J_{Ut} + (1-\delta)\left(b + E_t[\beta J_{Nt+1}^{W'}]\right)}_{\text{Value of refusing in order to make counteroffer}}$$

$b$: Unemployment flow value; $\delta$: Breakdown probability; $\chi$: Cost of delay

# Model

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- Worker to firm: $W_t'$

$$S_{Nt}^{W'} = \delta \times 0 + (1-\delta)\left(-\chi + E_t[\beta S_{Nt+1}^{W}]\right)$$

$b$: Unemployment flow value; $\delta$: Breakdown probability; $\chi$: Cost of delay

# Model

## Assume the firm makes the first offer:
## $W_t$ is the equilibrium wage

- Firm to worker: $W_t$

$$W_t = b - (1-s)\,\beta E_t\left[J^W_{Nt+1} - J_{Ut+1}\right] + \delta f_t \beta E_t\left[J^W_{Nt+1} - J_{Ut+1}\right] + (1-\delta)\beta E_t\left[J^{W'}_{Nt+1} - J_{Ut+1}\right]$$

- Worker to firm: $W'_t$

$$W'_t = X_t + \beta E_t\left[(1-s)S^{W'}_{Nt+1}\right] + (1-\delta)\left[\chi - \beta E_t S^W_{Nt+1}\right]$$

$b$: Unemployment flow value; $\delta$: Breakdown probability; $\chi$: Cost of delay

# Model

## Credible bargaining wage $W_t$: Polar cases $\delta = 1$ and $\delta = 0$

- $\delta = 1 \rightarrow$ Nash Bargaining wage set

$$W_t = b - (1-s)\,\beta E_t\left[J^W_{Nt+1} - J_{Ut+1}\right] + f_t \beta E_t\left[J^W_{Nt+1} - J_{Ut+1}\right] + 0 \times \beta E_t\left[J^{W'}_{Nt+1} - J_{Ut+1}\right]$$

- $\delta = 0 \rightarrow$ Limited influence of labor market conditions

$$W_t = b - (1-s)\,\beta E_t\left[J^W_{Nt+1} - J_{Ut+1}\right] + 0 \times f_t \beta E_t\left[J^W_{Nt+1} - J_{Ut+1}\right] + 1 \times \beta E_t\left[J^{W'}_{Nt+1} - J_{Ut+1}\right]$$

$b$: Unemployment flow value; $\delta$: Breakdown probability; $\chi$: Cost of delay;

# Model

## Equilibrium

The goods market clearing condition:

$$C_t + \kappa_t V_t = X_t N_t$$

The recursive competitive equilibrium consists of vacancies, $V_t^\star$; multiplier, $\lambda_t^\star$; and wages $W_t^\star$ and $W_t^{'\star}$:

- $V_t^\star$ and $\lambda_t^\star$ satisfy the intertemporal job creation condition and the Kuhn-Tucker conditions, while taking the wage equation as given
- $W_t^\star$ and $W_t^{'\star}$ satisfy the indifference conditions of the bargaining game
- The goods market clears

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# Computation

## Projection with parameterized expectations a la Christiano and Fisher (2000)

Solve for:

1. $V(N_t, X_t)$ and $\lambda(N_t, X_t)$
2. $W(N_t, x_t)$
3. $J_U(N_t, x_t), J_N^W(N_t, x_t)$, and $J_N^{W'}(N_t, x_t)$

From five functional equations:

1. A job creation condition
2. Wage offer to workers
3. Definitions of $J_{Ut}$, $J_{Nt}^W$ and $J_{Nt}^{W'}$

while obeying the Kuhn-Tucker conditions.

Numerical Details

# Calibration

## Monthly frequency

| Notation | Parameter | Value |
|---|---|---|
| $\beta$ | Time discount factor | $e^{-5.524/1200}$ |
| $\rho$ | Aggregate productivity persistence | $0.95^{1/3}$ |
| $\sigma$ | Conditional volatility of productivity shocks | 0.00635 |
| $s$ | Job separation rate | 0.045 |
| $\iota$ | Elasticity of the matching function | 1.25 |
| $b$ | The value of unemployment activities | 0.71 |
| $\delta$ | Probability of breakdown in bargaining | 0.1 |
| $\chi$ | Cost to employer of delaying in bargaining | 0.25 |
| $\kappa_0$ | The proportional cost of vacancy posting | 0.15 |
| $\kappa_1$ | The fixed cost of vacancy posting | 0.2 |

Target simulation means in non-crises samples to post-war data:

- January 1951 to December 2012 mean of 5.84%
- Steady state unemployment rate : 5.1%

# Calibration

## Monthly frequency

| | | MODEL | | | | U.S. DATA | | | |
|---|---|---|---|---|---|---|---|---|---|
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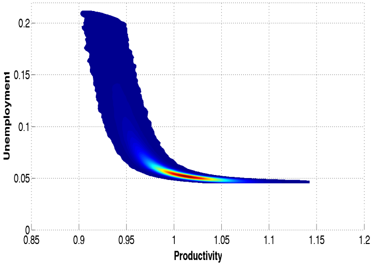
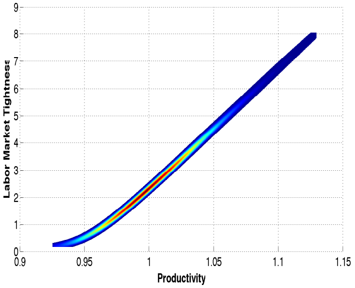
| | $V$ | | | 0.966 | 0.950 | | | 0.984 | 0.391 |
| | $\theta$ | | | | 0.938 | | | | 0.925 |

- Simulate 50,000 artificial samples from the model, with 1,005 months in each sample
- Split the samples into two groups
  - Non-crisis samples - maximum unemployment rate $< 20\%$
  - Crisis samples - maximum rate is $\geq 20\%$
- Report cross-simulation averages conditionally on the non-crisis samples and on the crisis samples

# Properties: model's stationary distribution

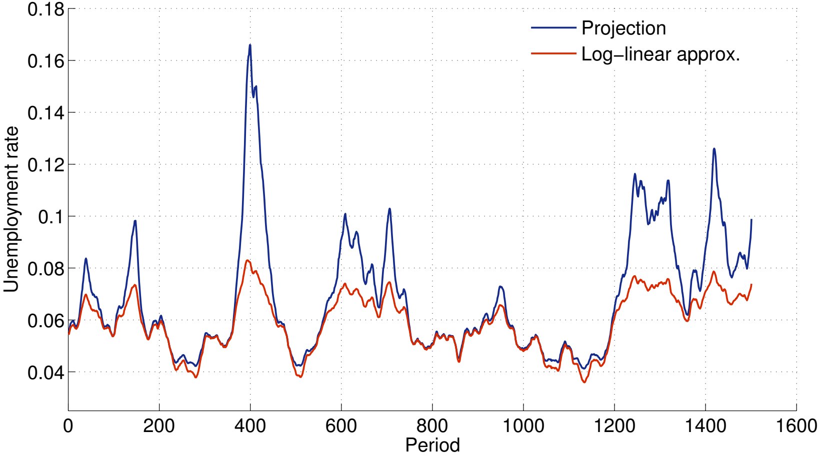



| Unemployment | | Labor market tightness | |
|---|---|---|---|
| mean | 5.84% | mean | 2.57 |
| median | 5.40% | median | 2.49 |
| 2.5 pctles | 4.70% | 2.5 pctles | 0.40 |
| 97.5 pctles | 15.15% | 97.5 pctles | 5.15 |

Frequency $V_t = 0$: 0 Back

# Projection vs. Linear Approximation

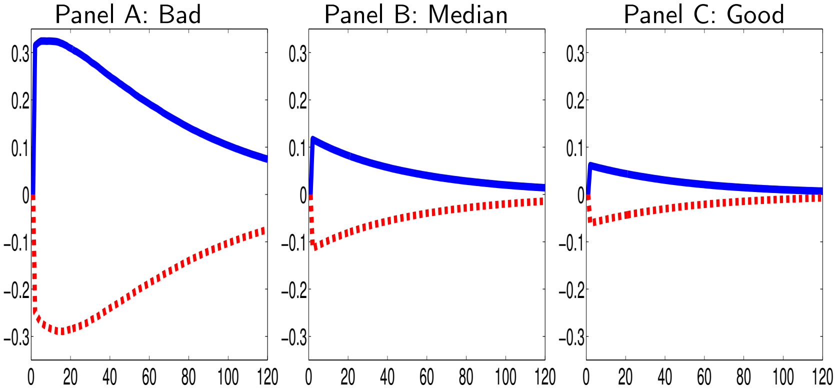



See Petrosky-Nadeau and Zhang (2013), Solving the DMP model Accurately

(Back)

# Results

## Nonlinear impulse response functions, $\theta_t$

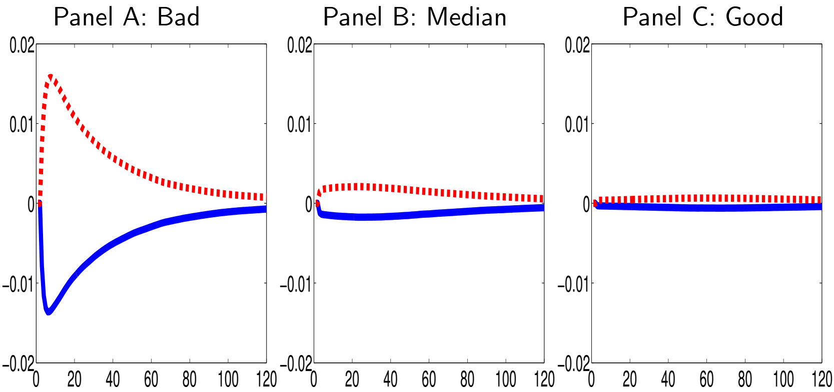



Bad ($U_t = 11.54\%$, $x_t = -0.0567$)
Median ($U_t = 5.40\%$, $x_t = 0$)
Good ($U_t = 4.75\%$, $x_t = 0.0564$)

Red: negative 1-$\sigma$ shock
Blue: positive 1-$\sigma$ shock

# Results

## Nonlinear impulse response functions, unemployment

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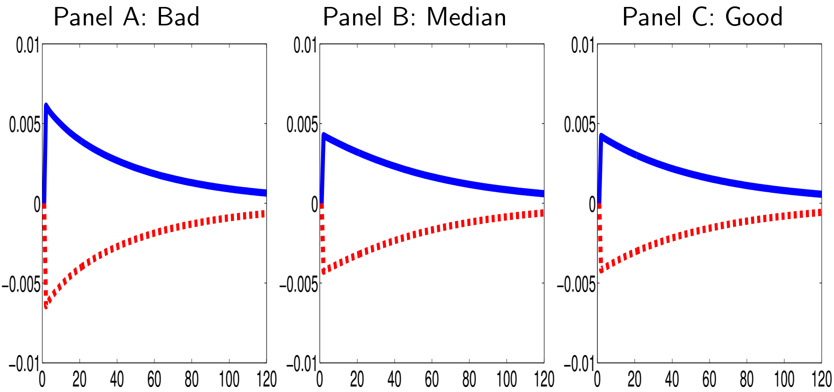
(Back)

# Results

## Nonlinear impulse response functions, $W_t$

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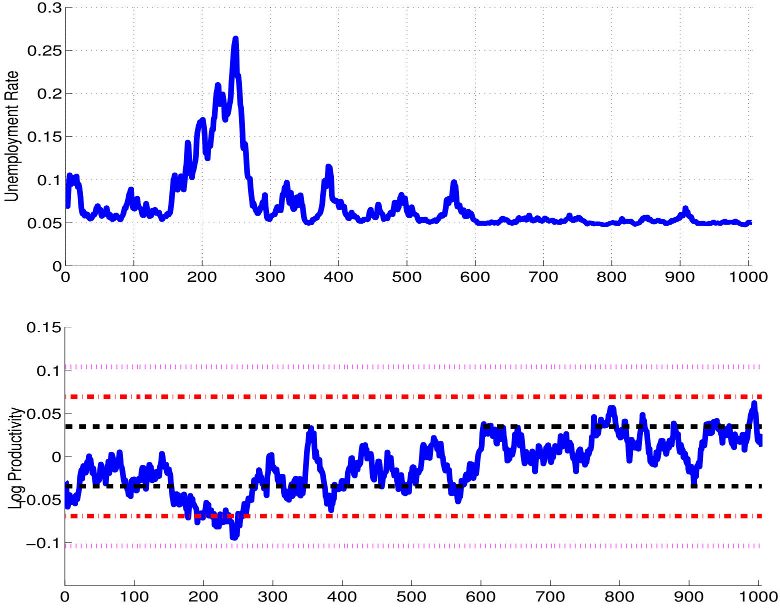
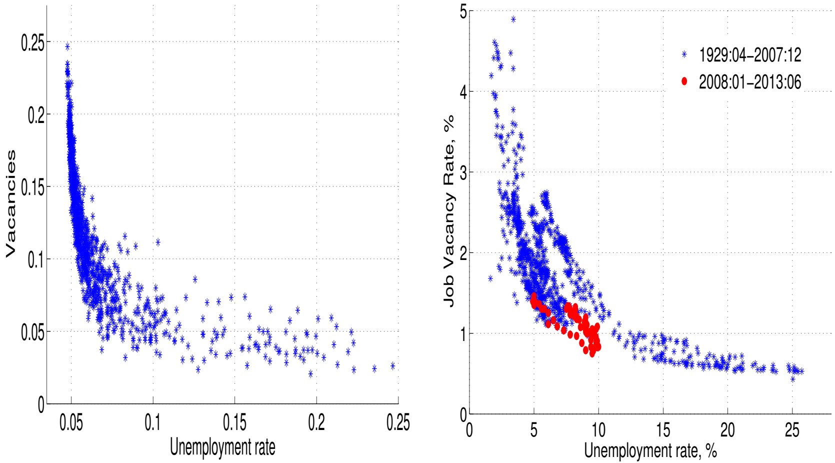
# An illustrative crisis example



# Beveridge curve

## Model and U.S., 1929:04–2012:12

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# Results

## Labor market volatilities in the model and data

| | | MODEL | | | | U.S. DATA | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $U$ | $V$ | $\theta$ | X | $U$ | $V$ | $\theta$ | $X$ |
| | | Non-crisis samples | | | | 1951:1–2012:12 | | | |
| Volatility | | 0.102 | 0.191 | 0.274 | 0.13 | 0.131 | 0.142 | 0.269 | 0.013 |
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| | $\theta$ | | | | 0.938 | | | | 0.925 |
| | | $U$ | $V$ | $\theta$ | $X$ | $U$ | $V$ | $\theta$ | $X$ |
| | | Crisis samples | | | | 1929:4–2012:12 | | | |
| Volatility | | 0.149 | 0.216 | 0.331 | 0.013 | 0.218 | 0168 | 0.368 | |
| Correlation | $U$ | | −0.630 | −0.861 | −0.710 | | −0.827 | −0.967 | |
| | $V$ | | | 0.937 | 0.926 | | | 0.943 | |
| | $\theta$ | | | | 0.925 | | | | |

# Facts

## Aggregate state transition matrix in the data: Chatterjee and Corbae (2007)

Fit a three-state Markov chain model via maximum likelihood:

- Economy evolves through good ($g$), bad ($b$), and crisis ($c$) states with different employment prospects
- Transition matrix of the Markov chain be given by:

$$\Lambda = \begin{bmatrix} \lambda_{gg} & \lambda_{bg} & \lambda_{cg} \\ \lambda_{gb} & \lambda_{bb} & \lambda_{cb} \\ \lambda_{gc} & \lambda_{bc} & \lambda_{cc} \end{bmatrix}$$

- Good: $U \leq 5.70\%$
- Bad: $5.70\% < U \leq 20\%$
- Crisis: $U > 20\%$

# Facts

## Aggregate state transition matrix in the data

| | Good | Bad | Crisis |
|---|---|---|---|
| Good | 0.959 | 0.041 | 0 |
| | (0.009) | (0.009) | (0) |
| Bad | 0.039 | 0.949 | 0.012 |
| | (0.009) | (0.010) | (0.005) |
| Crisis | 0 | 0.177 | 0.824 |
| | (0) | (0.065) | (0.065) |
| Unconditional probability | 0.468 | 0.497 | 0.035 |

- Good: $U \leq 5.70\%$
- Bad: $5.70\% < U \leq 20\%$
- Crisis: $U > 20\%$

# Results

## Aggregate state transition matrix in a macro labor model

| | Good | Bad | Crisis |
|---|---|---|---|
| Good | 0.979 | 0.021 | 0 |
| | (0.007) | (0.007) | (0) |
| Bad | 0.022 | 0.975 | 0.004 |
| | (0.007) | (0.008) | (0.002) |
| Crisis | 0 | 0.157 | 0.842 |
| | (0) | (0.221) | (0.223) |
| Unconditional probability | 0.494 | 0.473 | 0.032 |

- Good: $U \leq 5.70\%$
- Bad: $5.70\% < U \leq 20\%$
- Crisis: $U > 20\%$

# Results

## Robustness of results and comp. statics

- Non-linear dynamics and unemployment crises a robust feature
  - Survives setting high or low flow value of unemployment $b$
  - Survives absence of fixed costs
  - Survives assumption on wage bargaining

Key : Match mean and volatility of unemployment post W.W. II

- Two parameters matter for credible bargaining Comp Statics
  - A low probability of breakdown $\delta$
  - A high cost to delaying production $\chi$

# Welfare Costs of Business Cycles

## Lucas (1987): Negligible welfare cost of business cycles

Log utility with log-normal consumption growth:

- The agent is willing to sacrifice only 0.008% of consumption in perpetuity to eliminate all aggregate fluctuations

The welfare cost might be underestimated by overlooking:

- Crises in which the agent's marginal utility is high
- Steady state consumption great than stochastic mean

# Results

## Welfare cost of business cycles: Definition

Permanent percentage of the consumption flow $C_t$ that the household would sacrifice to eliminate aggregate fluctuations:

$$E_t \left[ \sum_{\triangle t=0}^{\infty} \beta^{\triangle t} \log \left[ (1 + \psi_t) C_{t+\triangle t} \right] \right] = \sum_{\triangle t=0}^{\infty} \beta^{\triangle t} \log \left( C^{\star} \right)$$

- $C^{\star}$: aggregate consumption at the deterministic steady state

The welfare cost is 1.2%, which is 150 times of the Lucas estimate

The stochastic mean is 0.95% lower than the steady state consumption

# Conclusion

A search and matching model with credible wage bargaining can add to our understanding of unemployment during the Great Depression

- Beveridge curve: supports complementarity of $U$ and $V$ in the matching function
- Credible bargaining: limited response of the wage to labor market conditions contributes to the crisis dynamics
- Policy and institutional shocks will have a greater (deleterious) effects on the labor market when it is slack

# Computation

## The five functional equations

$$
\begin{aligned}
\frac{\kappa_t}{q(\theta_t)} - \lambda(N_t, x_t) &= \\
& E_t \left[ \beta \left[ X_{t+1} - W_{t+1} + (1-s) \left[ \frac{\kappa_{t+1}}{q(\theta_{t+1})} - \lambda(N_{t+1}, x_{t+1}) \right] \right] \right] \\
W(N_t, x_t) &= b + (1-\delta)\beta E_t \left[ J_N^{W'}(N_{t+1}, x_{t+1}) - J_U(N_{t+1}, x_{t+1}) \right] \\
& - (1 - s - \delta f_t)\, \beta E_t \left[ J_N^{W}(N_{t+1}, x_{t+1}) - J_U(N_{t+1}, x_{t+1}) \right] \\
J_U(N_t, x_t) &= \\
& b + E_t \left[ \beta \left( f_t J_N^{W}(N_{t+1}, x_{t+1}) + (1 - f_t) J_U(N_{t+1}, x_{t+1}) \right) \right] \\
J_N^{W}(N_t, x_t) &= \\
& W_t + E_t \left[ \beta \left( (1-s) J_N^{W}(N_{t+1}, x_{t+1}) + s J_U(N_{t+1}, x_{t+1}) \right) \right] \\
J_N^{W'}(N_t, x_t) &= \\
& W_t' + E_t \left[ \beta \left( (1-s) J_N^{W'}(N_{t+1}, x_{t+1}) + s J_U(N_{t+1}, x_{t+1}) \right) \right]
\end{aligned}
$$

# Computation

## Parameterized expectations a la Christiano and Fisher (2000)

Approximate the right-hand side of the Euler equation

$$\mathcal{E}(N_t, X_t) = E_t\left[\beta\left[X_{t+1} - W_{t+1} + (1-s)\left[\frac{\kappa_{t+1}}{q(\theta_{t+1})} - \lambda(N_{t+1}, x_{t+1})\right]\right]\right]$$

No need to parameterize $\lambda_t$ separately

$$\frac{\kappa_t}{q(\theta_t)} - \lambda_t = \mathcal{E}_t$$

After obtaining $\mathcal{E}_t$, calculate $\tilde{q}(\theta_t) = \kappa_t/\mathcal{E}_t$

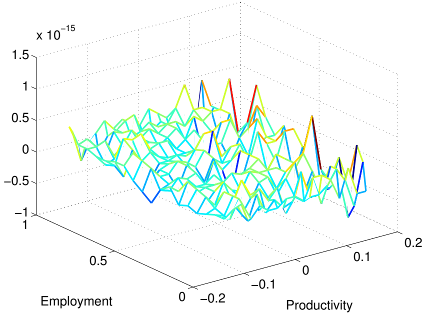
- If $\tilde{q}(\theta_t) \geq 1$ (binding constraint): $V_t = 0$, $\theta_t = 0$, $q(\theta_t) = 1$, and $\lambda_t = \kappa_t - \mathcal{E}_t$
- If $\tilde{q}(\theta_t) < 1$ (nonbinding constraint): $\lambda_t = 0$, $q(\theta_t) = \tilde{q}(\theta_t) \Rightarrow \theta_t = q^{-1}(\kappa_t/\mathcal{E}_t)$, $V_t = \theta_t(1 - N_t)$

# Computation

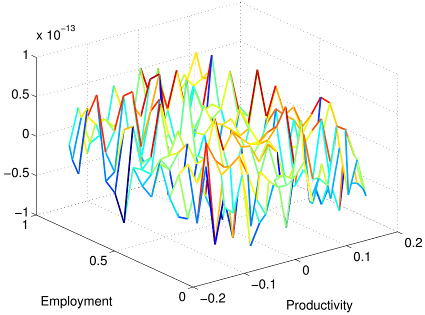
## Solution method: Projection with parameterized expectations

- $\log(X_t)$ discretized with 17 grid points
- Cubic splines (20 basis functions) in $N$ for each $\log(X)$-level

The $\mathcal{E}(N_t, x_t)$ error




The $W(N_t, x_t)$ error

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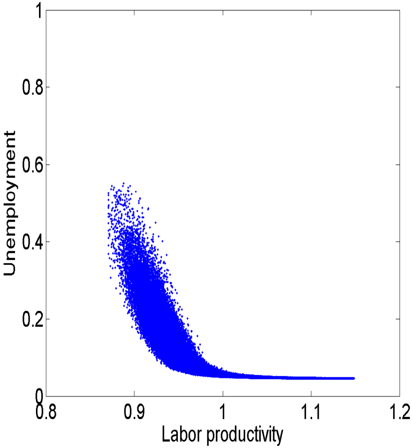
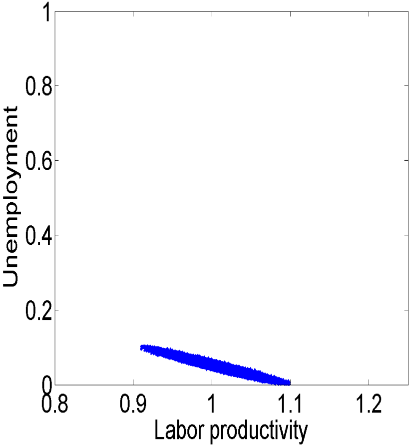
# Linear Approximation

## Petrosky-Nadeau and Zhang (2013): Solving DMP Accurately

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# Data - Unemployment rate

## Step 1

Construct monthly unemployment rate for U.S. starting 1929:04

- **April 1929 to February 1940** - National Industrial Conference Board, published by G. H. Moore Business Cycle Indicators, vol. II, p. 35 and p.123, from NBER data series m08292a
- **March 1940 to December 1946** - U.S. Bureau of the Census, Current Population Reports, Labor Force series P-50, no. 2, 13, and 19. From NBER data series m08292b.
- **January 1947 to December 1947** - use monthly (not S.A.) from January 1947 to December 1966 from Employment and Earnings and Monthly Report on the Labor Force, vol. 13, no. 9, March 1967 (NBER data series m08292c. Source:); apply X-12-ARIMA seasonal adjustment program from the U.S. Census Bureau; use S.A. series from January to December of 1947.
- **January 1948 to December 2012** - S.A. civilian unemployment rates from from Bureau of Labor Statistics (FRED series id: UNRATE)

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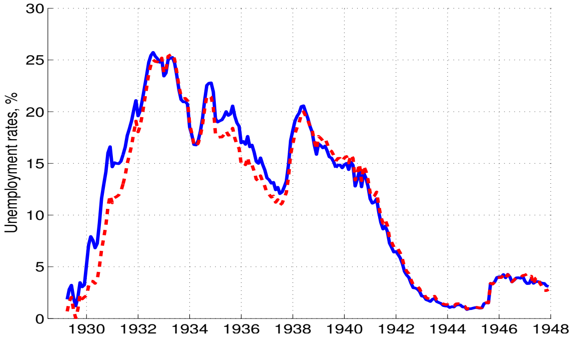
# Data - Unemployment rate

## Step 2

Adjust pre-1948 data as in Owyang, Ramey, and Zubairy (2013)

- Use the monthly unemployment rates from January 1930 to December 1947 to interpolate annual unemployment rates data from Weir (1992) using the Denton (1971) proportional interpolation procedure
- Scale the nine monthly rates from April to December 1929 so that their average matches the annual unemployment rate for 1929 reported in Weir.

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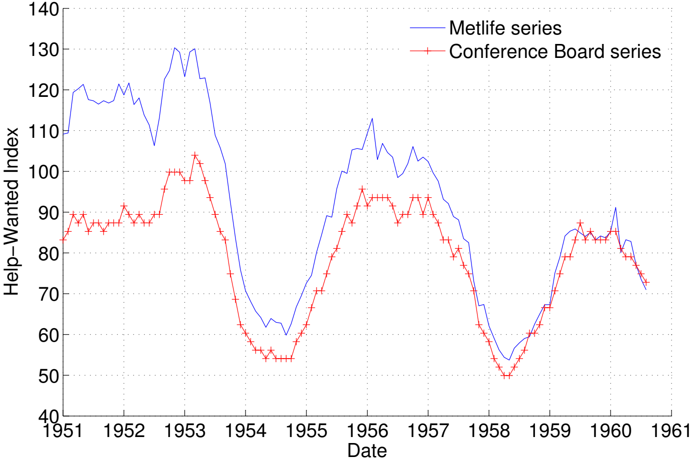
# Data

## Help-Wanted Index: MetLife and Conference Board

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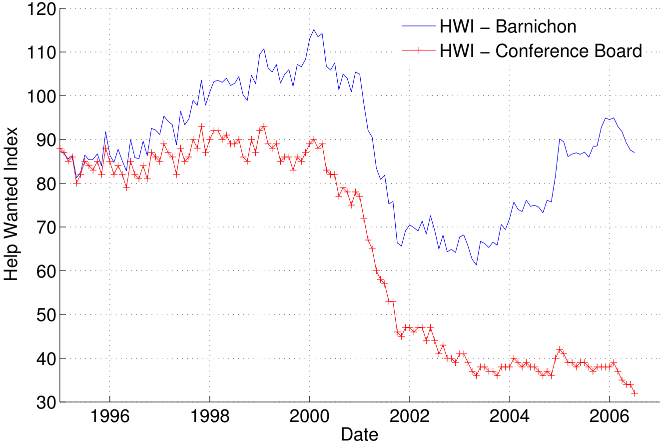
# Data

## Help-Wanted Index: Conference Board and Barnichon (2010)

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# Results

## Comparative statics, labor market volatilities

| | $U$ | $V$ | $\theta$ | $X$ | | $U$ | $V$ | $\theta$ | $X$ |
|---|---|---|---|---|---|---|---|---|---|
| | Non-crisis samples | | | | | Crisis samples | | | |
| | $\delta = 0.15$ | | | | | | | | |
| Volatility | 0.070 | 0.150 | 0.209 | 0.013 | | 0.106 | 0.162 | 0.245 | 0.014 |
| Autocorrelation | 0.792 | 0.708 | 0.772 | 0.775 | | 0.849 | 0.686 | 0.791 | 0.785 |
| Correlation | | −0.781 | −0.895 | −0.792 | $U$ | | −0.650 | −0.863 | −0.735 |
| | | | 0.977 | 0.970 | $V$ | | | 0.944 | 0.950 |
| | | | | 0.960 | $\theta$ | | | | 0.949 |
| | $\chi = 0.2$ | | | | | | | | |
| Volatility | 0.032 | 0.128 | 0.155 | 0.013 | | 0.108 | 0.173 | 0.253 | 0.014 |
| Autocorrelation | 0.763 | 0.747 | 0.769 | 0.775 | | 0.855 | 0.709 | 0.803 | 0.786 |
| Correlation | | −0.847 | −0.901 | −0.776 | $U$ | | −0.596 | −0.834 | −0.502 |
| | | | 0.993 | 0.968 | $V$ | | | 0.939 | 0.883 |
| | | | | 0.951 | $\theta$ | | | | 0.819 |

# Results

## Comparative statics, unemployment crises

| | Good | Bad | Crisis | Good | Bad | Crisis |
|---|---|---|---|---|---|---|
| | $\delta = 0.15$ (% crisis samples = 1.85) | | | $\chi = 0.2$ (% crisis samples = 1.54) | | |
| Good | 0.9807 | 0.0193 | 0 | 0.9801 | 0.0199 | 0 |
| Bad | 0.0197 | 0.9780 | 0.0023 | 0.0199 | 0.9779 | 0.0023 |
| Crisis | 0 | 0.2127 | 0.7873 | 0 | 0.2660 | 0.7340 |
| Uncond. prob. | 0.4946 | 0.4852 | 0.0201 | 0.4901 | 0.4929 | 0.0170 |

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