Unemployment Crises

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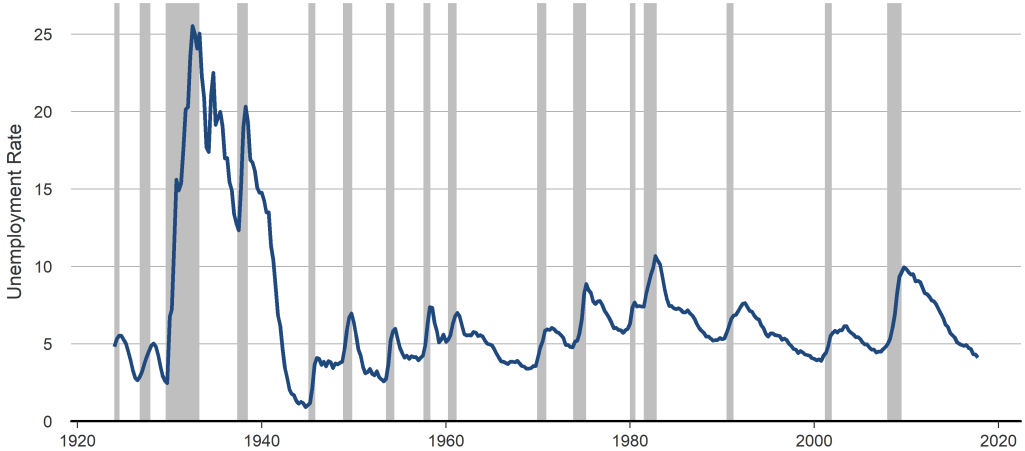
Joint Spring Conference: Systemic Risk and the Macroeconomy
Deutsche Bundesbank - ECB
May 15 - 16, 2019

The key messages

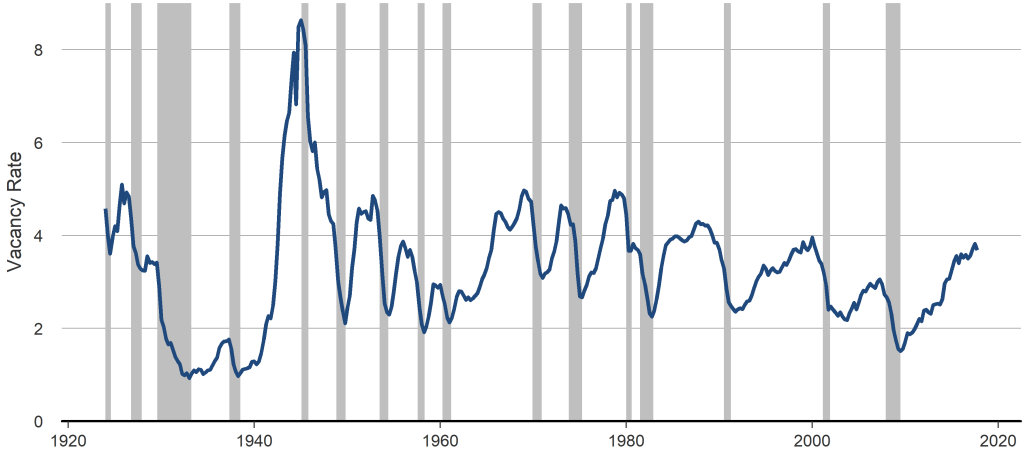
- Matching function with congestion effects a good description of aggregate relation between unemployment and vacancies going back to the 1920s
- Model calibrated to the mean and volatility of unemployment in the postwar sample generates high unemployment rates as in the Great Depression
- Feeding measured labor productivity into the model reproduces the severity, but not the persistence, of the rise in unemployment during the Great Depression

Facts: monthly U.S. unemployment rate, 1924:1–2017:12



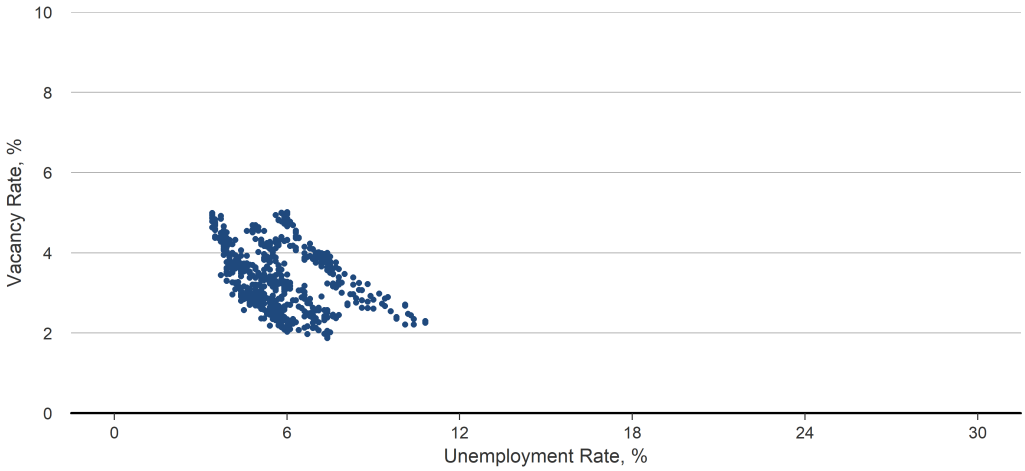
Data sources: NBER macro history files and BLS. [U data details]

Facts: monthly U.S. job vacancy rate, 1924:01–2017:12

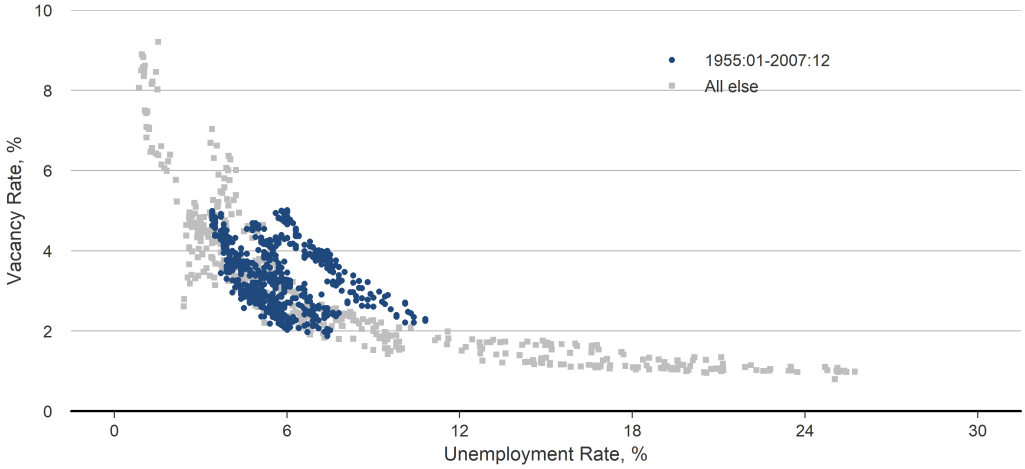


Data sources: NBER macro history files, Barnichon (2010) and BLS. [V data details]

Facts: U.S. Beveridge curve, 1955:01–2017:12



Facts: U.S. Beveridge curve, 1924:04–2017:12



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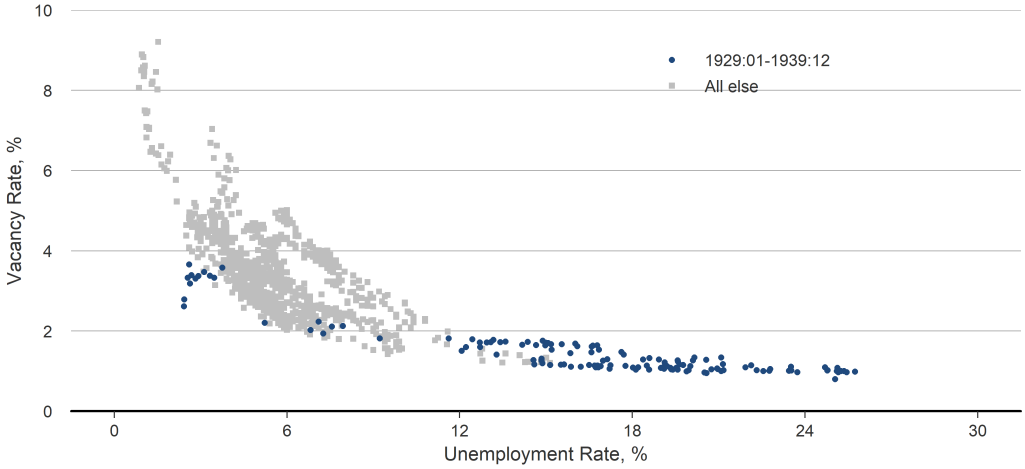

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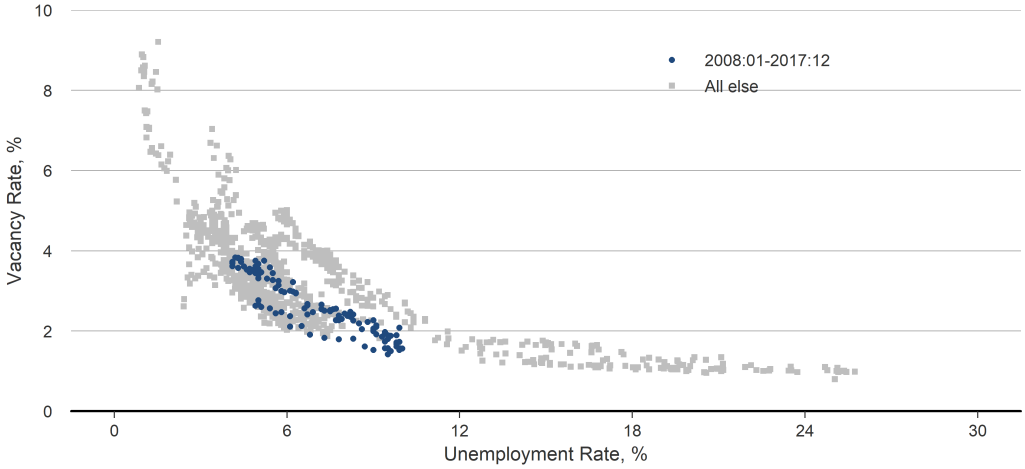


Facts: U.S. labor market moments, 1924:04–2017:12

Table: Quarterly business cycle moments for log-deviations from the HP-trend

		U	V	θ	X	U	V	θ	X
		Panel A: 1924:I–2017:IV				Panel B: 1951:I–2017:IV			
Standard deviation		0.26	0.17	0.38	0.04	0.13	0.14	0.26	0.01
Autocorrelation		0.90	0.90	0.91	0.59	0.89	0.91	0.91	0.76
Correlation matrix	U		−0.79	−0.96	−0.38		−0.92	−0.98	−0.22
	V			0.93	0.30			0.98	0.39
	θ				0.37				0.32

- U: unemployment rate
- $\theta = V/U$: vacancy to unemployment ratio

Facts: U.S. unemployment crisis statistics

Suppose an economy evolves through three states: (i) good; (ii) bad and; (iii) crisis, each with different employment prospects (as in Chatterjee and Corbae, 2007)

- Estimate a transition matrix from the unemployment rate time series with:
  (i) Good: $U \leq 5.54\%$; (ii) Bad: $5.54\% < U \leq 15\%$; (iii) Crisis: $U > 15\%$

Table: State transition probabilities (%) estimated on monthly unemployment rate

U.S. 1924-2017, Monthly	Good	Bad	Crisis
Good	95.96	4.04	0
	(0.71)	(0.71)	(0)
Bad	4.29	95.16	0.55
	(0.75)	(0.80)	(0.28)
Crisis	0	8.89	91.11
	(0)	(4.24)	(4.24)
Sample probability	49.97	47.10	2.93

A model for unemployment crises

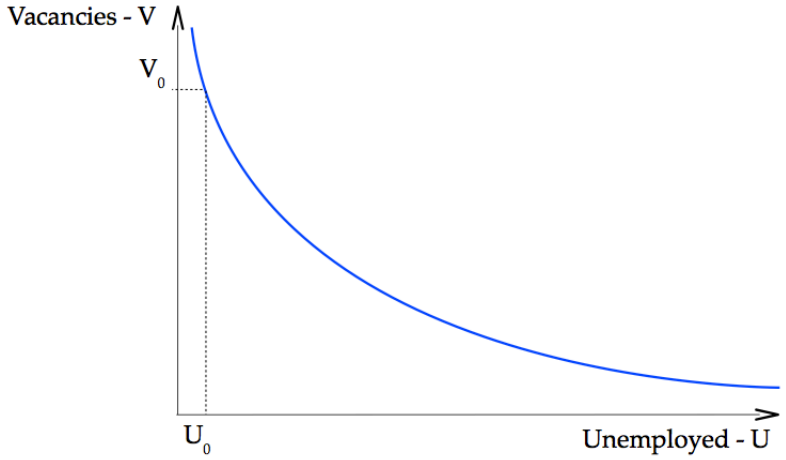
Model: Diamond-Mortensen-Pissarides with Hall-Milgrom wages [Details]

- 1 exogenous process: AR(1) labor productivity
- Calibrate to post-1951 U.S. data moments

Key intuition:

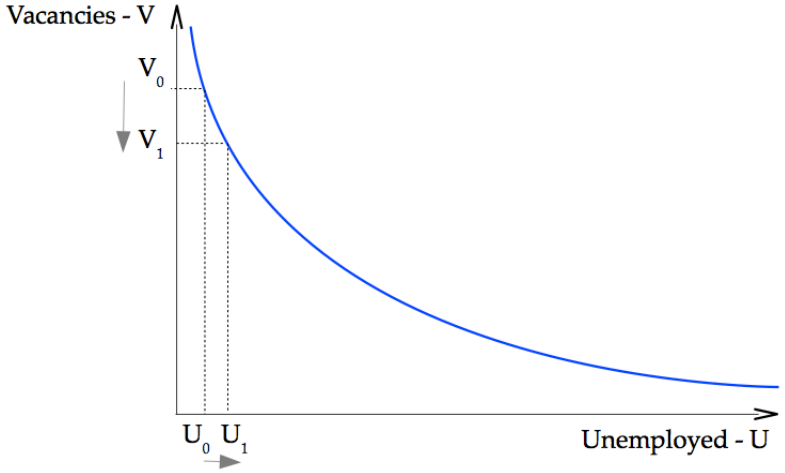
- Unemployment dynamics: $U_{t+1} - U_t = \underbrace{s(1-U_t)}_{\text{Inflows}} - \underbrace{G(U_t, V_t)}_{\text{Outflows}}$
- Matching function $G(U, V)$ is increasing and concave:
  - Increasingly difficult to recruit workers when job seekers become scarce
  - Greater impact of vacancies on outflows when unemployment is high, i.e., $\frac{\partial G(U_t, V_t)}{\partial V_t}$ increasing in U_t

Matching and congestion and crises through a Beveridge Curve



- Matching function leads to a convex relation between vacancies and unemployment
- Firms: determine the level of job vacancies given labor productivity

Matching and congestion and crises through a Beveridge Curve



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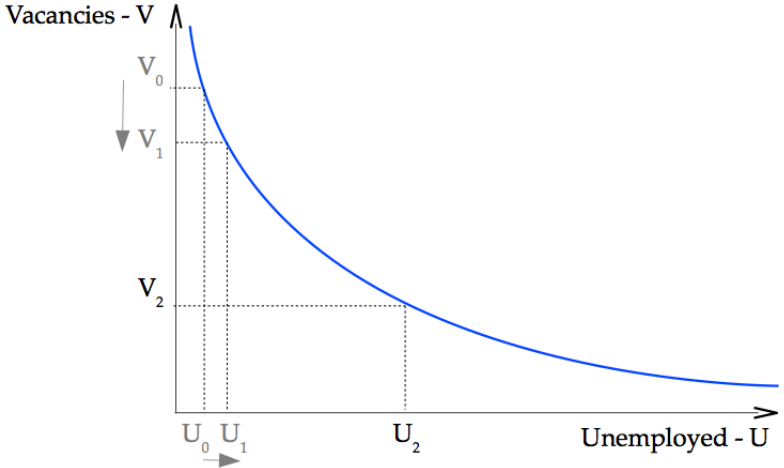

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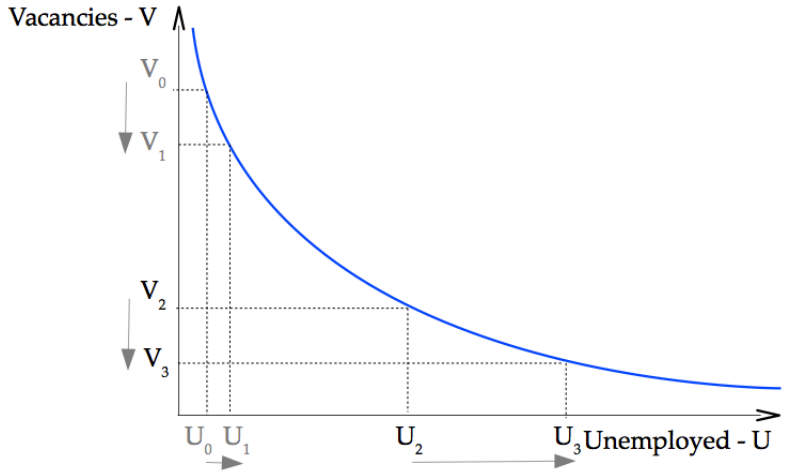

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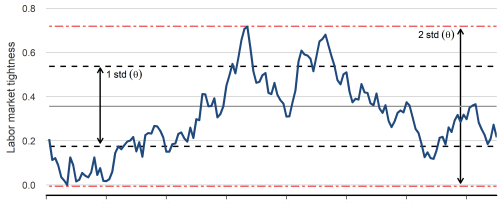
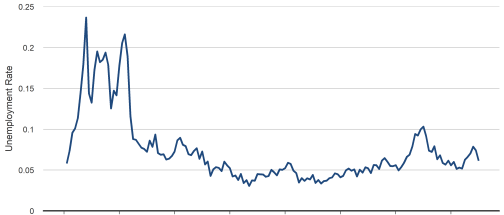
Matching, congestion, and the dynamics of unemployment



(a) Sample path: v-u ratio θ



(b) Sample path: unemployment rate U

In the calibrated model:

- Labor market tightness fluctuactes symmetrically around it's mean
- The unemployment rate is skewed, recessions are "deep"

Remarks on this result:

1 - Solution method matters in models of equilibrium unemployment [Details]

2 - The responses to shocks depend on the current rate of unemployment [Details]

Labor market business cycle moments, model and data

		MODEL				U.S. DATA			
		U	V	θ	X	U	V	θ	X
		Non-crisis samples				1951:I–2012:IV			
Volatility		0.13	0.17	0.27	0.01	0.13	0.14	0.26	0.01
Correlation	U		−0.68	−0.89	-0.82		−0.92	−0.98	−0.22
	V			0.93	0.94			0.98	0.39
	θ				0.97				0.32
		U	V	θ	X	U	V	θ	X
		Crisis samples				1924:I–2017:IV			
Volatility		0.16	0.18	0.30	0.01	0.26	01.17	0.38	0.04
Correlation	U		−0.60	−0.88	−0.82		−0.79	−0.96	-0.38
	V			0.91	0.91			0.93	0.30
	θ				0.97				0.37

Unemployment crisis statistics, model and data

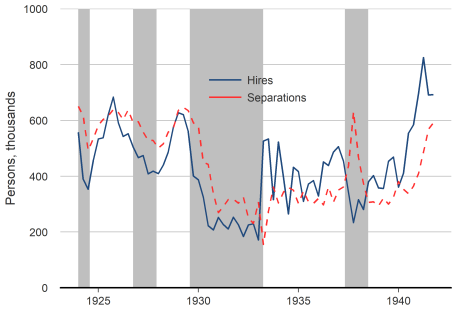
Table: State transition probabilities (%) estimated model and US data

Panel A: Data	Good	Bad	Crisis
Good	95.96	4.04	0
Bad	4.29	95.16	0.55
Crisis	0	8.89	91.11
Sample probability	49.97	47.10	2.93

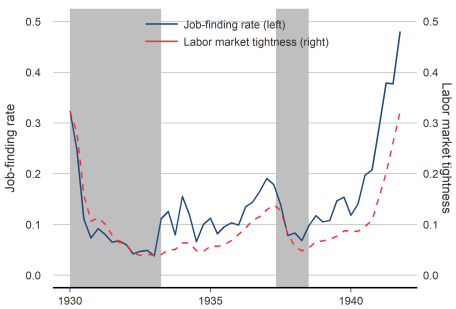
Panel B: Model	Good	Bad	Crisis
Good	97.93	2.07	0
Bad	2.29	97.18	0.53
Crisis	0	8.20	91.80
Sample probability	49.92	45.31	4.77

Is the matching approach reasonable for the Great Depression?

(a) Hires and separations from employment



(b) V-U ratio and the job finding rate

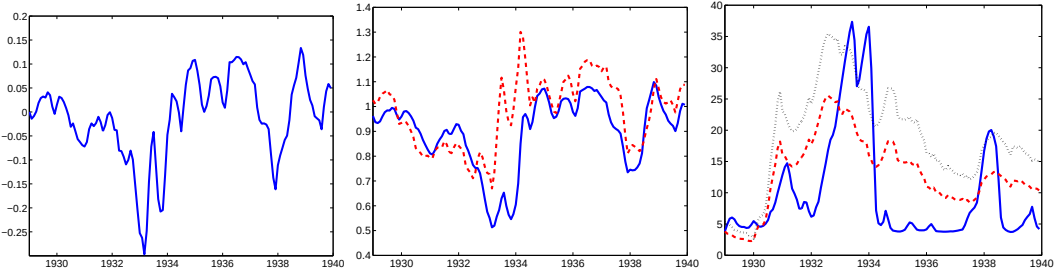


Labor market flows pre and post war: $\Delta N_t = \text{Hires}_t - \text{Separations}_t$

- Hires and separations follow similar business cycle patterns, changes in hires contributing to the majority of the variability of employment
- Changes in the job finding rate closely tied to changes in labor market tightness, with a similar elasticity pre and post war

Reproducing the Great Depression

Figure: Passing detrented log-labor productivity from Jan. 1929 to Dec. 1939 through the model



(a) Labor productivity (b) Aggregate output (c) Unemployment

- Model (blue) aggregate output tracks the US data (red) remarkably close
- Model generates the severity of the rise in unemployment, not its persistence

Conclusion

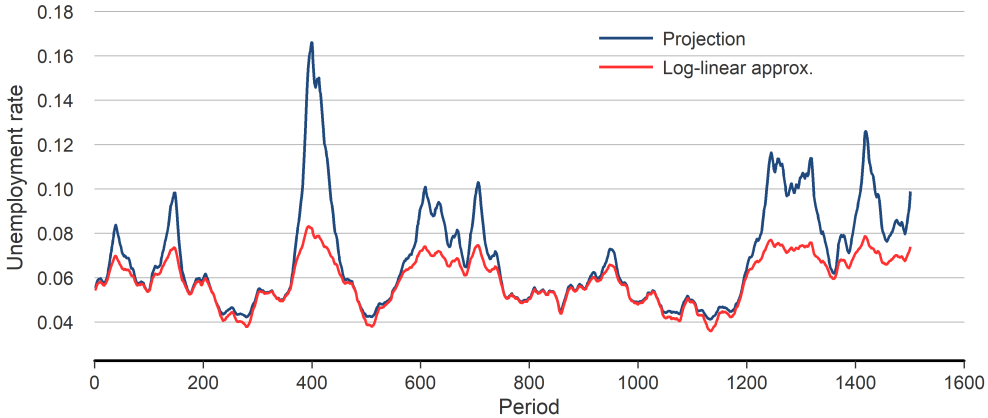
- A matching function is a good description of the aggregate relation between unemployment and vacancies over the last 100 years
- A search and matching models of equilibrium unemployment calibrated to the post-war business cycle can reproduce the high unemployment rates of the Great Depression
- Feeding measured labor productivity into the model reproduces the severity, but not the persistence, of the rise in unemployment during the Great Depression

Final take-away:

- Policy and institutional shocks will have greater effects on when the labor market is slack

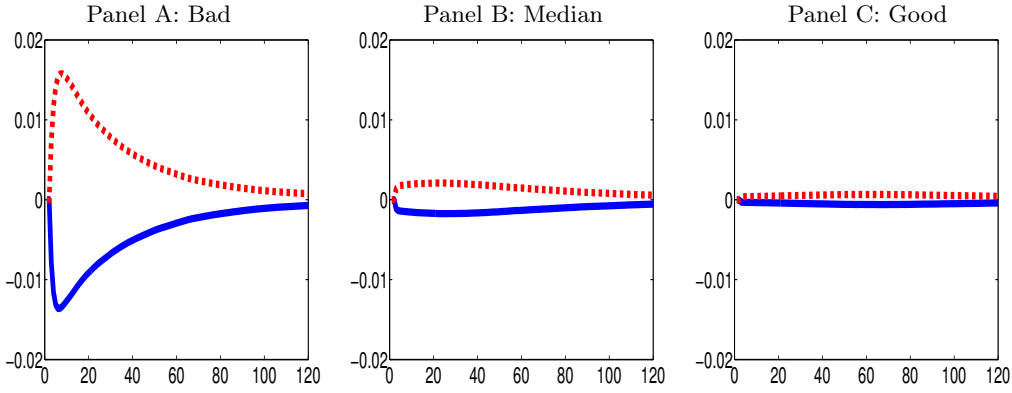
Additional Slides

Model solution method: projection vs. log-linearization



See Petrosky-Nadeau and Zhang (2017), Solving the DMP model Accurately [Back]

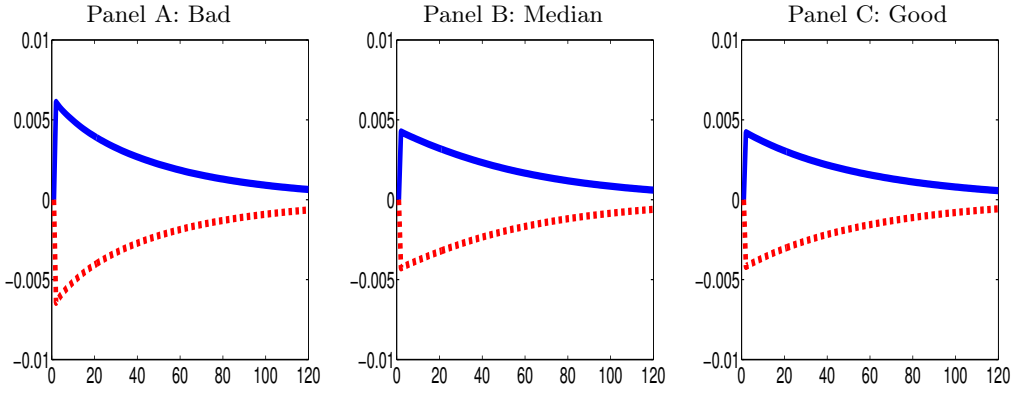
Nonlinear impulse response functions: unemployment



Bad ($U_t = 14.4\%$, $x_t = -0.06$)
Median ($U_t = 5.6\%$, $x_t = 0$)
Good ($U_t = 4.1\%$, $x_t = 0.06$)

Red: negative 1-σ shock
Blue: positive 1-σ shock

Nonlinear impulse response functions: wage



Bad ($U_t = 14.4\%$, $x_t = -0.06$)
Median ($U_t = 5.6\%$, $x_t = 0$)
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Red: negative 1-σ shock
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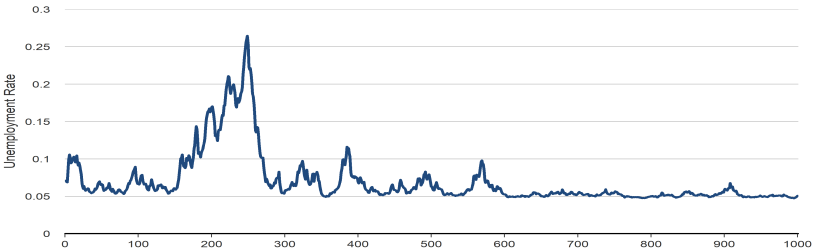
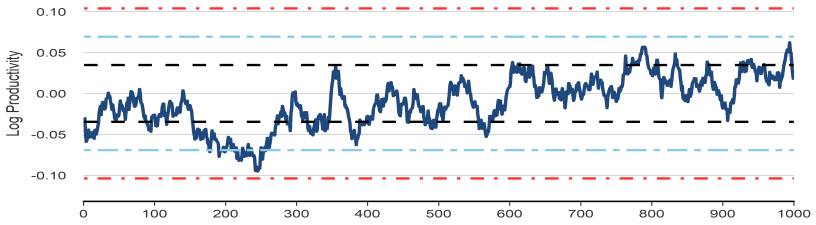
[Back]

An illustrative crisis example





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: $q'(\theta_t) < 0$

Two types of job creation cost:

- Flow posting cost κ_0
- Fixed cost paid after hiring κ_1

Average cost to hiring a worker:

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

Per period resources devoted to job creation:

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

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

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

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

Production technology:

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

The firm maximizes the market value of equity, S_t:

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

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

in which W_t is the wage rate

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

Response of equilibrium θ_t to productivity shocks:

- Benefit side: hinges on the equilibrium response of wage W
  - Implement credible wage bargaining, Hall-Milgrom (2008)
- Cost side: rigidity to changes in market tightness
  - $\kappa_t/q(\theta_t) = \kappa_0/q(\theta_t) + \kappa_1$ as in Pissarides (2009)

The goods market clearing condition:

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

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

- $V_t^\star$ satisfies the intertemporal job creation condition, 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

[Back]

Computation

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

Solve for:

1. $V(N_t, X_t)$
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 $J_{Nt}^{W'}$

Numerical Details

Value of employment at a wage W_t

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

Value of unemployment:

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

- 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

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

- 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; δ: Breakdown probability; χ: Cost of delay

Model

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

- Firm to worker: W_t

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

- 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; δ: Breakdown probability; χ: Cost of delay

Model

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

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

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

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

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

b: Unemployment flow value; δ: Breakdown probability; χ: Cost of delay; [Back]