Chapter 2
Business Cycle Properties

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Outline

1. Dynamics of the benchmark model
2. Calibration
3. Volatility in alternative structures
4. Nonlinear dynamics in the labor market

Dynamics of the benchmark model

Loglinearization of the Job Creation Condition

- Let x_t be the time-varying stochastic value of productivity.
- Use $\hat{x}_t \equiv (x_t - x)/x$ as the proportional deviations of x_t around its deterministic steady state
- Similarly, use $\hat{\theta}_t$ as proportional deviations of labor market tightness.

Loglinearization of the Job Creation Condition

- Assumptions
  - 1. Wage is fixed at some level $\overline{w}$ within the bargaining set
  - 2. Elasticity of the matching function $\eta_L(\theta)$ is a constant η_L

Loglinearization of the Job Creation Condition

- Using equation 1.19, the log-linearization around the steady state of the job creation condition with a fixed wage is:

$$\hat{\theta}_t = (\frac{1}{\eta_L})(\frac{x}{x-\overline{w}})(\frac{r+s}{1+r})\mathbb{E}_t[\sum_{i=0}(\frac{1-s}{1+r})^i \hat{x}_t + 1 + i] \qquad (1)$$

Loglinearization of the Job Creation Condition

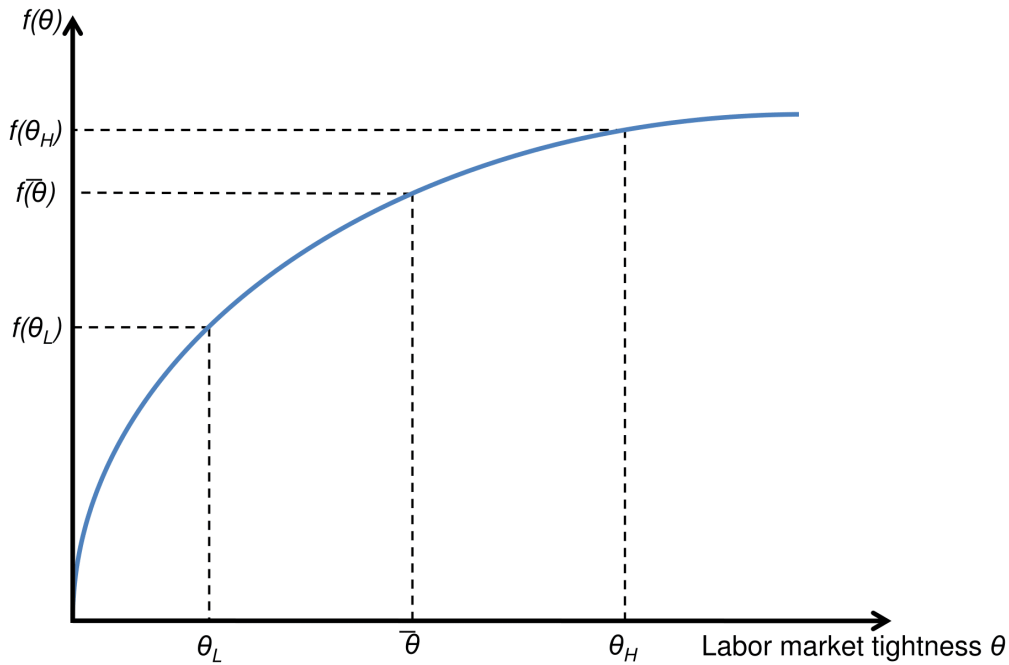
- First element of equation 2.1: The response of equilibrium labor market tightness to changes in labor productivity is decreasing in the elasticity of the matching function with respect to unemployment
- Second element: The response of market tightness is decreasing in the magnitude of the profit flow $x - \overline{w}$
- Amplification of labor market tightness due ti labor market congestion and the size of profit flow:

$$\frac{1}{\eta_L} \frac{x}{x - \overline{w}} \tag{2}$$

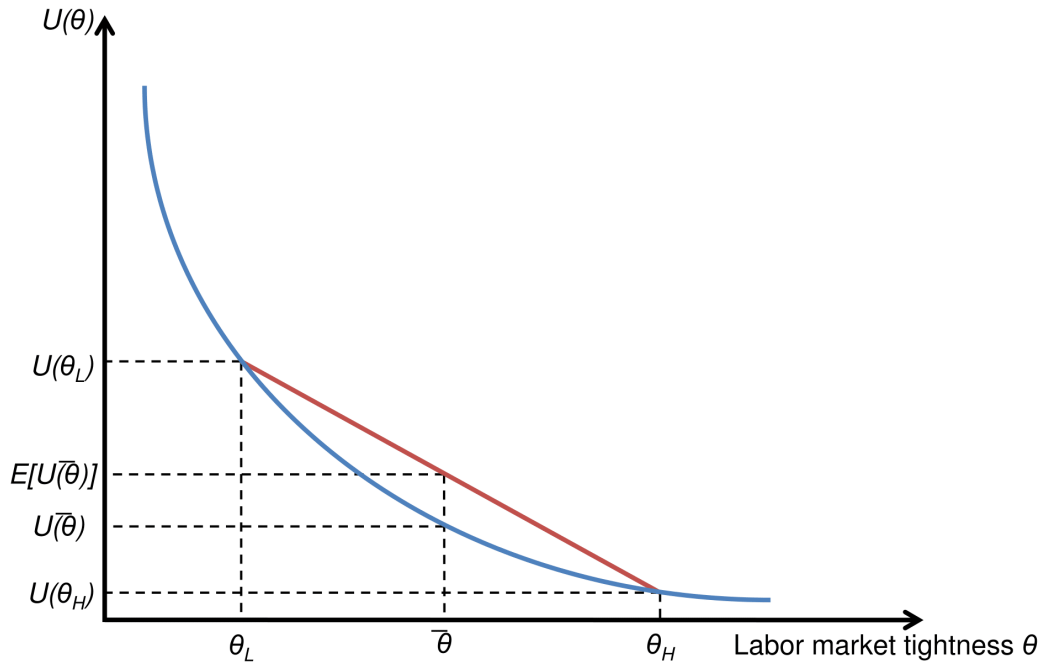
Asymmetries in the cycle

- Movements in labor market tightness affect the unemployment rate through the job finding rate $f(\theta_t$
- The concavity of the matching function means that increases in unemployment during recessions will be pronounced
- Declines in unemployment during expansions will be modest

The Job Finding Rate as a Function of Labor Market Tightness



Relation of Market Tightness to Unemployment



Asymmetries in the cycle

- As economy fluctuates between high and low unemployment, the average rate of unemployment is strictly greater than steady-state unemployment
- The convexity of unemployment-labor market tightness is due to the congestion in the matching function
- The job finding rate decreases more as θ drops from its steady state to θ_L than it increases when θ rises to θ_H

Calibration

Calibrated Parameters

- Assumption: Use the model's stimulated moments, matching them to empirical moments in the calibration process

Parameter Values in the Monthly US Calibration of the Benchmark Model

	Parameter	Value		Reference or Target:
Technology:				
persistence parameter	ρ_x	$0.95^{1/3}$	$\rightarrow$	BLS labor productivity
standard deviation	σ_x	0.00625	$\rightarrow$	BLS labor productivity
Labor market:				
job separation rate	s	0.035	$\rightarrow$	JOLTS
matching curvature	ν_L	1.25	$\rightarrow$	DenHannRameyWatsonAER2000
vacancy cost	γ	0.26	$\rightarrow$	Unemployment rate
worker bargaining weight	α_L	0.50	$\rightarrow$	Equal surplus sharing
nonemploymentnon-employment value	z	0.71	$\rightarrow$	HallMilgrom2008

Discounting and Productivity

- The time discounted rate r is set to 4% per annum, which is the average return on 3-month US Treasury Bill.
- Labor productivity x assumed to follow AR(1) process in logs:

$$log x_t = \rho_x log x_{t-1} + \sigma_x \epsilon_t \tag{3}$$

- $\rho_x \in (0, 1)$
- $\sigma_x > 0$

Matching Function Parameters

- Matching function $\mathcal{M}_L = \mathcal{V}_t \mathcal{U}_t / \left(\mathcal{V}_t^{\nu_L} + \mathcal{U}_t^{\nu_L}\right)^{1/\nu_L}$, where $\nu_L > 0$, and set $\nu_L = 1.25$ (den Haan et al, 2000)
- Meeting rates $f(\theta_t)$ and $q(\theta_t)$ are bounded between 0 and 1

Flow Value of Unemployment z

- The value of z involves two components:
  1. a value of leisure and nonmarket activities l
  2. the value of unemployment benefits b
- Allowing for a leisure component l in the flow value of unemployment z permits a calibration of z above the replacement value of unemployment benefits.

Job Separation rate s

- Job separation rate (s) set to 3.5%, based on the Bureau of Labor Statistic's Job Openings and Labor Turnover Survey (JOLTS).

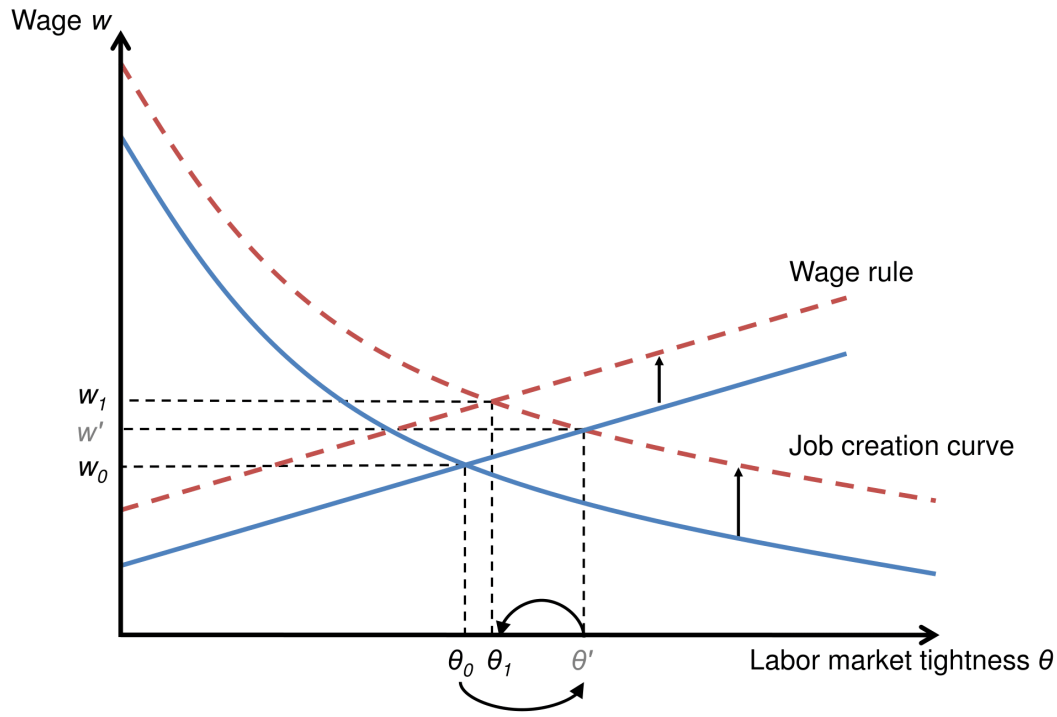
Vacancy Costs γ

- γ is set such that the mean rate of unemployment in the model corresponds to the empirical sample mean of 5.80 percent.
- $\gamma = 0.26$

Bargaining Weight α_L

- The Nash bargaining weight affects the importance of the time-varying components x_t and θ_t in the wage.
- A low value of α_L places most weight on the time-invariant flow value of unemployment z and the equilibrium wage fluctuates little over the business cycle.
- A high value of α_L allows productivity x_t and labor market tightness θ_t to make the wage pro-cyclical
- $\alpha_L = 0.5$; by using a symmetric sharing parametrization in the benchmark model

The Business Cycle in the Calibrated Model



The Business Cycle in the Calibrated Model

- Increase in productivity shifts job creation curve upwards
- Greater entry in labor market by firms
- Upward movement along the Nash wage curve from θ_0 to θ'
- Simultaneous increase in wage curve in proportion α_I of the change in productivity
- Rise in wages limits amount of entry by firms
- New equilibrium tightness θ_1 is below θ'

Volatility in alternative structures

Small Labor Surplus

- Increase the flow value of unemployment z up to 0.85. Keep all other parameters identical.
- New volatility of the labor market tightness is now 0.1 (up from 0.05).
- Narrowing the gap between the flow value of nonmarket activities and market productivity causes even small changes in productivity to induce proportionally large changes in the surplus from hiring labor.
- This amplifies the effect of productivity shocks on θ_t over the business cycle by a factor of two

Credible Bargaining

- Leads to less volatile wages
- Wage becomes less responsive to current labor market tightness
- Additional parameters:
  1. the negotiation breakdown probability $\varphi = 0.1$
  2. the cost of delaying to the firm $\zeta = 0.25$
  3. reduce the flow value of unemployment to 0.60 such that $\zeta + z = 0.85$

Entry Costs and Amplification

- Assume a job creation cost structure with a fixed post-match creation cost $C > 0$ to be payed upon hiring a worker
- The resulting average cost of recruiting, $\gamma/q(\theta_t) + C$, is now augmented with C
- Job creation condition with fixed entry costs:

$$\frac{\gamma}{q(\theta_t)} + C = \frac{1}{1+r}\mathbb{E}_t\left[x_{t+1} - w_{t+1} + (1-s)\left(\frac{\gamma}{q(\theta_{t+1})} + C\right)\right] \tag{4}$$

Entry Costs and Amplification

- Under assumption of a fixed wage the log-linearization of the job creation condition with extra costs is:

$$\widehat{\theta}_t = \frac{1}{\eta_L} \times \frac{x}{x - \bar{w} - (r+s)C} \times \frac{r+s}{1+r} \mathbb{E}_t \left[\sum_{i=0} \left(\frac{1-s}{1+r} \right)^i \widehat{x}_{t+1+i} \right] \tag{5}$$

- Amplification due to labor frictions with fixed wage and entry cost C:

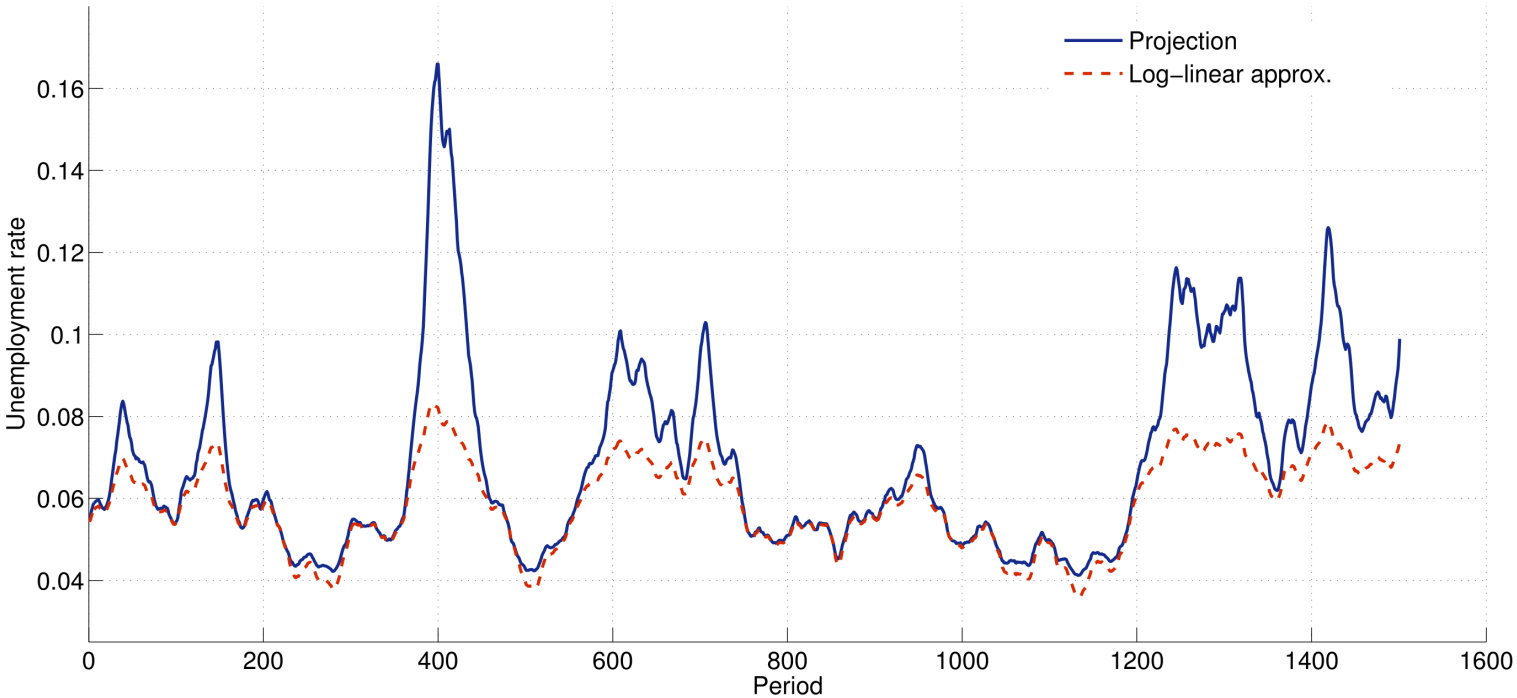
$$\frac{1}{\eta_L} \frac{x}{x - \bar{w} - (r+s)C} \tag{6}$$

Nonlinear Dynamics in the labor market

Solving Models with Search Frictions

- In order to determine the inaccuracy from log-linearization around a deterministic steady state for a search and matching model, solve the same model in two different ways:
  1. global (projection) method
  2. local (log-linearization)
- Then subject both solutions to a same path of labor productivity

Example of Path of Unemployment



Example of Path of Unemployment

- The solid line represents the accurate global model
- Takes into account the curvature of the matching function for the evolution of unemployment as labor market tightness changes over time
- Log-linearization model fails during recessions

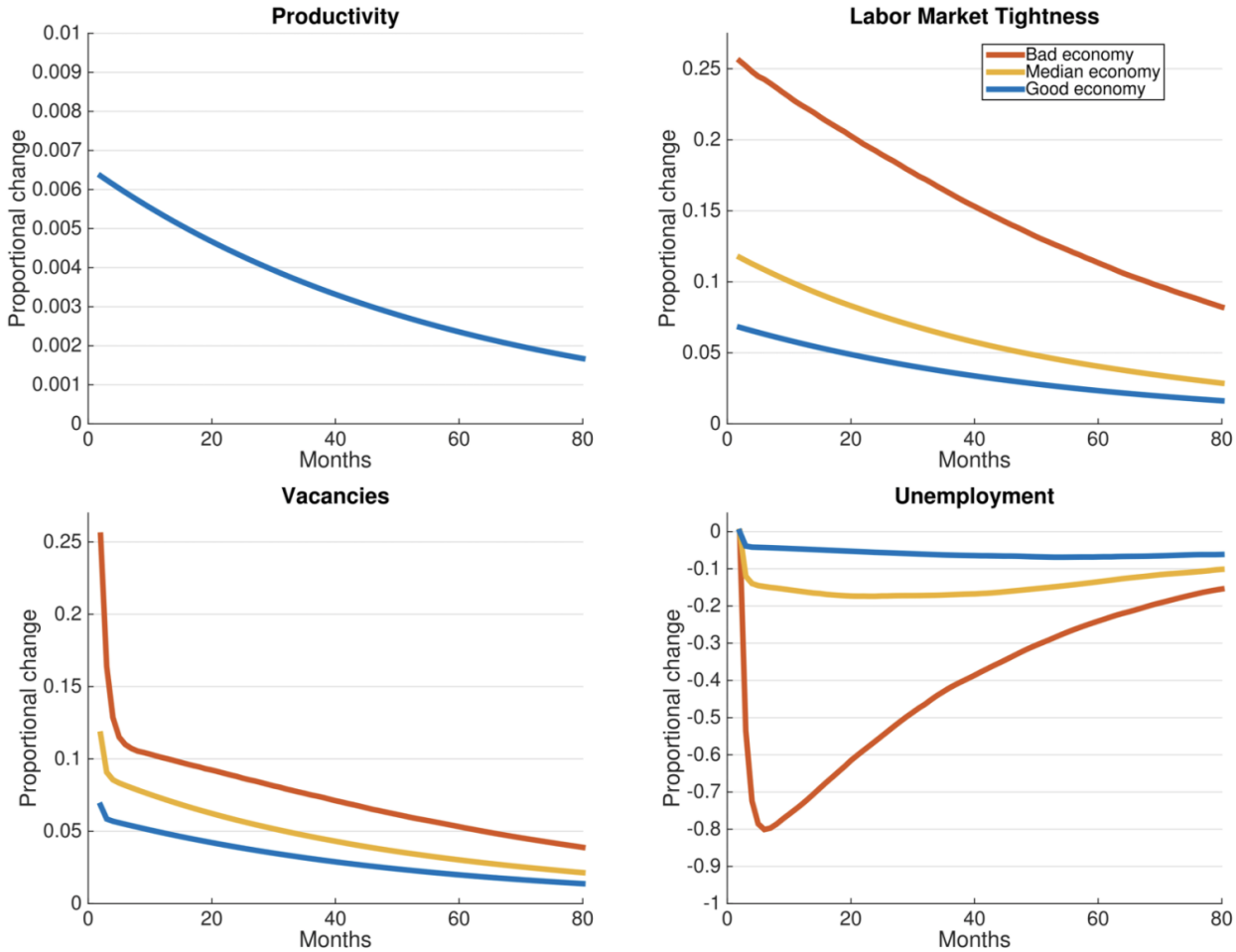
Labor market moments - the inaccuracy of local approximations

	Log-linear approximation					Global solution method			
	$\mathcal{U}$	$\mathcal{V}$	θ	x		$\mathcal{U}$	$\mathcal{V}$	θ	x
Standard deviation	0.108	0.115	0.291	0.013		0.291	0.158	0.216	0.013
Correlation matrix		-0.861	-0.818	-0.934	$\mathcal{U}$		-0.496	-0.542	-0.593
			0.817	0.986	$\mathcal{V}$			0.841	0.873
				0.842	θ				0.992

Labor market moments - the inaccuracy of local approximations

- The first set of columns follow a calibration in the assumption of increasing the value of nonemployment z and it is a log-linearization approximation that is solved.
- The second set of columns uses a global method
- The volatility of unemployment is 3 times greater in panel B than in panel A
- the correlation between unemployment and vacancies is nearly halved

Impulse Response Functions



- Consider a shock during a midpoint of a business cycle when unemployment is at its median
- The strongest increase in labor market tightness θ_t is contemporaneous to the shock, returning to trend at the same rate as labor productivity
- Job vacancies exhibit a pronounced decline following the initial jump, then a progressive return to trend
- The rise in market tightness pushes job creation above job destruction, and the unemployment rate declines
- Job vacancies at a given level of labor productivity are increasing in unemployment
- During the first several months following the productivity shock, job vacancies are also responding to the sharp decline in unemployment
- In the subsequent months unemployment and job vacancies follow a similar paths back towards their trends

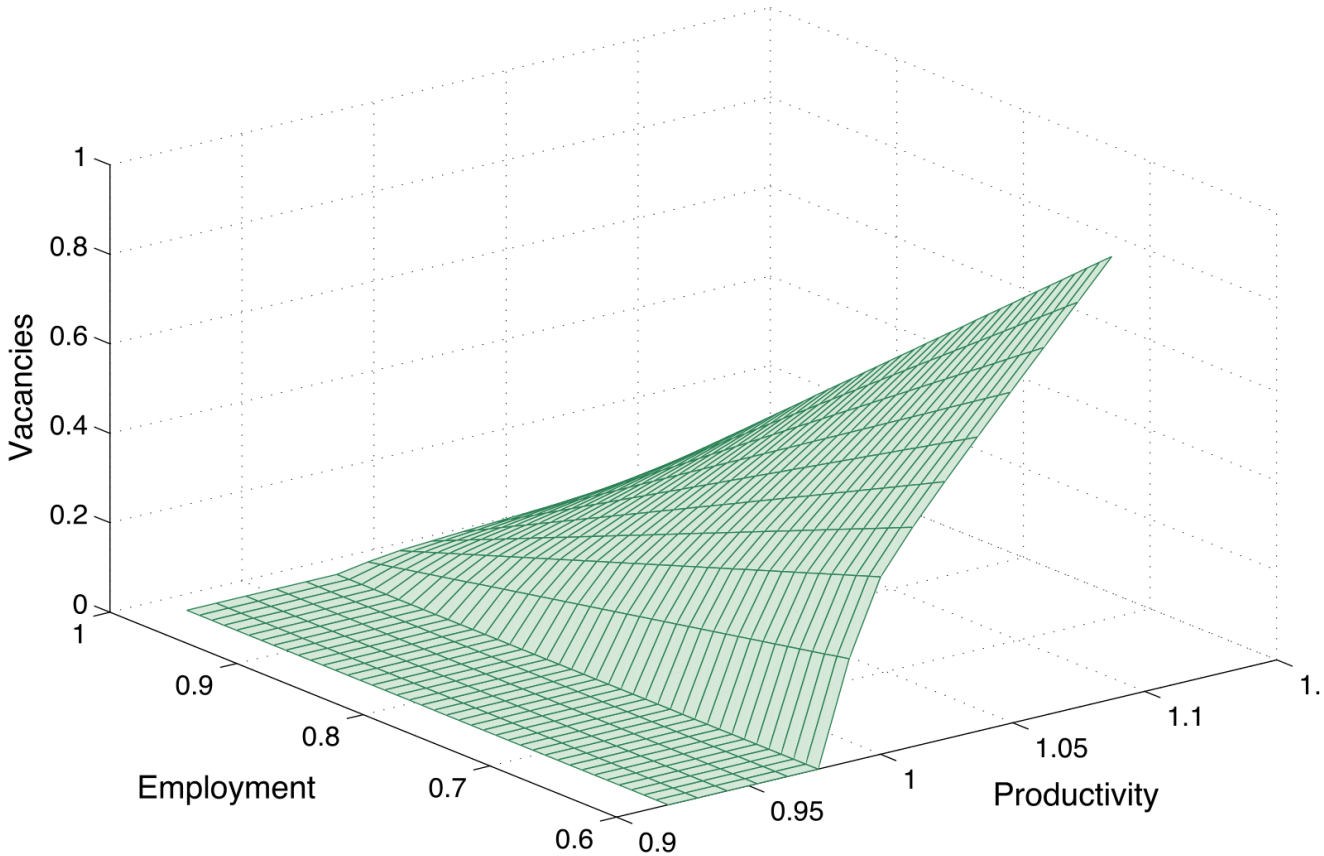
Impulse Response Functions

- Job vacancies and unemployment are complementary in producing new meetings per unit of time
- The dynamics of the labor market are more sensitive to shocks when the labor market is slack than when it is tight

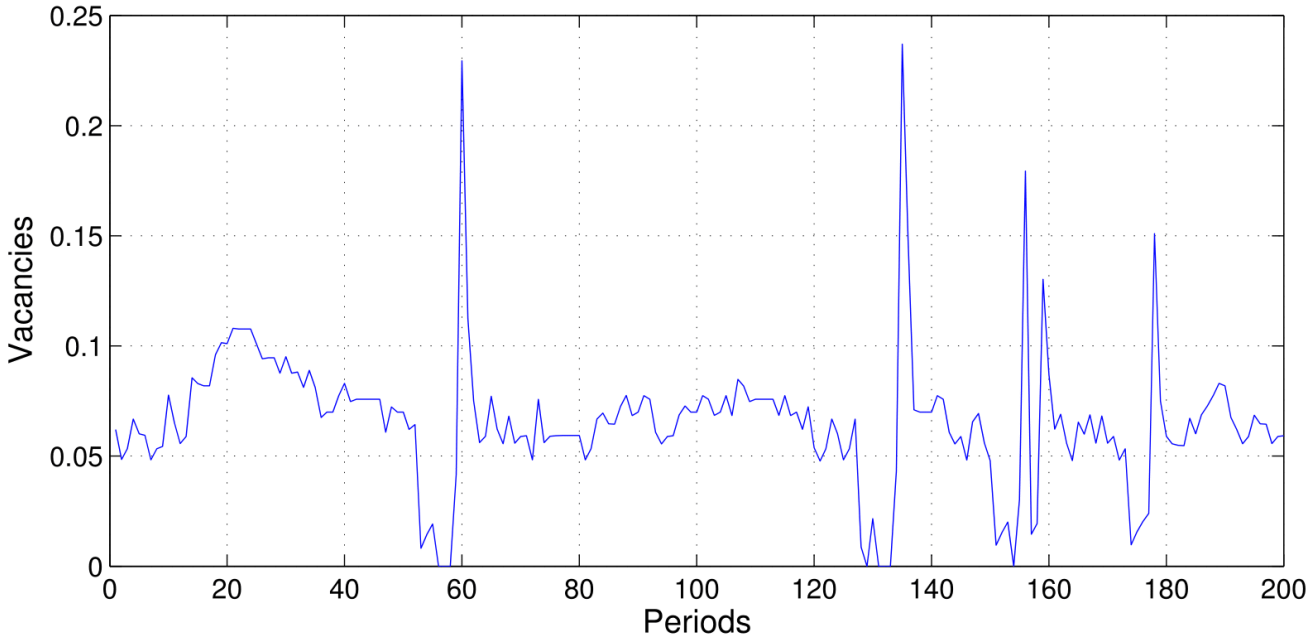
Other nonlinearities: the small surplus assumption and the zero bound for vacancies

- Firms enter the labor market posting job vacancies as long as the expected benefit from filling the job exceeds the cost of posting a vacancy.
- If the cost γ is greater than $\mathbb{E}_t[J_{\pi t+1}]$, then there is no surplus to entering and the result is a shutting down of hiring with $\mathcal{V}_t = 0$.

Job Vacancies in $(x, \mathcal{N})$ space



Model Job Vacancies Time Series



Model Job Vacancies Time Series

- First 50 periods are standard response of model to stochastic change sin productivity
- Series of negative shocks pushes productivity under its boundaries
- Corner solution $\mathcal{V}_t = 0$ for several periods
- Existing jobs continue to be destroyed at rate s and there is a sharp rise in unemployment
- When productivity finally returns to a value such that firms enter the labor market once again, employment is very low and there is massive entry by firms into the market.