Unemployment Fluctuations with Staggered Nash Wage Bargaining

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Motivation

Long-standing challenge in macroeconomics is accounting for

- the relatively volatile cyclical behavior of employment
- the relatively smooth cyclical behavior of wages

Recent vintage of DSGE models (CEE, 2005, SW, 2003)

- rely heavily on staggered wage contracting, but
- have employment adjusting along the intensive margin, and
- are subject to the Barro's (1977) critique

Shimer (2005), Hall (2005), Costain and Reiter (2004):

- Conventional Mortensen-Pissarides model cannot explain the cyclical fluctuations in labor market activity

- Problem: period-by-period Nash bargaining makes wages too flexible

Possible solutions:

- Hall (2005), Shimer (2005), Farmer (2004)

  Ad hoc wage rigidity: constant wage or partially smoothed wage rule

- Menzio (2005), Kennan (2005), Shimer and Wright (2005)

  Axiomatic foundation for wage rigidity based on information structure

- Hagedorn and Manovskii (2004)

  Alternative parameterization

Our approach

- Retain Nash bargaining

- Allow for staggered multiperiod wage contracting

Staggered multiperiod wage contracting

- Each period only a subset of firms/workers negotiate a wage contract

- Each firm negotiates with its existing workforce including new hires

- Workers hired-in between contract settlements receive existing wage

- Form of the contract: fixed wage per period over an exogenous horizon

  $\Rightarrow$ fixed probability $1 - \lambda$ to renegotiate the wage

  $\Rightarrow$ λ matches average frequency of wage renegotiations

Results

- Tractable generalization of the period-by-period Nash bargaining

- Differences from conventional time-dependent staggered wage setting

  - No unexploited bilateral gains from renegotiating the wage

  - General-equilibrium spillovers of average wages on contract wages

- Explain cyclical behavior of US economy, including wages

Model

Variation of Merz (1995) and Andolfatto (1996)

MP model embedded in a general equilibrium framework with

- staggered multiperiod wage contracting
- large firms hiring a continuum of workers ($+$ CRS)
- quadratic costs of adjusting employment size

Unemployment, vacancies and matching

- Each firm i employs $n_t(i)$ workers and post $v_t(i)$ vacancies

- $n_t = \int_0^1 n_t(i)di, \quad v_t = \int_0^1 v_t(i)di$ and $u_t = 1 - n_t$

- $m_t = \sigma_m u_t^{\sigma} v_t^{1-\sigma}, \quad q_t = \dfrac{m_t}{v_t}$ and $s_t = \dfrac{m_t}{u_t}$

- Exogenous separation $1 - \rho$

Firms: setup

$$F_t(i) = y_t(i) - w_t(i)\, n_t(i) - \frac{\kappa}{2} x_t(i)^2\, n_t(i) - z_t k_t(i) + \beta E_t \Lambda_{t,t+1} F_{t+1}(i)$$

- Technology: $y_t(i) = a_t k_t(i)^{\alpha}\, n_t(i)^{1-\alpha}$

- Workforce dynamics: $n_{t+1}(i) = \rho n_t(i) + q_t v_t(i)$

- Hiring rate: $x_t(i) = \dfrac{q_t v_t(i)}{n_t(i)}$

Firms: rental capital decision

$$z_t = \alpha \frac{y_t\,(i)}{k_t\,(i)} = \alpha \frac{y_t}{k_t}$$

Firms: hiring decision

$$\kappa x_t\left(i\right) = \beta E_t \Lambda_{t,t+1} J_{t+1}\left(i\right)$$

where $J_t\left(i\right)$ is the value of a marginal worker at firm i

$$J_t\left(i\right) = f_{nt} - w_t\left(i\right) + \frac{\kappa}{2} x_t\left(i\right)^2 + \rho\beta E_t \Lambda_{t,t+1} J_{t+1}\left(i\right)$$

Workers

- Value of employment

$$V_t(i) = w_t(i) + \beta E_t \Lambda_{t,t+1}\left[\rho V_{t+1}(i) + (1-\rho) U_{t+1}\right]$$

- Value of unemployment

$$U_t = b + \beta E_t \Lambda_{t,t+1}\left[s_t V_{t+1} + (1-s_t) U_{t+1}\right]$$

- Worker surplus

$$H_t(i) = w_t(i) - b + \beta E_t \Lambda_{t,t+1}\left(\rho H_{t+1}(i) - s_t H_{t+1}\right)$$

Period-by-period Nash bargaining

- The contract wage w_t is chosen to solve

$$\max \left(H_t\right)^{\eta} \left(J_t\right)^{1-\eta}$$

- The solution is

$$\eta J_t = (1-\eta)\, H_t$$

- Rearranging, we obtain

$$w_t = \eta \left(f_{nt} + \frac{\kappa}{2} x_t^2 \right) + (1-\eta) \left(b + s_t \beta E_t \Lambda_{t,t+1} H_{t+1} \right)$$

or

$$w_t = \eta \left(f_{nt} + \frac{\kappa}{2} x_t^2 + \kappa s_t x_t \right) + (1-\eta)\, b$$

Staggered Nash bargaining: the problem

- The contract wage w_t^* is chosen to solve

$$\max H_t(r)^{\eta} J_t(r)^{1-\eta}$$

where

$$J_t(r) = E_t \sum_{s=0}^{\infty} \frac{n_{t+s}}{n_t}(r)\beta^s \Lambda_{t,t+s} \left[f_{nt+s} - \frac{\kappa}{2} x_{t+s}(r)^2 \right] - W_t^f(r)$$

$$H_t(r) = W_t^w(r) - E_t \sum_{s=0}^{\infty} (\rho\beta)^s \Lambda_{t,t+s} \left[b + s_{t+s}\beta\Lambda_{t+s,t+s+1} H_{t+s+1} \right]$$

- $W_t^f(r)$ denotes the firm present values of wages

$$W_t^f(r) = \mathbf{\Sigma}_t(r)\, w_t^* + (1-\lambda)\, E_t \sum_{s=1}^{\infty} \frac{n_{t+s}}{n_t}(r)\beta^s \Lambda_{t,t+s}\mathbf{\Sigma}_{t+s}(r) w_{t+s}^*$$

$$\text{where} \quad \mathbf{\Sigma}_t(r) = E_t \sum_{s=0}^{\infty} \frac{n_{t+s}}{n_t}(r)\,(\lambda\beta)^s\, \Lambda_{t,t+s}$$

- $W_t^w(r)$ denotes the worker present values of wages

$$W_t^w(r) = \mathbf{\Delta}_t w_t^* + (1-\lambda)\, E_t \sum_{s=1}^{\infty} (\rho\beta)^s\, \Lambda_{t,t+s}\mathbf{\Delta}_{t+s} w_{t+s}^*$$

$$\text{where} \quad \mathbf{\Delta}_t = \sum_{s=0}^{\infty} (\rho\beta\lambda)^s\, \Lambda_{t,t+s}$$

Staggered Nash bargaining: the solution

- The solution is

$$\eta \Delta_t J_t(r) = (1-\eta)\,\Sigma_t(r)\,H_t(r)$$

with

$$\Delta_t = \frac{\partial H_t(r)}{\partial w_t^*} \quad \text{and} \quad \Sigma_t(r) = -\frac{\partial J_t(r)}{\partial w_t^*}$$

- It can be rewritten as

$$\chi_t(r)\,J_t(r) = (1-\chi_t(r))\,H_t(r)$$

with

$$\chi_t(r) = \frac{\eta}{\eta + (1-\eta)\,\Sigma_t(r)\,/\Delta_t}$$

- Rearranging, the contract wage is a weighted sum of future expected target wages $w_t^o(r)$

$$w_t^*(r) = E_t \sum_{s=0}^{\infty} \phi_{t,t+s} w_{t+s}^o(r)$$

with

$$\phi_{t,t+s} = \frac{(\rho\lambda\beta)^s \Lambda_{t,t+s}}{E_t \sum_{s=0}^{\infty} (\rho\lambda\beta)^s \Lambda_{t,t+s}}$$

and

$$w_t^o(r) = \chi_t(r)\left(f_{nt} + \frac{\kappa}{2} x_t(r)^2\right) + (1 - \chi_t(r))\left(b + s_t \beta E_t \Lambda_{t,t+1} H_{t+1}\right)$$

Spillover effects

Spillover effects emerge directly from the bargaining problem:

- direct spillover effect

$$E_t H_{t+1} = x_t + \text{function} E_t \left[w_{t+1} - w^*_{t+1} (r) \right]$$

- indirect spillover effect

$$x_t (r) = x_t + \text{function} \left[w_t - w^*_t (r) \right]$$

Contract wage

- Combining equations and loglinearizing

$$\widehat{w}_t^* = (1 - \rho\lambda\beta)\,\widehat{w}_t^o(r) + \rho\lambda\beta E_t \widehat{w}_{t+1}^*$$

with

$$\widehat{w}_t^o(r) = \widehat{w}_t^o + \frac{\tau_1}{1-\rho\lambda\beta} E_t\left(\widehat{w}_{t+1} - \widehat{w}_{t+1}^*\right) + \frac{\tau_2}{1-\rho\lambda\beta}\left(\widehat{w}_t - \widehat{w}_t^*\right)$$

$$\widehat{w}_t^o = \varphi_{fn}\widehat{f}_{nt} + \varphi_s \widehat{s}_t + (\varphi_x + \varphi_s)\,\widehat{x}_t + \varphi_\chi \widehat{\chi}_t + (1-\chi)^{-1}\varphi_s E_t \widehat{\chi}_{t+1}$$

- The aggregate wage can be written as

$$\widehat{w}_t = (1-\lambda)\,\widehat{w}_t^* + \lambda \widehat{w}_{t-1}$$

Wage dynamics

$$\widehat{w}_t = \gamma_b \widehat{w}_{t-1} + \gamma \widehat{w}_t^o + \gamma_f E_t \widehat{w}_{t+1}$$

with

$$\gamma_b = (1 + \tau_2)\,\phi^{-1} \qquad \gamma = \varsigma\phi^{-1} \qquad \gamma_f = (\rho\beta - \tau_1)\,\psi\phi^{-1}$$

$$\phi = 1 + \tau_2 + \varsigma + \rho\beta - \tau_1$$

$$\varsigma = (1 - \lambda)\,(1 - \rho\lambda\beta)\,\lambda^{-1}$$

and

$$\gamma_b + \gamma + \gamma_f = 1$$

Hiring dynamics

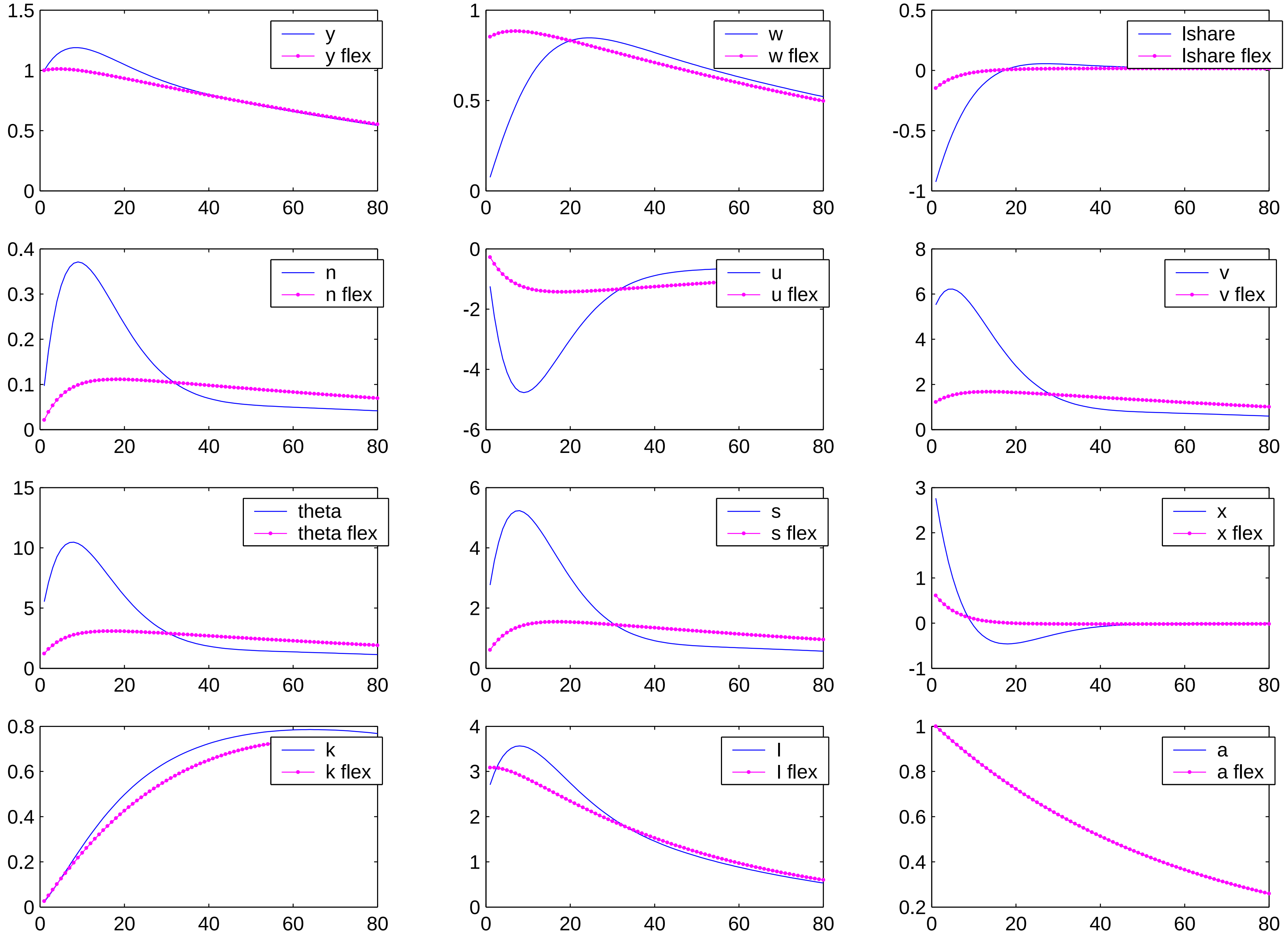
$$\widehat{x}_t = E_t\widehat{\Lambda}_{t,t+1} + \epsilon E_t\left(f_n\widehat{f}_{nt+1} - w\widehat{w}_{t+1}\right) + \beta E_t\widehat{x}_{t+1}$$

Calibration

Parameters values		
Production function parameter	α	0.33
Discount factor	β	0.997
Capital depreciation rate	δ	0.008
Technology autoregressive parameter	ρ_a	0.983
Survival rate	ρ	0.965
Elasticity of matches to unemployment	σ	0.5
Bargaining power parameter	η	0.5
Job finding probability	s	0.45
Relative unemployment flow value	$\bar{b}$	0.4
Renegotiation frequency	λ	0.889

Implied steady state values		
Unemployment rate	u	0.07
Hiring rate	x	0.035
Horizon-adjusted bargaining power	χ	0.44
Labor share	ls	0.65
Investment/output ratio	$\frac{I}{y}$	0.24
Consumption/output ratio	$\frac{c}{y}$	0.75
Adjustment cost/output ratio	$\frac{ac}{y}$	0.01

Figure 1: Impulse responses to a technology shock



Aggregate statistics

	y	w	ls	n	u	v	θ	y/n
			US Economy, 1964:1-2005:01					
Relative Std Deviation	1.00	0.52	0.51	0.60	5.15	6.30	11.28	0.61
Autocorrelation	0.87	0.91	0.73	0.94	0.91	0.91	0.91	0.79
Correlation with y	1.00	0.56	-0.20	0.78	-0.86	0.91	0.90	0.71
			Model Economy, $\lambda \longrightarrow$ 3Q					
Relative Std Deviation	1.00	0.56	0.57	0.35	4.46	5.83	9.88	0.71
Autocorrelation	0.84	0.95	0.65	0.90	0.90	0.83	0.88	0.76
Correlation with y	1.00	0.66	-0.56	0.77	-0.77	0.91	0.94	0.97
			Model Economy, $\lambda \longrightarrow$ 4Q					
Relative Std Deviation	1.00	0.47	0.58	0.44	5.66	7.25	12.47	0.64
Autocorrelation	0.85	0.96	0.68	0.91	0.91	0.86	0.90	0.74
Correlation with y	1.00	0.56	-0.59	0.78	-0.78	0.94	0.95	0.95

Spillover effect and robustness

Relative standard deviations								
	y	w	ls	n	u	v	θ	y/n
Model Economy	1.00	0.56	0.57	0.35	4.46	5.83	9.88	0.71
No spillover	1.00	0.70	0.48	0.18	2.35	3.18	5.25	0.84
Flexible Wages	1.00	0.88	0.09	0.10	1.25	1.58	2.74	0.93
FW + Std Hiring Costs	1.00	0.93	0.02	0.06	0.72	1.01	1.63	0.95
No horizon effect	1.00	0.53	0.53	0.39	5.13	6.70	11.37	0.67

Wages and labor share statistics

	el(w,a)	corr(w,a)	σ_w/σ_a
U.S. data	0.53	0.62	0.85
MP baseline	0.98	1.00	0.98
HM	0.49	1.00	0.49
GT	0.50	0.62	0.80
	el(ls,a)	corr(ls,a)	σ_{ls}/σ_a
U.S. data	-0.50	-0.60	0.83
MP baseline	-0.02	-0.96	0.02
HM	-0.51	-1.00	0.51
GT	-0.51	-0.64	0.80

Bargaining set

- Consider a firm and a worker that have not renegotiated for τ periods
- Wage equals the contract wage negotiated τ periods before: $w_t^*(\tau)$
- Worker reservation wage $\Rightarrow$ wage $R_t^w(\tau)$ such that $H_t(\tau) = 0$
- Firm reservation wage $\Rightarrow$ wage $R_t^f(\tau)$ such that $J_t(\tau) = 0$
- Set τ such that $\lambda^\tau < 1\%$

  $\lambda = 1 - 1/9$ and $\tau = 40 \Rightarrow \lambda^\tau = 0.89\%$

  Generate artificial series and check that $R_t^w(\tau) < w_t^*(\tau) < R_t^f(\tau)$

Figure 2: Bargaining set for contracts still in place after the average duration (3Q)

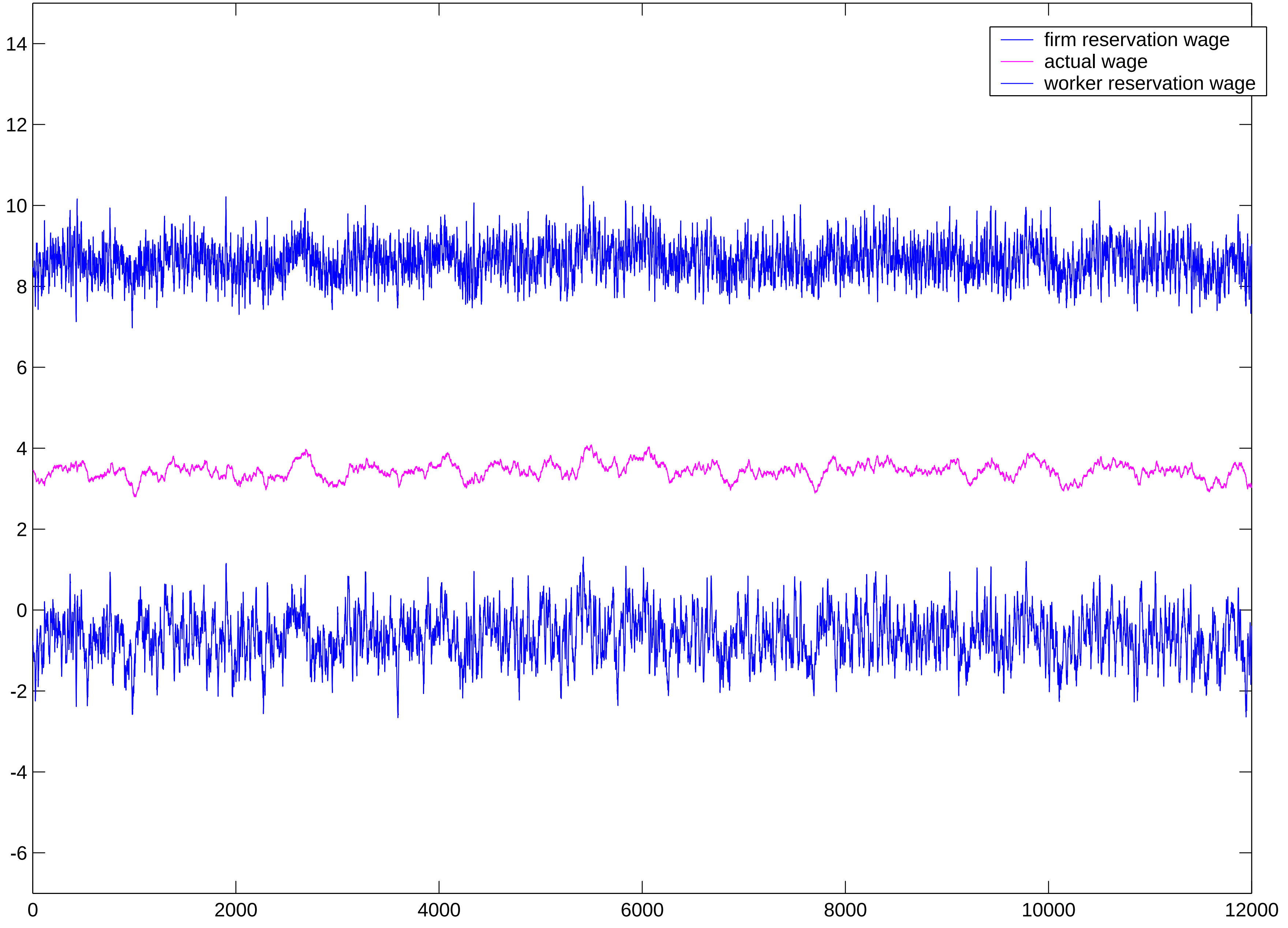
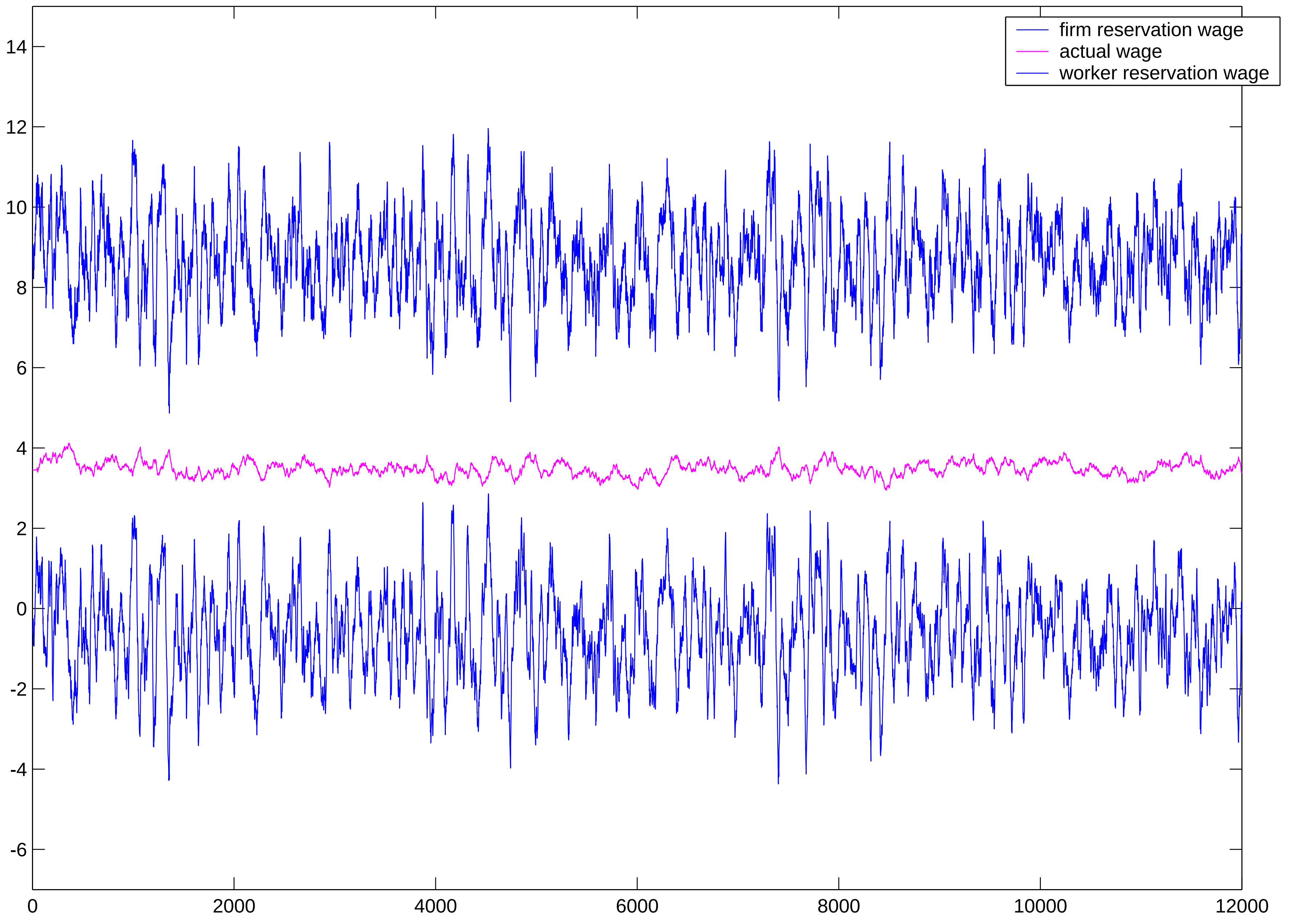


Figure 3: Bargaining set for contracts of 40 months duration



Conclusions

- Conventional MP model with staggered multiperiod wage contracting:
  - tractable generalization of period-by-period Nash bargaining
  - explain cyclical behavior of US economy, including wages
- The wage rigidity does not cause inefficient allocation of labor from the joint perspective of a firm-worker pair:
  - our approach may provide a solution to potential weaknesses of existing macro models relying on staggered wage setting