Unemployment and Business Cycles

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Federal Reserve Bank of San Francisco, September 2014

Background

- Key challenge for modern business cycle models.
  - How to account for observed volatility of labor market variables?
  - Central issue going back to dawn of modern macro models, Lucas and Rapping (1969).

- Standard view
  - For plausibly parameterized models, in a boom, wages rise too rapidly, limiting expansion of employment.
  - Classic RBC models, standard efficiency wage models (Alexopolous), standard DMP models (Shimer).

Ongoing Efforts

- Empirical NK models more successful in accounting for cyclical properties of employment.

- Problems
  - Assume result: wages are exogenously sticky,
  - Agents wouldn't choose this wage arrangement.
  - Limits class of experiments you can sensibly conduct.
  - Can't use models to examine some key policy issues, e.g. extension of unemployment benefits.

  - Wages are always changing because of indexation.

What We Do

- Develop and estimate model that accounts for key business cycle properties of labor market.

- We derive wage inertia as an *equilibrium* outcome.

- Modified version of Hall-Milgrom (2008, HM):
  - When workers and firms bargain, they think they're better off reaching agreement than parting ways.
  - Disagreement leads to continued negotiations.
  - If negotiation costs don't depend sensitively on state of economy, neither do wages.

- We embed this source of inertia in an empirical, dynamic GE model.

Key Model Property

- After expansionary shock, rise in wages is relatively small.
  - Firms receive large share of rents associated with matches.
  - Firms have strong incentive to expand employment.

- Muted response of wages means firms' marginal costs are relatively acyclical.
  - Allows model to account for inertial response of inflation with 'sticky prices' that are consistent with micro data.

Spot wages?

- In benchmark model, workers and firms bargain over wage rate in each period.

- Also consider approach where agents bargain over expected discounted value of wage payments.

- Two approaches lead to identical allocations, though possibly different spot wages.
  - Latter approach is consistent with nominal wage of given worker at a firm being constant for extended periods of time.
  - Wage changes only for new hires.
  - Volatility of wages of job changers can be different from those of incumbents.

Spot wages

- 'Spot wage' approach is useful benchmark for two reasons.
  - Let's us easily incorporate wage data into our empirical analysis.
  - PV approach makes strong assumptions about agents' ability to commit to stream of wage payments.

Comparisons

- Estimation strategy: Bayesian impulse response matching.
  - Standard macro variables, hours worked, real wages, unemployment, job findings and vacancies.

- Model outperforms standard DMP and sticky wage models.
  - Econometric measures of fit, plausibility of estimated structural parameters.
  - Estimated DMP has a replacement ratio well in excess of 0.90.
    - DMP model performance deteriorates dramatically with smaller replacement ratio.
- There's just no need to work with sticky wage models anymore.

Alternative strategy

- Focus on 'Shimer-type' unconditional moments.
  - Example: labor market tightness is much more volatile than labor productivity.
  - Our model has no difficulty in accounting for this fact.

- There's no Shimer puzzle in this environment.

Labor Market Model

- Large number of identical and competitive firms; produce homogeneous output using only labor, l_t.
- Firm pays fixed cost, κ, to meet a worker with probability 1 (GT, GST).
- In our empirical work we also consider a standard DMP setup where cost of meeting a worker is increasing function of labor market tightness.

Labor Market Model

- Worker and firm engage in alternating offer bargaining.
- Upon agreement, production begins immediately.
- Job continues in next period with probability, ρ.

Value Functions

- J_t is the value to a firm of an employed worker:

$$J_t = \vartheta_t - w_t + \rho E_t m_{t+1} J_{t+1}.$$

- ϑ_t and m_{t+1} are determined in general equilibrium.

- Free entry and zero profits dictate:

$$\kappa = J_t.$$

Value Functions

- Value of employment to a worker:

$$V_t = w_t + E_t m_{t+1} \left[\rho V_{t+1} + (1-\rho) \left(f_{t+1} \bar{V}_{t+1} + (1 - f_{t+1}) U_{t+1} \right) \right]$$

  where $f_{t+1}\bar{V}_{t+1}$ are job-to-job transitions, $\bar{V}_{t+1} = V_{t+1}$ in equilibrium.

- Employment law of motion and job finding rate:

$$l_t = (\rho + x_t) l_{t-1} \text{ and } f_t = \frac{x_t l_{t-1}}{1 - \rho l_{t-1}}$$

  where x_t denotes the hiring *rate*.

Value Functions

- Value of unemployment to a worker:

$$U_t = D + E_t m_{t+1} \left[f_{t+1} V_{t+1} + (1 - f_{t+1}) U_{t+1} \right].$$

where D denotes unemployment benefits.

Alternating Offer Bargaining

- Baseline specification:
  - Firms and workers bargain over current wage rate.
    - Each is entitled to reject an offer and either terminate negotiations or propose a counteroffer.
  - Agents take outcome of future wage bargains and economy-wide variables as given

- Bargaining occurs between two types of workers and firms
  - Those that just met for the first time.
  - Those that reached an agreement in previous period and match survived.

Alternating Offers

- Each quarter is divided into M equal subperiods, $m = 1, .., M$.
  - Firm makes an opening wage offer in $m = 1$.
  - Worker can reject and make a counter offer in $m = 2$.
  - Firm can reject worker's wage offer and make a new offer in next sub-period,...
  - If we get there because of rejections, worker makes a take-it-or-leave-it offer in last subperiod M.

- If an offer is accepted in any sub-period m, production begins immediately.
  - Value of production in any subperiod is ϑ_t / M.

- Solution to the problem:

$$w_t^1 \left(\equiv w_t \right), w_t^2, ..., w_t^M.$$

Firm's Offer: round 1

- Firm offers w_t^1 as low as possible subject to worker not rejecting it.

- Optimization by firm leads to:

$$\overbrace{V_t^1}^{\substack{\text{utility of worker who accepts} \\ \text{firm offer and goes to work}}} = \overbrace{\delta U_t^1 + (1-\delta)\left(\frac{D}{M} + V_t^2\right)}^{\substack{\text{utility of worker who rejects} \\ \text{firm offer and intends to make counteroffer}}}$$

where,

$$V_t^1 \equiv w_t^1 + E_t m_{t+1}\left[\rho V_{t+1} + (1-\rho)\left(f_{t+1}\bar{V}_{t+1} + (1-f_{t+1})\,U_{t+1}\right)\right]$$

Worker Offer: round 2

- Worker proposes highest possible wage w_t^2 subject to firm not rejecting it.

$$\overbrace{J_t^2}^{\text{value of firm that accepts worker offer}} = \overbrace{\delta \times 0 + (1-\delta)\left[-\gamma + J_t^3\right]}^{\text{value of firm that rejects worker offer and intends to make counteroffer}}$$

- The firm incurs cost γ to make a counter offer.

- Firm value:

$$J_t^2 \equiv \overbrace{\vartheta_t \frac{M-1}{M}}^{\text{value of worker output in subperiods 2 to } M} - w_t^2 + \rho E_t m_{t+1} J_{t+1}$$

Alternating Offers, Final Round

- Each bargaining round requires the wage for the next round.
- In the last round, the worker makes a final, take-it-or-leave-it-offer:

$$\overbrace{J_t^M}^{\substack{\text{value of firm that} \\ \text{accepts worker offer in last round}}} = \overbrace{0}^{\substack{\text{value of firm that rejects worker's} \\ \text{take-it-or-leave-it offer}}}$$

or

$$J_t^M \equiv \frac{1}{M}\vartheta_t - w_t^M + \rho E_t m_{t+1} J_{t+1} = 0$$

Calculations

- To determine $w_t \equiv w_t^1$, firm first solves w_t^M, w_t^{M-1}, w_t^{M-2}, ..., w_t^2.

  - M equilibrium conditions for the M unknowns.
  - Equations collapse into the following single equation:

$$J_t = \beta_1 (V_t - U_t) - \beta_2 + \beta_3 (\vartheta_t - D),$$

    where the β_i's are functions of M, γ and δ.

- Note the constant terms that aren't a function of the state of the economy.

Comparisons

- *Reduced Form Sharing Rule*

$$J_t = \beta_1 (V_t - U_t) - \beta_2 + \beta_3 (\vartheta_t - D) + \beta_5 U_t$$

- *Alternating Offer Sharing Rule*: $\beta_5 = 0$, β_i's satisfy model restrictions.where the β_i's are functions of M, γ and δ.
  - Testable special case of general sharing rule.

- In standard DMP setup, *Nash sharing rule*: $\beta_1 = (1 - \eta) / \eta$, $\beta_i = 0$, for $i = 2, 3, 4, 5$.
  - Nash is a *testable* special case of our specification.

- *Generalized Wage-setting Rule*: w_t a linear function of period t state.

Alternating Offers in a Simple Macro Model

- Competitive final goods production: $Y_t = \left[\int_0^1 Y_{j,t}^{\frac{1}{\lambda_f}} dj \right]^{\lambda_f}$.
- j^{th} input produced by monopolistic 'retailers':
  - Production: $Y_{jt} = \exp(a_t) h_{j,t}$.

$$a_t = \tau a_{t-1} + \varepsilon_t$$

  - Homogenous good, $h_{j,t}$, purchased in competitive markets for real price, ϑ_t.
  - Retailers' prices subject to Calvo sticky price frictions (no price indexation).

- Homogeneous input good h_t produced by the firms in our labor market model.

A Simple Macro Model ...

- Representative household:

$$E_0 \sum_{t=0}^{\infty} \beta^t \ln C_t$$

$$P_t C_t + B_{t+1} \leq W_t l_t + P_t D\,(1 - l_t) + R_{t-1} B_t + T_t$$

- Calibration: values for parameters that are common to simple macro model, medium-sized DSGE model correspond to prior means for latter model.

Figure 1: Small Model Impulse Responses to a 25 ABP Monetary Policy Shock

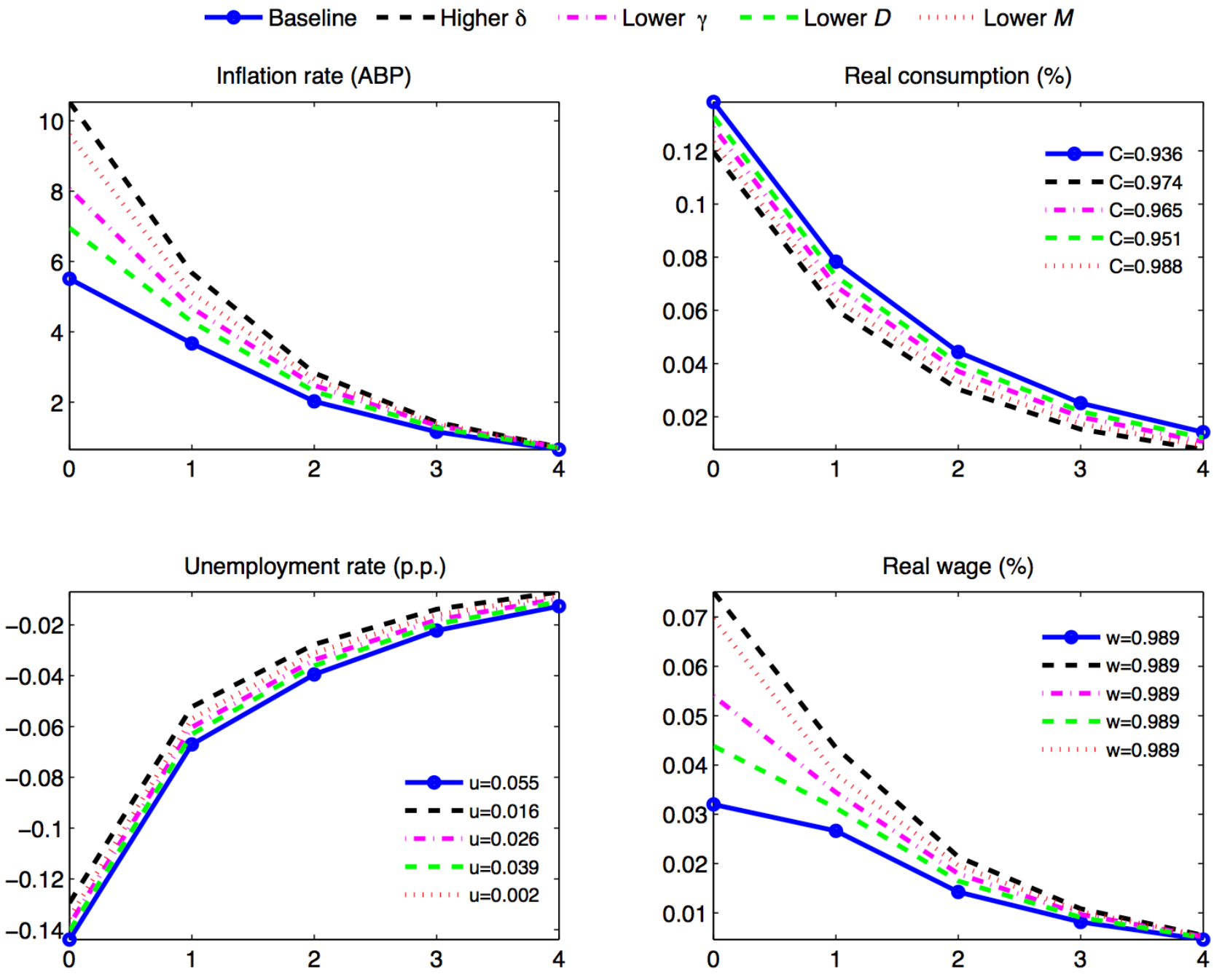
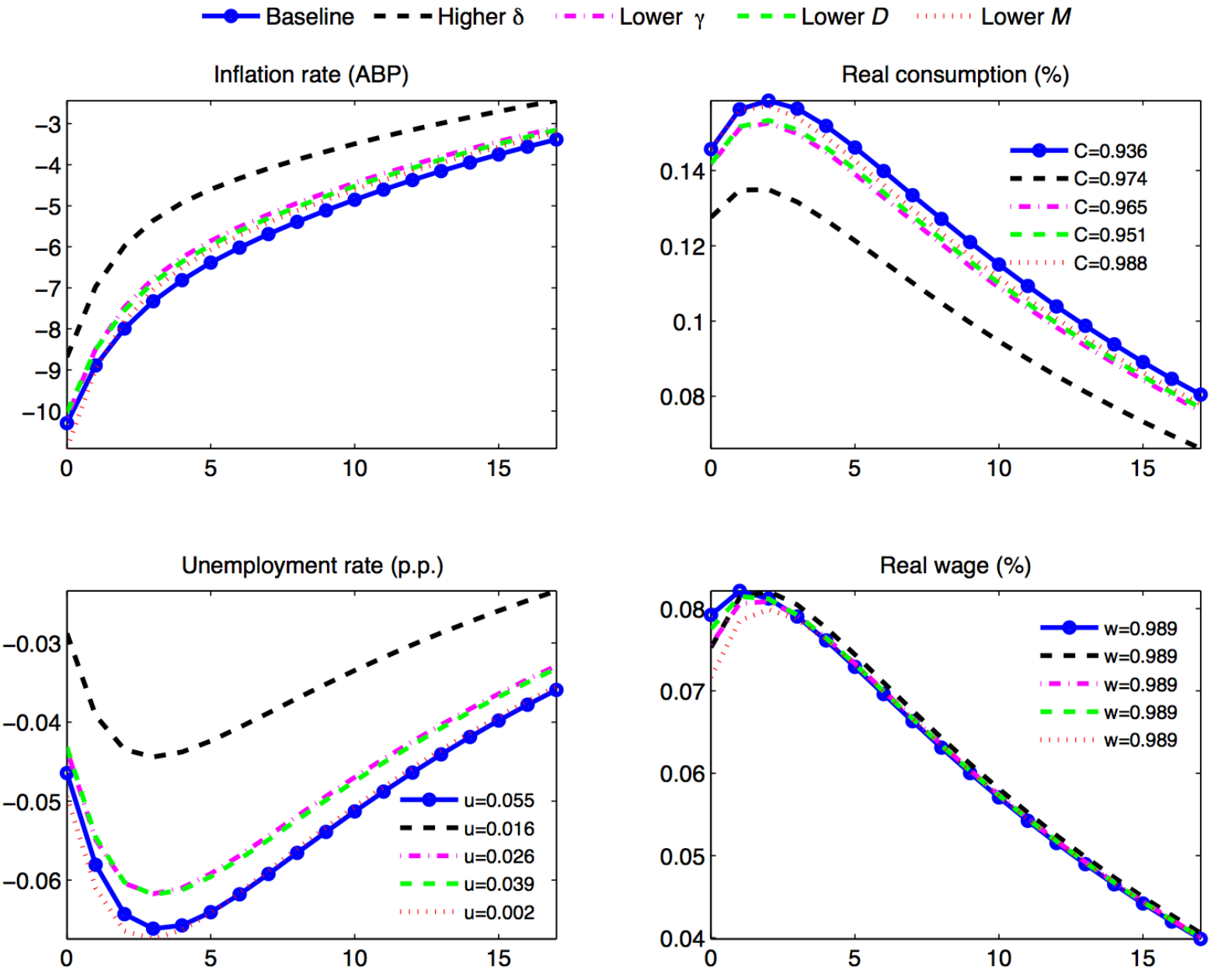


Figure 2: Small Model Impulse Responses to a 0.1 Percent Technology Shock



Intuition

- Policy shock drives real interest rate down.
  - Induces increase in demand for output of final good producers and therefore output of sticky price retailers.
  - Latter must satisfy demand, so retailers purchase more of wholesale good driving up its relative price.
  - Marginal revenue product (ϑ_t) associated with worker rises.
  - Wholesalers hire more workers, raising probability that unemployed worker finds a job.

- Workers' disagreement payoffs rise.
  - Increase in workers' bargaining power generates rise in real wage.

- Alternating offer bargaining mutes rise in real wage.
  - Allows for large increase in employment, substantial decline in unemployment, small rise in inflation.

Simple Macro Model Implications

- Our model is in principle capable of accounting for business cycle facts and Shimer puzzle without exogenously sticky wages.

- Next, do a formal macro data analysis using medium-sized DSGE model.

Medium-Sized DSGE Model

Medium-Sized DSGE Model

- Standard empirical NK model (e.g., CEE, ACEL, SW).
  - Calvo price setting frictions, but no indexation
  - Habit persistence in preferences.
  - Variable capital utilization.
  - Investment adjustment costs.
- Our labor market structure

Estimated Medium-Sized DSGE Mode

- Estimate VAR impulse responses of aggregate variables to a monetary policy shock and two types of technology shocks.

- 11 variables considered:
  - Macro variables and real wage, hours worked, unemployment, job finding rate, vacancies.

- Estimate model using Bayesian variant of CEE (2005) strategy:
  - Minimizes distance between dynamic response to three shocks in model, analog objects in the data.
  - Particular Bayesian strategy developed in Christiano, Trabandt and Walentin (2011).

Posterior Mode of Key Parameters

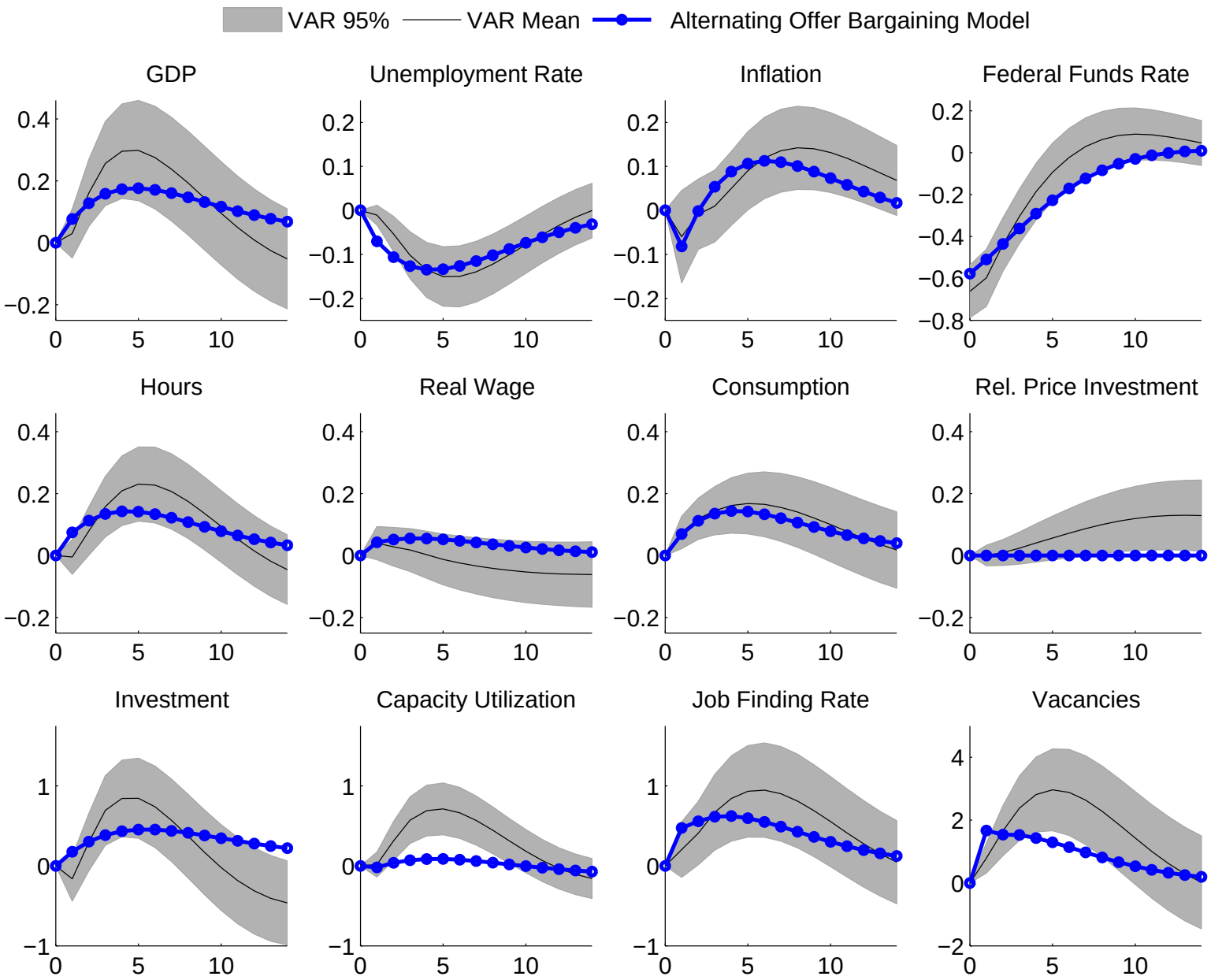
- Prices change on average every 2.4 quarters (no price indexation).
- δ : roughly 0.30% chance of a breakup after rejection.
- γ : cost to firm of preparing counteroffer is 1/4 of a day's worth of production.
- Posterior mode of hiring cost as a percent of total wages newly hired workers (depends on κ): 6.7%.

Posterior Mode of Key Parameters

- Replacement ratio is 0.67.
  - Defensible based on micro data (Gertler-Sala-Trigari, Aguiar-Hurst-Karabarbounis).

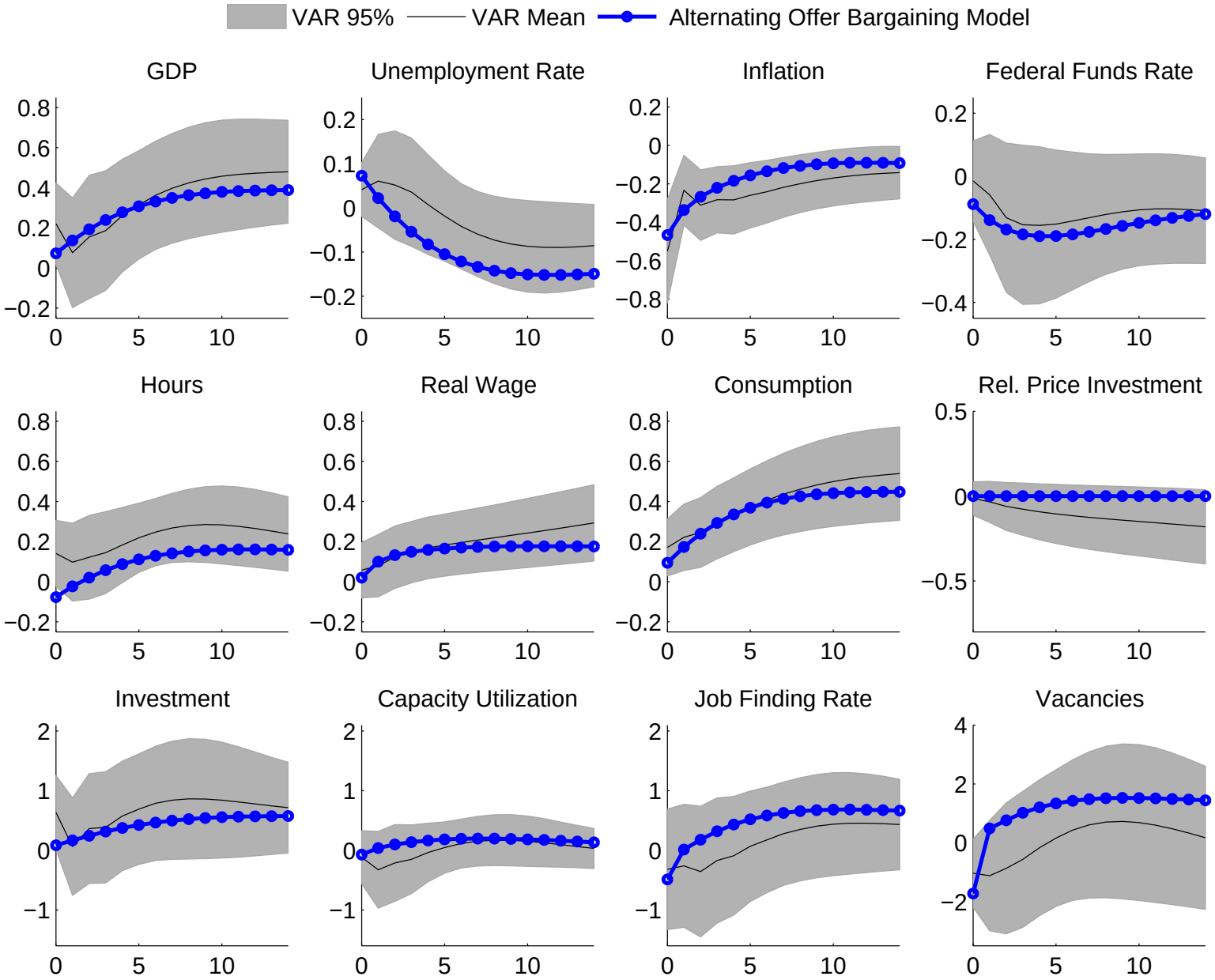
- Gertler, Sala and Trigari (2008) : plausible range for replacement ratio is 0.4 to 0.7.
  - Lower bound based on studies of unemployment insurance benefits
  - Upper boundary takes into account informal sources of insurance.
- Home production sector reduces required replacement ratio (see CET 2014).

Medium−Sized Model Impulse Responses to a Monetary Policy Shock



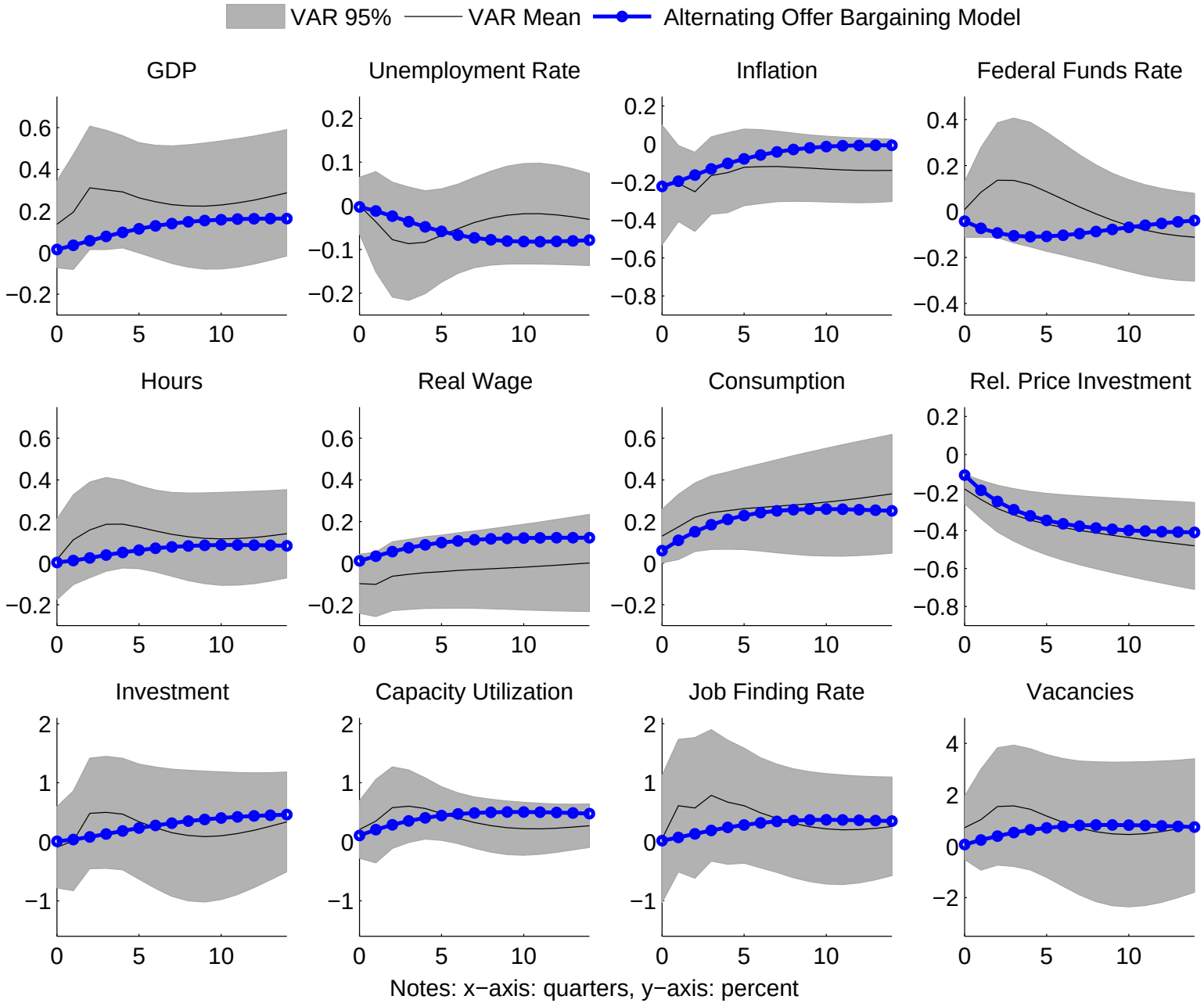
Notes: x−axis: quarters, y−axis: percent

Medium−Sized Model Impulse Responses to a Neutral Technology Shock



Notes: x−axis: quarters, y−axis: percent

Medium−Sized Model Responses to an Investment−specific Technology Shock



Comparison With Other Models

- Erceg, Henderson and Levin (2000, EHL) setup:
  - Wage setting subject to Calvo sticky wage frictions (no indexation)
  - Marginal likelihood strongly prefers our model over sticky wage by about 67 log points
    - stems from lots of stuff, particularly inflation response to monetary policy and neutral technology shocks

Comparison With Other Models...

- Standard Nash with Search costs (DMP setup):
  - Firm posts vacancies, ν_t and meets worker with probability Q_t that depends on job market tightness.
  - Free entry and zero profit condition: $\kappa = Q_t J_t$.
  - Workers and firms split surplus using Nash-sharing rule:

$$J_t = \frac{1-\eta}{\eta}\left[V_t - U_t\right]$$

- Also considered Standard Nash with Hiring Costs

- Marginal likelihood results:
  - Prefers our model over Nash with search (hiring) costs by 40 (20) log points.

Model Comparisons, cont'd

- Estimated parameter values for Nash models implausible.
- Posterior mode for replacement ratio:
  - Nash search model: 0.96
  - Nash hiring model: 0.90

Cyclicality of Unemployment and Vacancies

- Similar to Shimer (2005), we simulate our model subject to a stationary neutral technology shock only.
  - Fixed parameter values.

Standard Deviations of Data vs. Models

	$\frac{\sigma(\text{Labor market tightness})}{\sigma(\text{Labor productivity})}$
Data	27.6
Standard DMP Model	13.2
Our Model	27.8

- Estimated DMP models also do well here.

Conclusion

- We constructed a model that accounts for the economy's response to various business cycle shocks.
- Our model implies that nominal and real wages are inertial.
  - Allows the model to account for weak response of inflation and strong responses of quantity variables to business cycle shocks.
- Model outperforms sticky wage (no-indexation) NK in terms of statistical fit.
- Given limitations of sticky wage model, there's simply no need to work with it.