Teaching version of ‘Involuntary Unemployment and the Business Cycle’

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Motivation

- Unemployment and labor force participation important phenomena
- Still, many business cycle models silent regarding these variables
- Monetary DSGE models tend to have perfect insurance against unemployment ➔unemployment voluntary
- Constant labor force participation bad approximation

Goal of paper

- Construct monetary DSGE model where:
  - Unemployment is involuntary
    - Perfect unemployment insurance a simplifying assumption that has outlived its usefulness
  - Labor force participation endogenous
    - Check on model (Veracierto, JME, 2008)
    - Interesting phenomenon in its own right

What We Do:

- Investigate a particular approach to modeling unemployment – job search effort unobserved
  - Hopenhayn-Nicolini (1997), Shavell-Weiss (1979).
  - Related to efficiency wage literature, Alexopoulos (2004)

- Explore the implications for monetary equilibrium (DSGE) models.
  - Simple NK model without capital (CGG)
  - Standard empirical NK model (e.g., CEE, ACEL, SW)

Unemployment

- To be ‘unemployed’ in US data, must
  - Not be working
  - be ‘willing and able’ to work.
  - recently, made concrete efforts to find a job.

- Our presumption: a person has lower utility when unemployed than when employed.
  - Some indicators of utility (health, suicide, subjective sense of well being, kids’ well being) deteriorate when people experience unemployment
- Current monetary DSGE models with ‘unemployment’:
  - Unemployed are the lucky ones.
  - Finding a job requires **no** effort.

  ➔A BLS employee dropped into current monetary DSGE models would find **zero unemployment**.

Prototype Model

- Explore simple prototype model of unemployment, which has two key features:

1. More effort, e, increases probability, $p(e)$, of securing a job.
   - To be actively looking for work is an essential component of empirical measure of unemployment.

2. Unemployed worse off than employed.
   - assume household effort, e, is not publicly observable.
   - full insurance against household labor market outcomes is not possible.
     - Because then, no one would make an effort to secure a job.

Outline

- Simple Clarida-Gali-Gertler (CGG) NK model
  - For conveying the model mechanism
- Standard empirical model, Christiano, Eichenbaum and Evans (=Smets and Wouters)
  - Evaluate model's ability to match US macroeconomic data, including unemployment and labor force.
    - Does fine on unemployment rate and labor force.
    - No loss on standard macro variables.

Clarida-Gali-Gertler Model

- Goods Production: $Y_t = \left[\int_0^1 Y_{i,t}^{\frac{1}{\lambda_f}} di \right]^{\lambda_f}, \; 1 \le \lambda_f < \infty.$
- Monopolists produce intermediate goods
  - Technology: $Y_{i,t} = A_t h_{i,t}$
  - Enter competitive markets to hire labor.
  - Calvo sticky prices:

$$P_{i,t} = \begin{cases} P_{i,t-1} & \text{with prob. } \xi_p \\ \text{chosen optimally} & \text{with prob. } 1 - \xi_p \end{cases}$$

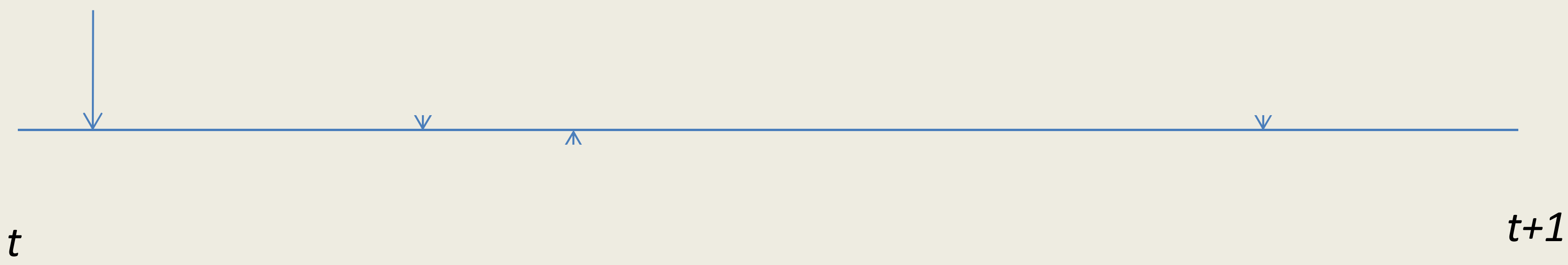
- Policy: $\hat{R}_t = \rho_R \hat{R}_{t-1} + (1 - \rho_R)[r_\pi \hat{\pi}_t + r_y \hat{x}_t] + \varepsilon_t$

Households

- This is where the new stuff is...

A Time Period for a Household

Draw privately observed, idiosyncratic shock, l,
from Uniform, $[0,1]$, that determines utility cost
of work:



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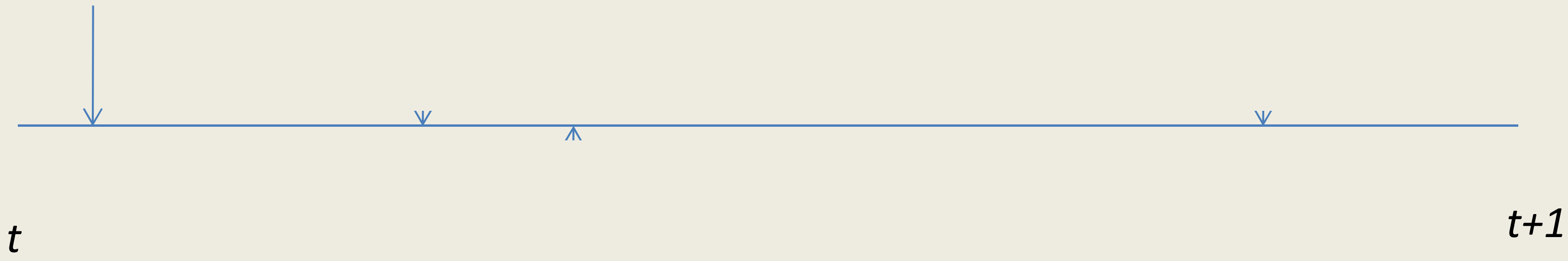
$$F + \varsigma_t(1+\sigma_L)l^{\sigma_L}.$$



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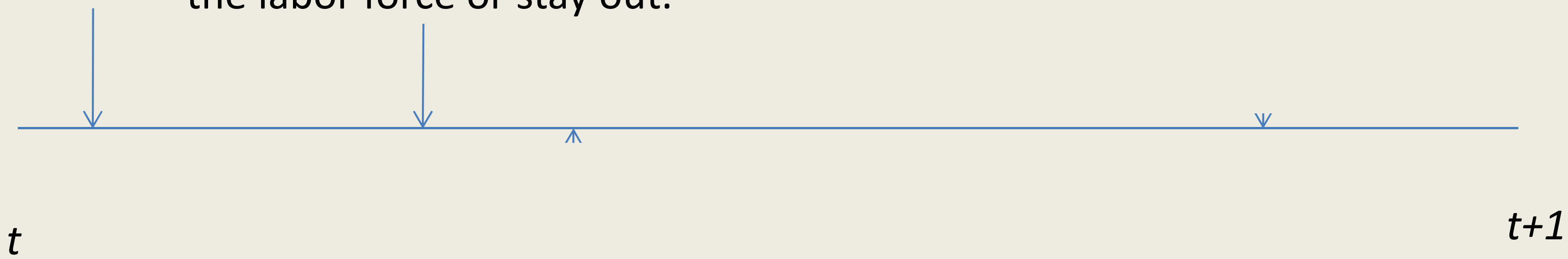
After observing l , decide whether to join the labor force or stay out.



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Household that stays out of labor market does not work and has utility

$$\log c_t^{\text{out of labor force}}$$

t

$t+1$

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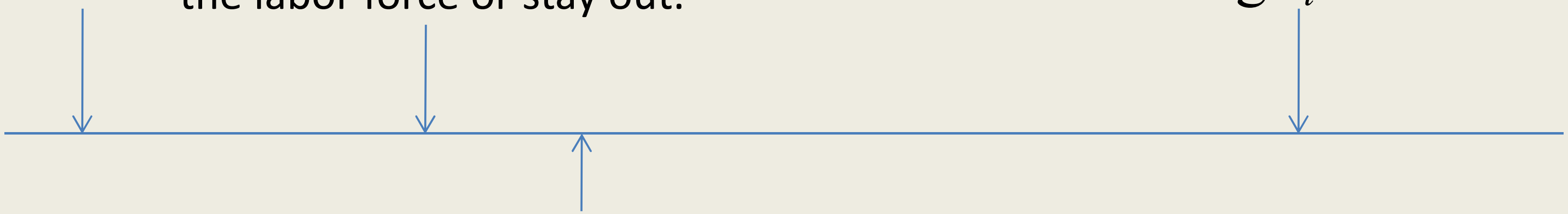

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t+1

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Household that stays out of labor market does not work and has utility

$$\log c_t^{\text{out of labor force}}$$

After observing l, decide whether to join the labor force or stay out.

t

Household that joins labor force tries to find a job by choosing effort, *e*, and has ex ante utility:

$t+1$

$$p(e_{l,t})\left[\overbrace{\log(c_t^w) - F - \varsigma_t(1+\sigma_L)l^{\sigma_L} - \frac{1}{2}e_{l,t}^2}^{\text{ex post utility in case household finds a job}}\right] + (1-p(e_{l,t}))\left[\overbrace{\log(c_t^u) - \frac{1}{2}e_{l,t}^2}^{\text{ex post utility in case of unemployment}}\right]$$

$$p(e_{l,t}) = \eta + ae_{l,t}$$

Household Insurance

- They need it:
  - Concave utility (log)
  - Idiosyncratic work aversion.
  - Uncertainty whether finds job
- Assume households gather into large families
  - Family is “stand-in” for all forms of insurance against unemployment risk
  - Alternative labels: "zero profit insurance company“ or "social planner"
- With *complete* information:
  - Households with low work aversion told to make large effort to find work.
  - All households given same consumption.
- With *private* information:
  - To give households incentive to look for work, must make them better off in case they find work.

➔**Trade-off between incentives and insurance.**

Optimal Insurance

- Relation of family to household: standard principal/agent relationship.
- Family objective: Maximize sum of ex ante utility of households
  - By allocating consumption: $c_t^w,\ c_t^{nw}$
  - c_t^w / c_t^{nw} big enough to incentivize employment, h_t.
  - must satisfy family resource constraint:

$$h_t c_t^w + (1 - h_t) c_t^{nw} = C_t.$$

- For this problem: Take C_t and h_t as given

Incentives

- Family must respect the way private decisions are made.
- Household in the labor force chooses effort to maximize its own ex ante utility:

$$p(e_{l,t})[\log(c_t^w) - F - \varsigma_t(1+\sigma_L)l^{\sigma_L}] + (1-p(e_{l,t}))\log(c_t^{nw}) - \frac{1}{2}e_{l,t}^2$$

- Solution:

$$e_{l,t} = \max\left\{a\left(\log\left[\frac{c_t^w}{c_t^{nw}}\right] - F - \varsigma_t(1+\sigma_L)l^{\sigma_L}\right), 0\right\}$$

- Probability of finding a job:

$$p(e_{l,t}) = \eta + a^2 \max\left\{\log\left[\frac{c_t^w}{c_t^{nw}}\right] - F - \varsigma_t(1+\sigma_L)l^{\sigma_L}, 0\right\}.$$

Incentives, cnt'd

- m is value of l such that household indifferent regarding labor force participation:

$$\log\left[\frac{c_t^w}{c_t^{nw}}\right] = F + \varsigma_t\left(1+\sigma_L\right)m_t^{\sigma_L}.$$

- Number of employed households (using uniform distr over *l*):

$$h_t = \int_0^{m_t} p(e_{l,t})dl$$

$$h_t = -\eta m_t + a^2\varsigma_t\sigma_L m_t^{\sigma_L+1}$$

- By choosing consumption premium, c_t^w / c_t^{nw} family determines
  - $e_{l,t}$: Each household's job finding effort
  - **h** : employment
  - **m** : labor force participation

Connection LFP and u

- Define u=(m-h)/m
- Can show that unemployment is decreasing in LFP (m), i.e. periods of high LFP has low unemployment
- They are driven by the same mechanism: the consumption premium affects both search intensity $e_{l,t}$ and LFP similarly.

Cyclicality of consumption premium c_t^w / c_t^{nw}

- Recall $\log\left[\frac{c_t^w}{c_t^{nw}}\right] = F + \varsigma_t (1+\sigma_L) m_t^{\sigma_L}.$

$$p(e_{l,t}) = \eta + a^2 \max\left\{\log\left[\frac{c_t^w}{c_t^{nw}}\right] - F - \varsigma_t (1+\sigma_L) l^{\sigma_L}, 0\right\}.$$

- In boom, more labor is demanded, so higher c_t^w / c_t^{nw} needed to increase m and incentivize higher job search effort

➔procyclical consumption premium
(= countercyclical replacement ratio)

- – Coincide with Landais, Michaillat and Saez (2012)
- – Contradicts Mitman and Rabinovich (2011)

Confirming happiness of employed

- Utility of finding work – utility of not finding:

$$\Delta(l) = \log\left[c_t^w / c_t^{nw}\right] - F - \varsigma_t (1 + \sigma_L) l^{\sigma_L}.$$

- Recall:

$$\log\left[\frac{c_t^w}{c_t^{nw}}\right] = F + \varsigma_t (1 + \sigma_L) m_t^{\sigma_L}.$$

- So for l<m: happy for job
  - Vice versa: unhappy when unemployed

Family Indirect Utility Function

- Utility: $u(C_t, h_t, \varsigma_t) = \log(C_t) - z(h_t, \varsigma_t)$

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$$- \frac{a^2 \varsigma_t^2 (1 + \sigma_L) \sigma_L^2}{2\sigma_L + 1} f(h_t, \varsigma_t)^{2\sigma_L + 1} + \eta \varsigma_t \sigma_L f(h_t, \varsigma_t)^{\sigma_L + 1}$$

Family Indirect Utility Function

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$$- \frac{a^2\varsigma_t^2(1+\sigma_L)\sigma_L^2}{2\sigma_L+1} f(h_t,\varsigma_t)^{2\sigma_L+1} + \eta\varsigma_t\sigma_L f(h_t,\varsigma_t)^{\sigma_L+1}$$

- Clarida-Gali-Gertler utility function:

$$u(C_t, h_t, \varsigma_t) = \log(C_t) - \varsigma_t h_t^{1+\sigma_L}$$

Family Problem

$$\max_{\{C_t, h_t, B_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t [\log(C_t) - z(h_t, \varsigma_t)]$$

– Subject to:

$$P_t C_t + B_{t+1} \leq B_t R_{t-1} + W_t h_t + Transfers\ and\ profits_t.$$

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– Subject to:

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- Family takes market wage rate as given and tunes incentives so that marginal cost (disutility) of extra work equals marginal benefit:

$$C_t z_h(h_t, \varsigma_t) = \frac{W_t}{P_t}.$$

Reduced Form Properties

- Model is observationally equivalent to standard NK model, when represented only in terms of output, interest rate, inflation:

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$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \frac{(1-\beta\xi_p)(1-\xi_p)}{\xi_p}(1+\sigma_z)\hat{x}_t$$

$$\hat{x}_t = E_t \hat{x}_{t+1} - \left(\hat{R}_t - \hat{\pi}_{t+1} - \hat{R}_t^*\right).$$

$$\hat{R}_t = \rho_R \hat{R}_{t-1} + (1-\rho_R)[r_\pi \hat{\pi}_t + r_y \hat{x}_t] + \varepsilon_t,$$

Reduced Form Properties

z function: disutility of labor for family

'curvature of disutility of labor': $\sigma_z \equiv \frac{z_{hh}h}{z_h}$

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \frac{(1-\beta\xi_p)(1-\xi_p)}{\xi_p}(1+\sigma_z)\hat{x}_t$$

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Put our theory of unemployment into a medium-sized DSGE Model

- Habit persistence in consumption.
- Variable capital utilization.
- Investment adjustment costs.
- Sticky nominal wages, and positive wage markup

Estimated medium-sized DSGE Model

- Estimate model by matching VAR impulse responses of macro variables, including unemployment and labor force, to
  - Monetary policy shock
  - Neutral technology shock
  - Investment technology shock

Replacement ratio

Our estimate: b=0.81

- = Landais, Michaillat and Saez (2012)
- > Hamermesh (1982)
- <0.90 in Chetty and Looney (2006) and Gruber (1997)

Figure 1: Dynamic Responses of Non−Labor Market Variables to a Monetary Policy Shock

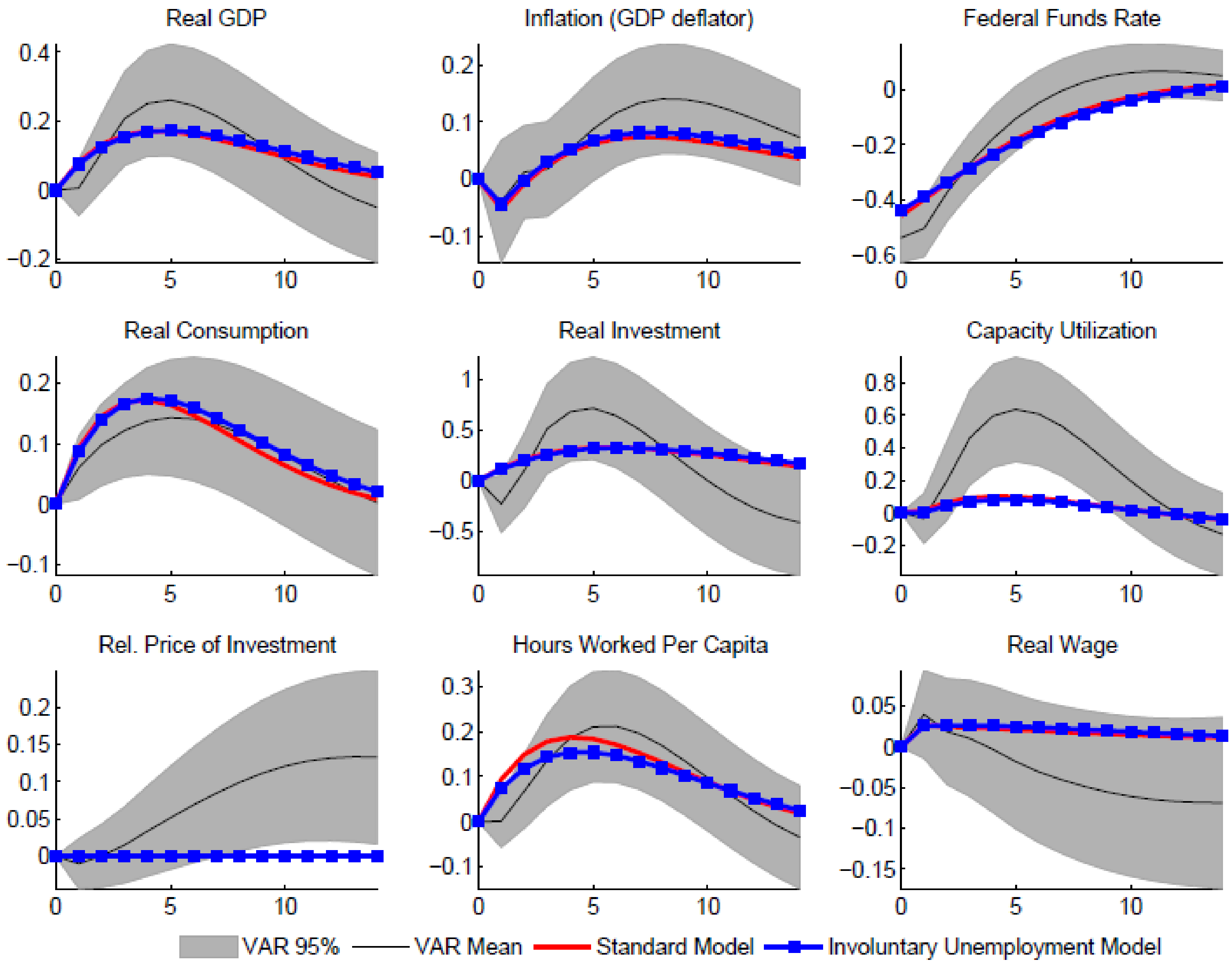
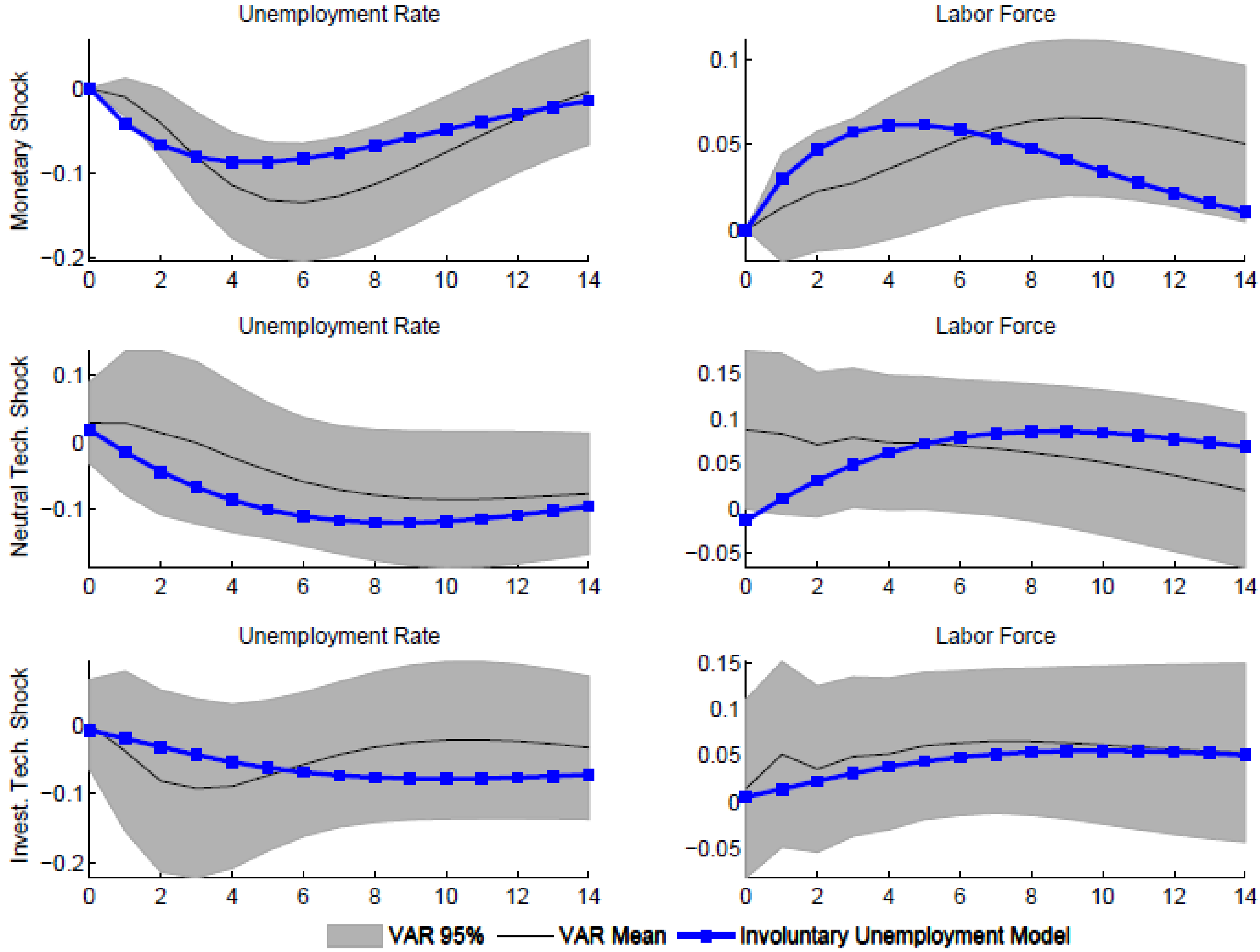


Figure 4: Dynamic Responses of Labor Market Variables to Three Shocks



Conclusion

- Integrated a model of involuntary unemployment into monetary DSGE model.
- Results:
  - Obtained a simple model of **frictional unemployment**, but without search costs/vacancy posting on firm side
  - Able to match responses of unemployment and labor force to macro shocks.
- Useful to jointly model unemployment, LFP and usual macro variables
  - In particular for central banks in current situation

Extra material

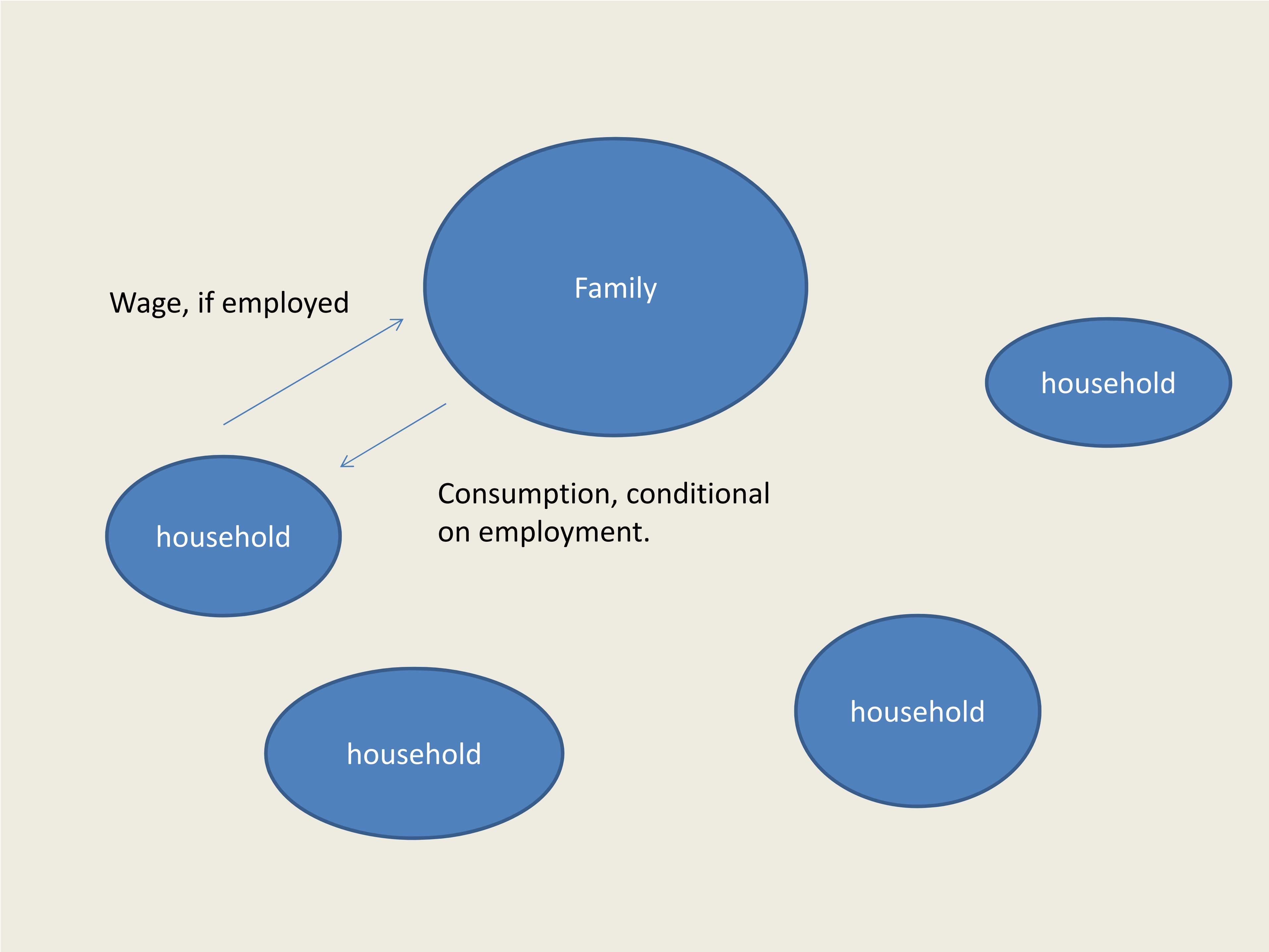
Calibration of the small model

Parameter	Value	Description
β	$1.03^{-.25}$	Discount factor
g_A	1.0047	Technology growth
ξ_p	0.75	Price stickiness
λ_f	1.2	Price markup
ρ_R	0.8	Taylor rule: interest smoothing
r_π	1.5	Taylor rule: inflation
r_y	0.2	Taylor rule: output gap
η_g	0.2	Government consumption share on GDP

Parameterize preference and job finding function to match:

labor force participation rate: *m=0.67*
employment rate: *h=0.63*
unemployment rate: *u=0.056*

Miracle to Malaise: What’s next for Japan, Cox and Koo, Economic letter, Dallas Fed, Jan. 2006.


Family
Wage, if employed
household
Consumption, conditional on employment.
household
household
household

NK Model: Monetary Policy

- Taylor rule:

$$\hat{R}_t = \rho_R \hat{R}_{t-1} + (1-\rho_R)[r_\pi \hat{\pi}_t + r_y \hat{x}_t] + \varepsilon_t$$

- Here: $\hat{x}_t \equiv \hat{h}_t - \hat{h}_t^*$

  – $\hat{h}_t$: percent deviation of hours from steady state.

  – $\hat{h}_t^*$: percent deviation of hours in 'natural equilibrium' from steady state.

- Efficient equilibrium: first best allocations
  – monopoly power and inflation distortions extinguished.

Table 1: Non-Estimated Parameters in the Medium-sized Model

Parameter	Value	Description
α	0.25	Capital share
δ	0.025	Depreciation rate
β	0.999	Discount factor
π	1.0083	Gross inflation rate
η_g	0.2	Government consumption to GDP ratio
κ_w	1	Wage indexation to π_{t-1}
λ_w	1.01	Wage markup
ξ_w	0.75	Wage stickiness
$\overline{p}$	0.97	Max, $p(e)$
μ_n	1.0041	Gross neutral tech. growth
μ_ψ	1.0018	Gross invest. tech. growth

Estimation results – steady states

Table 3: Medium-sized Model Steady State at Posterior Mean for Parameters

Variable	Value	Description
$p_{k'}k/y$	7.73	Capital to GDP ratio (quarterly)
c/y	0.56	Consumption to GDP ratio
i/y	0.24	Investment to GDP ratio
$H = h$	0.63	Employment
c^{nw}/c^{w}	**0.81**	**Replacement ratio**
R	1.014	Gross nominal interest rate (quarterly)
R^{real}	1.006	Gross real interest rate (quarterly)
r^{k}	0.033	Capital rental rate (quarterly)
u	0.056	Unemployment rate
m	0.67	Labor force
ς	**1.95**	**Slope, labor disutility**
F	**0.75**	**Intercept, labor disutility**
a	**0.52**	**Slope,** $p(e)$
η	**0.75**	**Intercept,** $p(e)$

Table 2: Priors and Posteriors of Parameters for the Medium-sized Model

Parameter		Prior		Posterior
		Distribution	Mean, Std.Dev.	Mean, Std.Dev.
		Price setting parameters		
Price Stickiness	$\boldsymbol{\xi_p}$	**Beta**	**0.50, 0.15**	**0.64, 0.04**
Price Markup	λ_f	Gamma	1.20, 0.15	1.36, 0.09
		Monetary authority parameters		
Taylor Rule: Int. Smoothing	ρ_R	Beta	0.80, 0.10	0.89, 0.01
Taylor Rule: Inflation Coef.	r_π	Gamma	1.60, 0.15	1.47, 0.11
Taylor Rule: GDP Coef.	r_y	Gamma	0.20, 0.10	0.06, 0.02
		Household parameters		
Consumption Habit	b	Beta	0.75, 0.15	0.79, 0.02
Power, labor disutility	σ_L	Uniform	10.0, 5.77	7.40, 0.47
Inverse labor supply elast.	$\boldsymbol{\sigma_z}$	**Gamma**	**0.30, 0.20**	**0.13, 0.02**
Capacity Adj. Costs Curv.	σ_a	Gamma	1.00, 0.75	0.30, 0.09
Investment Adj. Costs Curv.	S''	Gamma	12.00, 8.00	20.26, 4.06
		Shocks		
Autocorr. Invest. Tech.	ρ_ψ	Uniform	0.50, 0.29	0.59, 0.08
Std.Dev. Neutral Tech. Shock	σ_n	Inv. Gamma	0.20, 0.10	0.22, 0.02
Std.Dev. Invest. Tech. Shock	σ_ψ	Inv. Gamma	0.20, 0.10	0.16, 0.02
Std.Dev. Monetary Shock	σ_R	Inv. Gamma	0.40, 0.20	0.43, 0.03

Figure 2: Dynamic Responses of Non−Labor Market Variables to a Neutral Technology Shock

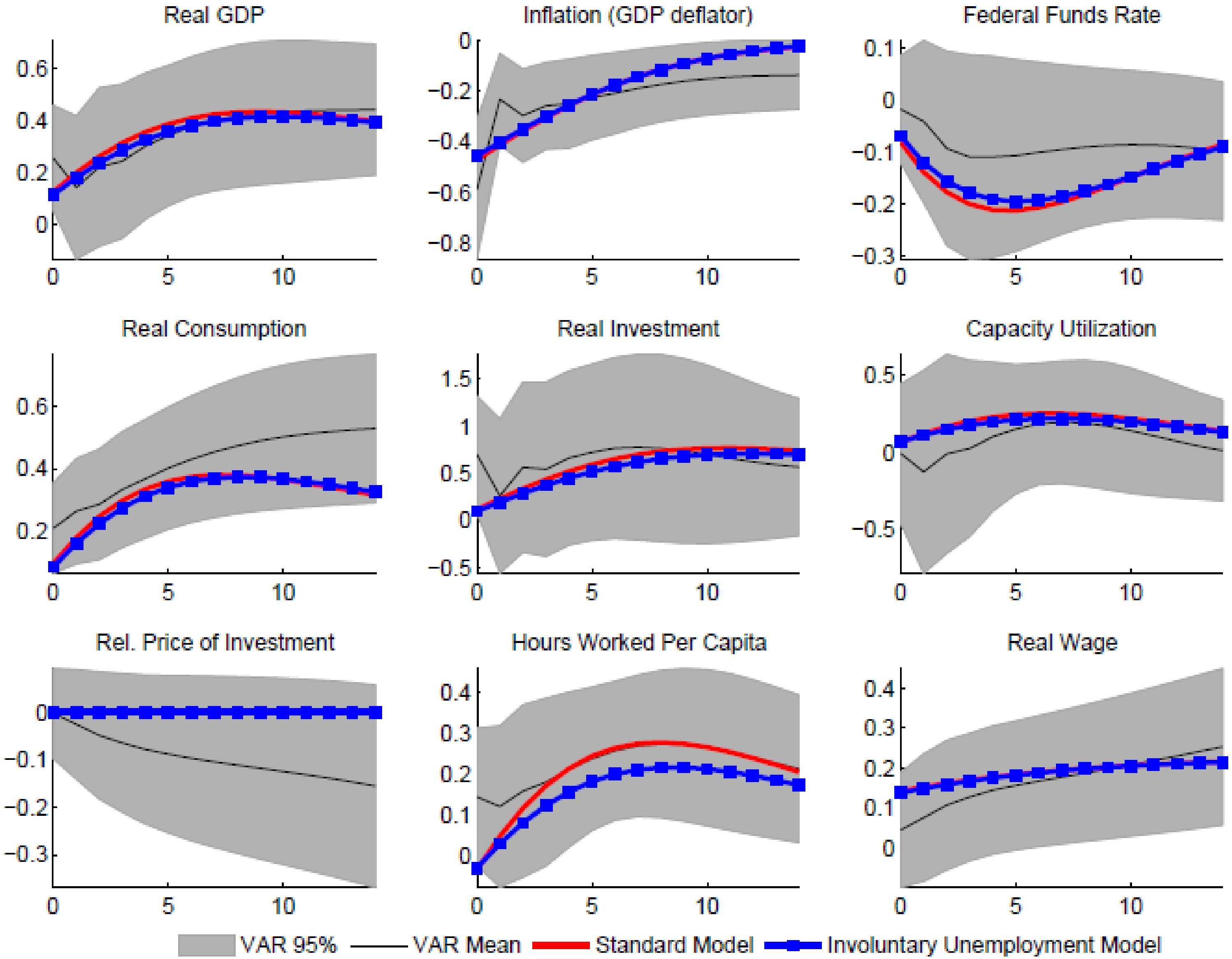


Figure 3: Dynamic Responses of Non−Labor Market Variables to an Investment Specific Technology Shock

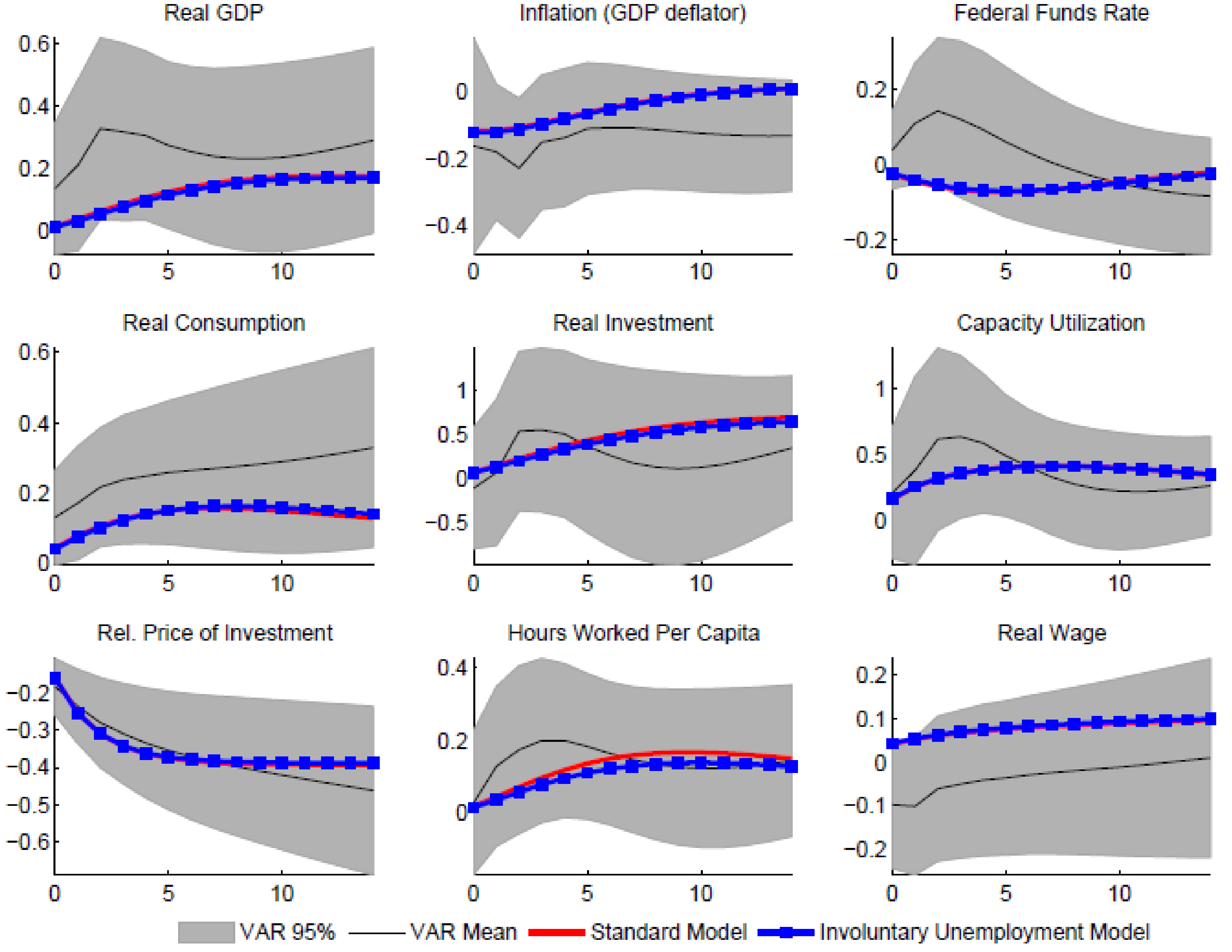


Figure 5: Dynamic Responses of Labor Market Variables to Three Shocks