DSGE Models for Monetary Policy

(provisional title)

Lawrence Christiano (Nortwestern)

Mathias Trabant (ECB and Riksbank)

Karl Walentin (Riksbank)

Background:

- A consensus macro model has emerged for the analysis of monetary policy.

- Developing versions of the model to address urgent, *practical* monetary policy questions:

  - How should policy react to asset price volatility, interest rate spreads?
  - Define ‘exigent circumstances’ and how the effects of monetary and fiscal policy might be different then.

- That model fits the data well (CEE, SW, LOWW, CMR).

- But,
  - Lacks implications for standard labor market variables: unemployment, vacancies, separations, etc

- ‘Parallel’ literature on search and matching in the labor market:
  - Mortensen-Pissarides, Hall, Shimer, Gertler-Trigari, Gertler-Sala-Trigari (GST), den Haan-Ramey-Watson.

What we do:

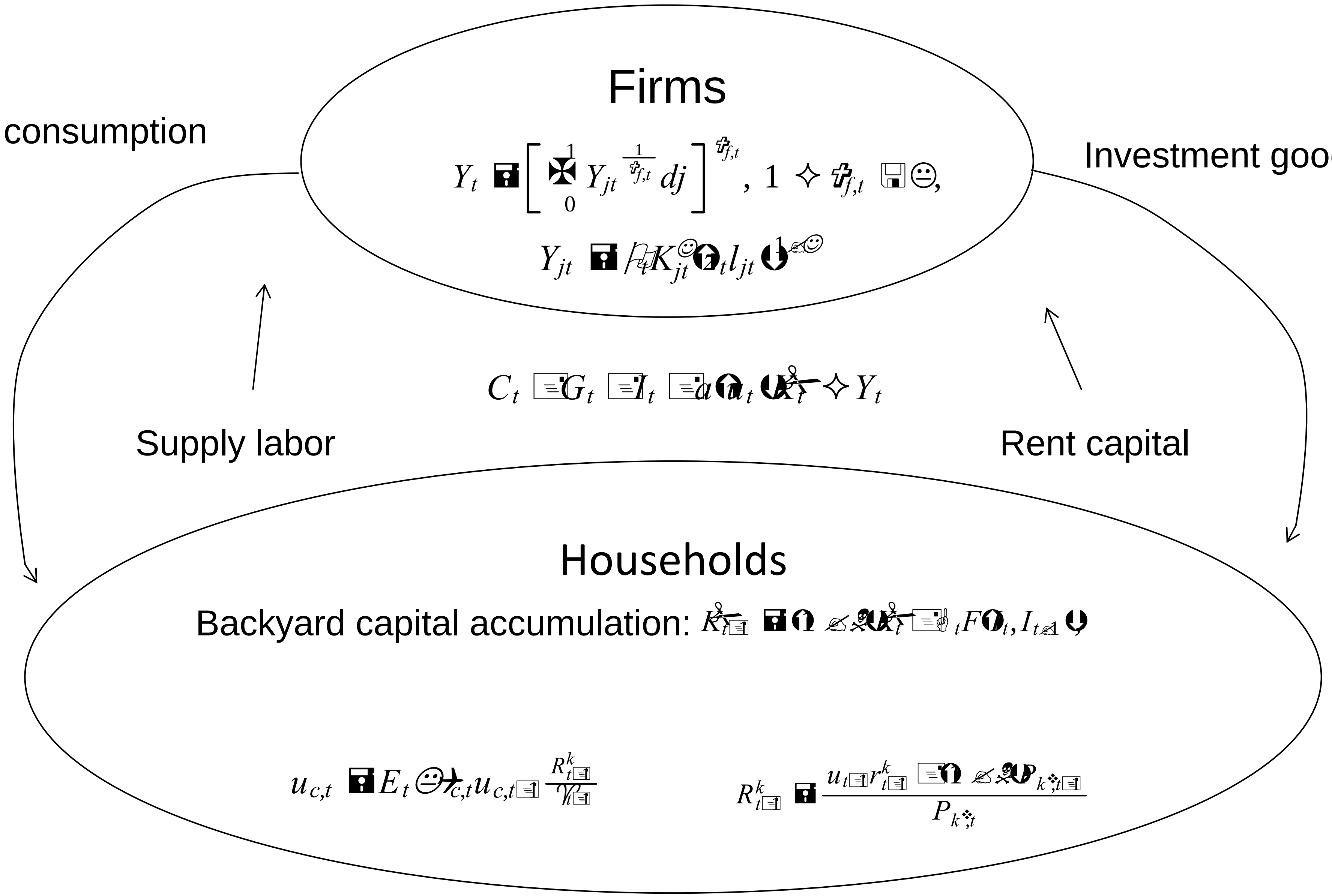
- Consider a version of GST model (Christiano-Ilut-Motto-Rostagno).
  - Like GST, has *fixed* rate of job separations

- Model fits less well than standard model with EHL labor market (i.e., CEE model).

- Introduce endogenous separations:

  - Fit is similar to that of standard model, but depends on how exactly separations are endogenized.

Standard Model



Impulse Response Matching

- We estimate and evaluate models by matching SVAR and model impulse responses.

- Advantages of this approach:
  - Focus
  - Transparency

- We give that procedure a Bayesian interpretation.

Impulse Response Matching

- Would like to make use of Bayesian concepts of priors, posteriors, marginal densities…

- Posterior:

$$\text{posterior}(\theta|Y) \propto \overbrace{L(Y|\theta)}^{\text{likelihood of data, } Y} \times \underbrace{p(\theta)}_{\text{prior distribution over parameters}}$$

- But, what if ‘data’ is not actual time series data, but observations on impulse response functions?

Impulse Response Matching

- Approximately (for large *T*):

likelihood of data, $\hat{\psi}$

prior distribution over parameters

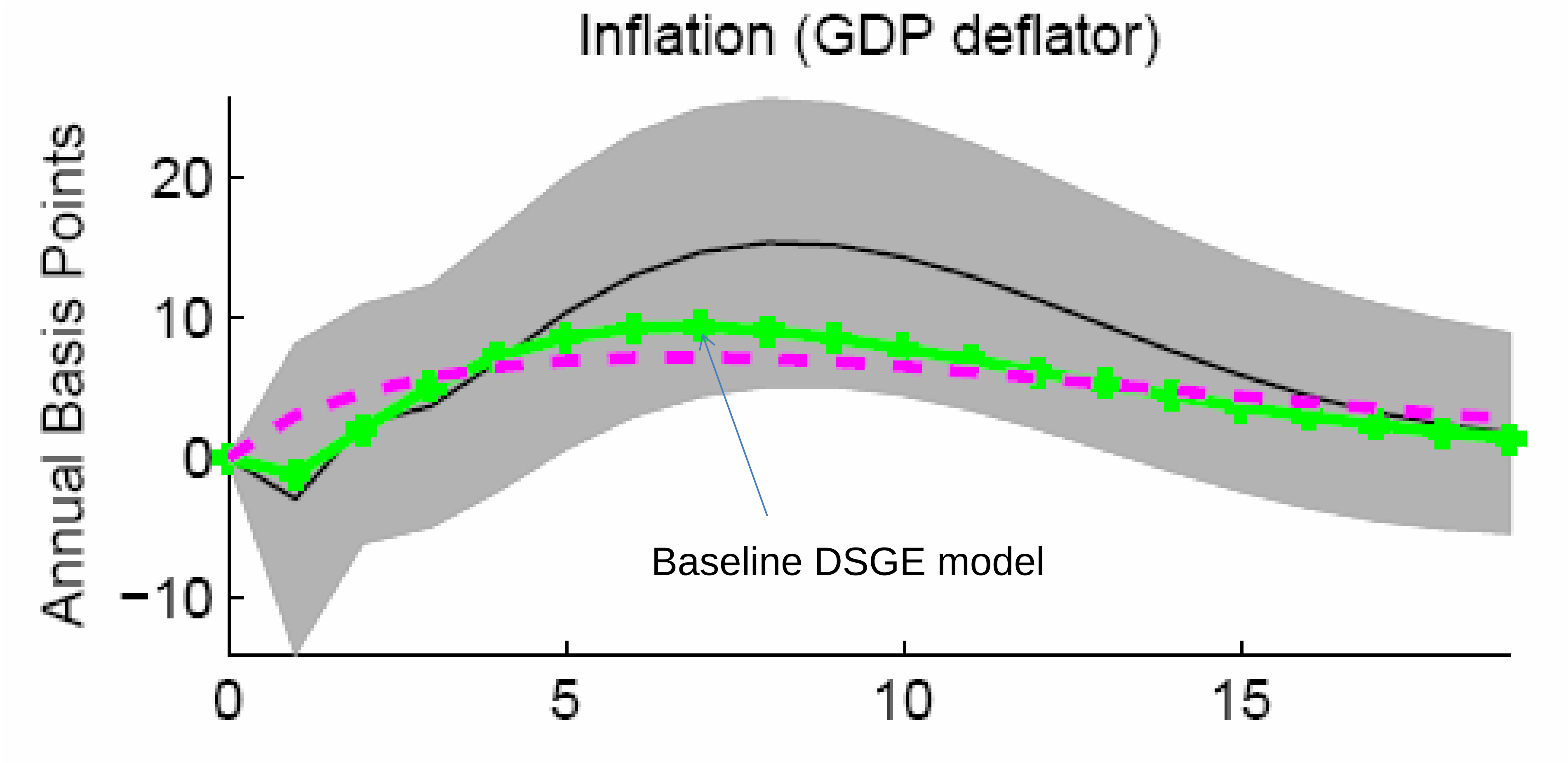
$$\text{posterior}\left(\theta \mid \hat{\psi}, \hat{V}\right) \sim \overbrace{L\left(\hat{\psi} \mid \theta, \hat{V}\right)}^{} \times p(\theta)$$

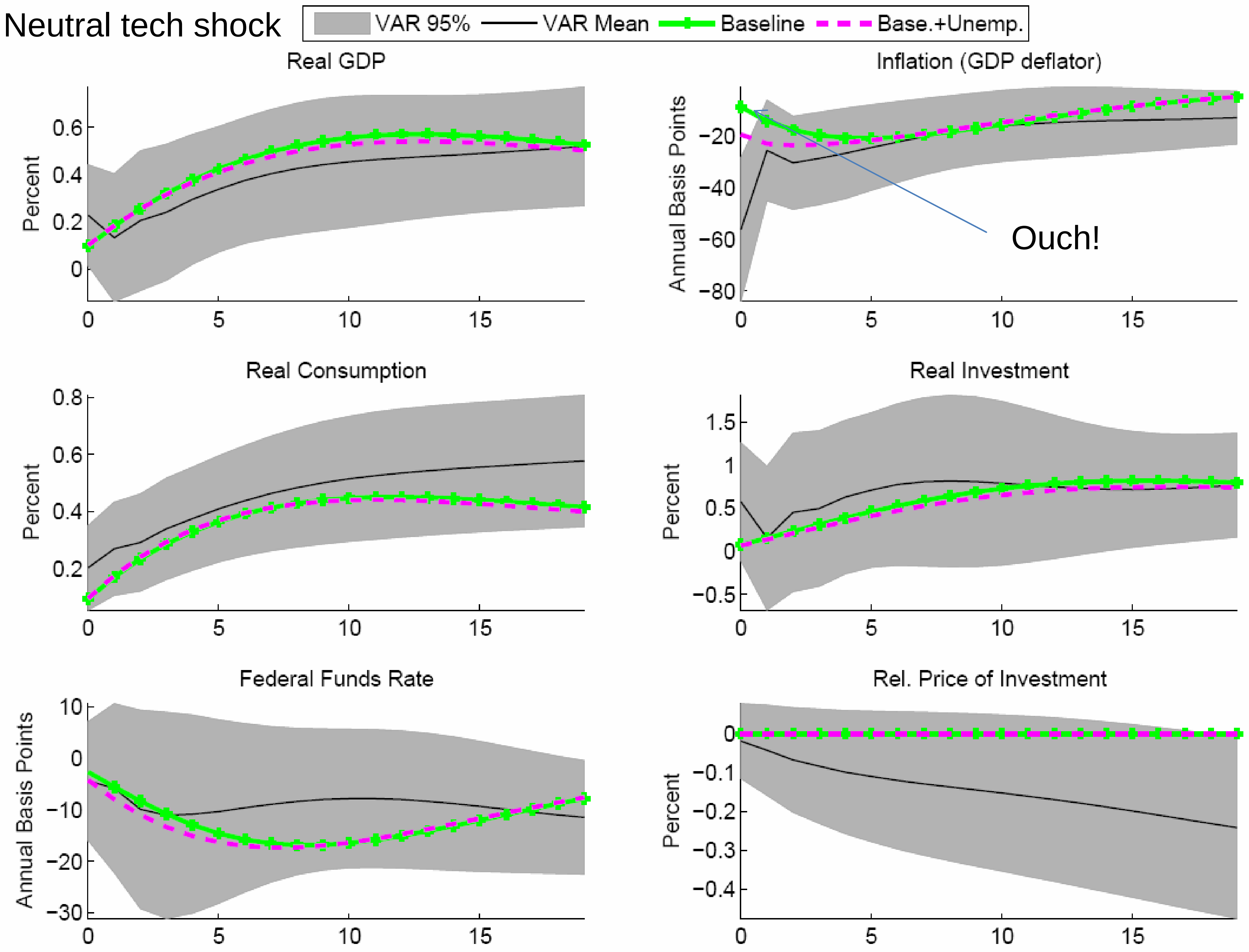
Consistent estimate of $V(\theta_0, \zeta_0)$

Next, Estimate the Baseline Model

- Data: 1952-2008
- Three identified shocks: monetary policy, neutral and embodied technology
- Key Issue:
  - can you account for
    - Gradual, delayed response of inflation to monetary policy shock?
    - Using model without crazy parameters?

Response to a Monetary Policy Shock




Neutral tech shock
VAR 95%
VAR Mean
Baseline
Base.+Unemp.
Real GDP
Percent
0.6
0.4
0.2
0
0
5
10
15
Inflation (GDP deflator)
Annual Basis Points
-20
-40
-60
-80
0
5
10
15
Ouch!
Real Consumption
Percent
0.8
0.6
0.4
0.2
0
5
10
15
Real Investment
Percent
1.5
1
0.5
0
-0.5
0
5
10
15
Federal Funds Rate
Annual Basis Points
10
0
-10
-20
-30
0
5
10
15
Rel. Price of Investment
Percent
0
-0.1
-0.2
-0.3
-0.4
0
5
10
15

Conclusion about Baseline Model

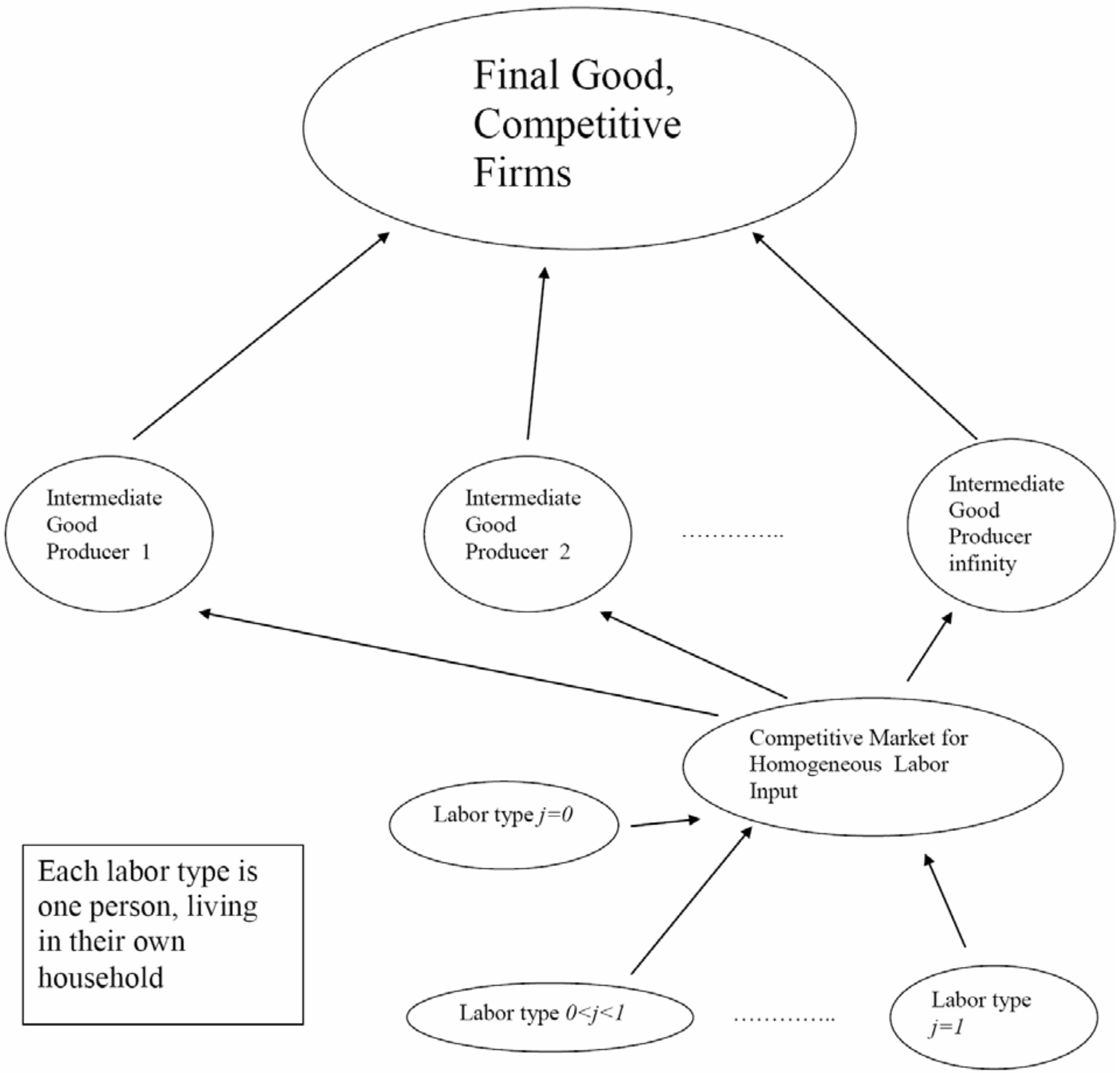
- Gradual, delayed response of inflation after monetary policy shock can be reconciled with rapid response after technology shock.
- Need to drop price indexation for this.
- Wage stickiness in these results needs to be studied more closely (not seen in previous studies, but we use longer data set).

- But, no unemployment…..!

Gali Showed that Standard Macro Model Naturally Delivers a Theory of Unemp.

- In standard model:
  - household is a monopoly supplier of a differentiated labor service.
  - Posts wage above marginal cost of providing labor.
    - If you ask a worker, ‘would you work more, if offered a job at the current wage’, answer is ‘yes’ (like any monopolist)
    - So, theory has a flavor of unemployment in it, due to wages being too high.

Firm Sector, Baseline Model



- Household utility in Lagrangian form:

multiplier on household buget constraint

$$E_t \sum_{i=0}^{\infty} (\beta\xi_w)^i \left[-\zeta_{t+i} A_L \int_0^1 \frac{(h_{j,t+i})^{1+\sigma_L}}{1+\sigma_L} dj + \upsilon_{t+i} \int_0^1 W_{j,t+i} h_{j,t+i} dj \right],$$

- Household utility in Lagrangian form:

multiplier on household buget constraint

$$E_t \sum_{i=0}^{\infty} (\beta \xi_w)^i \left[-\zeta_{t+i} A_L \int_0^1 \frac{(h_{j,t+i})^{1+\sigma_L}}{1+\sigma_L} dj + \upsilon_{t+i} \int_0^1 W_{j,t+i} h_{j,t+i} dj \right],$$

Gali showed how to interpret $h_{j,t+i}$ as a quantity of type j workers

Unemployment and Labor Force

- Type *j* labor force: number of type *j* workers who would like to work at the market wage rate.

$$W_{j,t} = \frac{\zeta_t A_L \left(l_{j,t}^{s} \right)^{\sigma_L}}{\psi} \Leftrightarrow l_{j,t}^{s} = \left[\frac{\psi W_{j,t}}{\zeta_t A_L} \right]^{\frac{1}{\sigma_L}}$$

- Unemployment rate:

$$u_{n,t} = \frac{\int_0^1 \left(l_{j,t}^{s} - h_{j,t} \right) dj}{\int_0^1 l_{j,t}^{s} dj}.$$

Issue

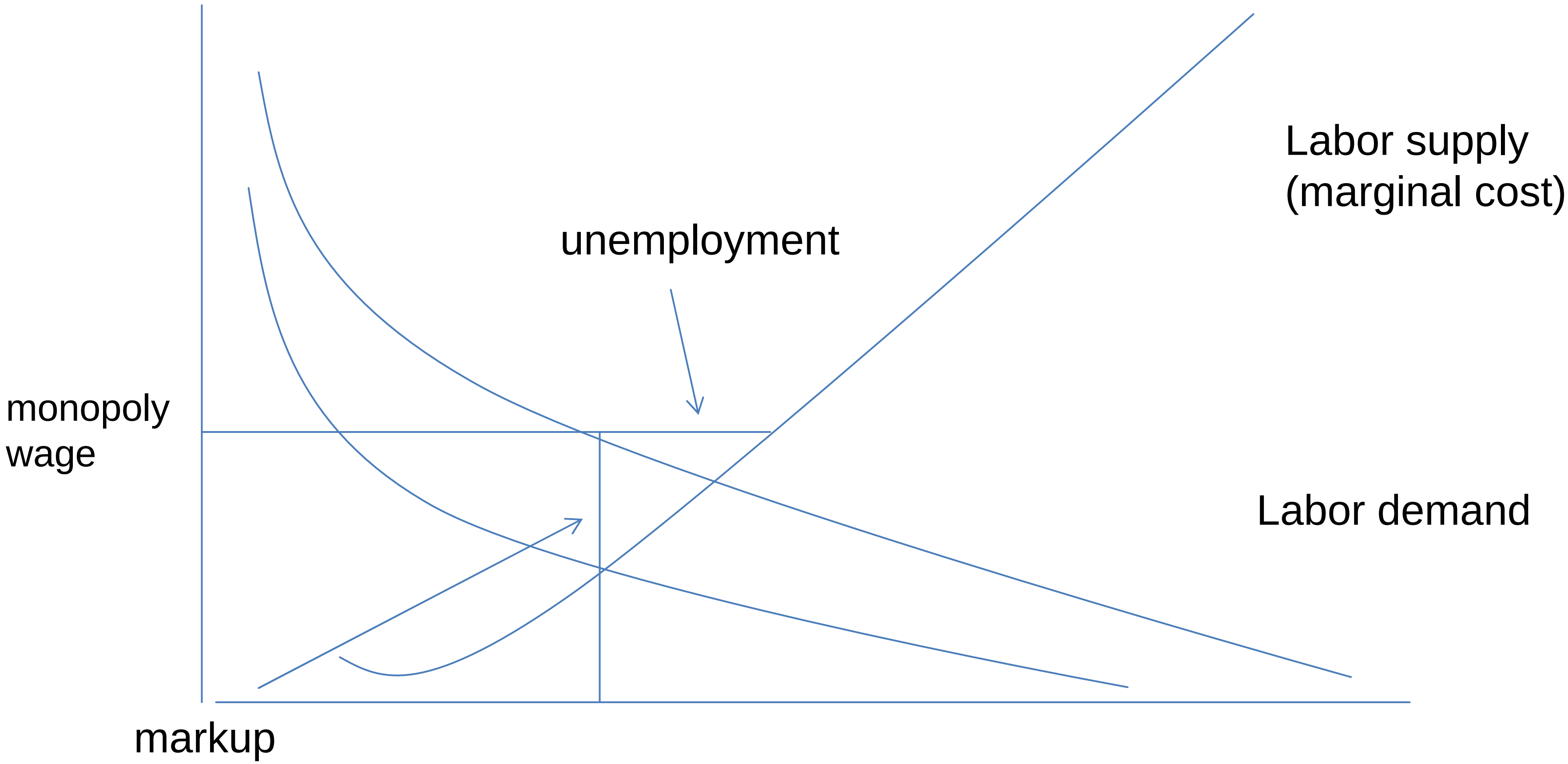
- Labor force solves static equation, likely to jump around a lot:

$$l_{j,t}^{\Delta} = \left[\frac{\chi_t W_{j,t}}{\Theta_t A_L} \right]^{\frac{1}{\sigma_L}}$$

- Worse, with a monetary expansion, as consumption rises, χ_t falls and people don't want to work (too much insurance!)

- After an expansionary monetary policy shock, labor force drops sharply (counterfactual), unemployment collapses

Monopoly Wage and Unemployment



A Quick Fix, to Quantify the Problem

- Let ζ_t be an inverse function of aggregate employment

$$\zeta_t = \left(\frac{h_t}{h}\right)^{-\varphi_1} \left(\frac{h_t}{h_{t-1}}\right)^{-\varphi_2}$$

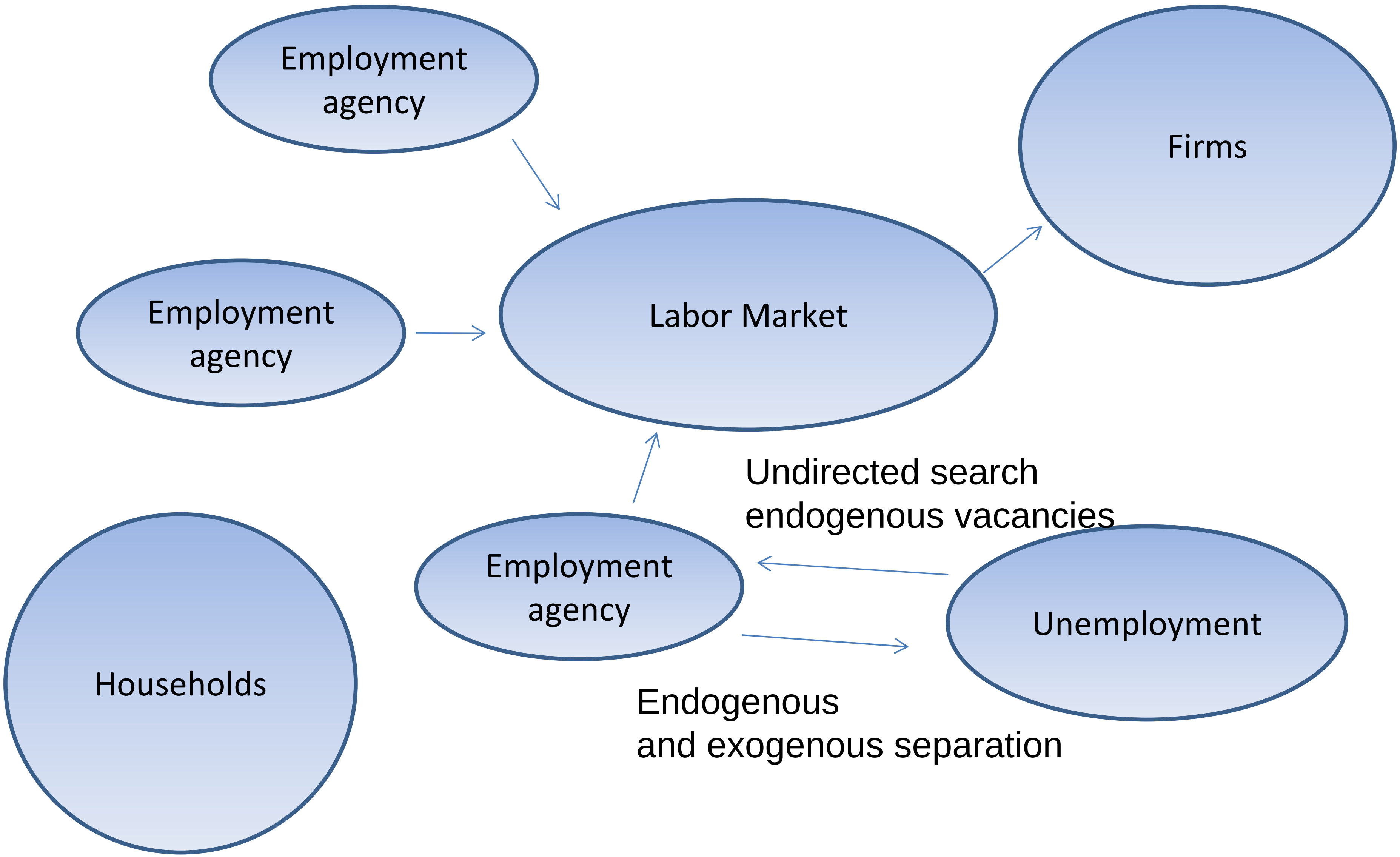
- Now, when an expansionary monetary policy shock drives up employment, labor force increases:

$$l_{j,t}^{s} = \left[\frac{\upsilon_t W_{j,t}}{\zeta_t A_L}\right]^{\frac{1}{\sigma_L}}$$

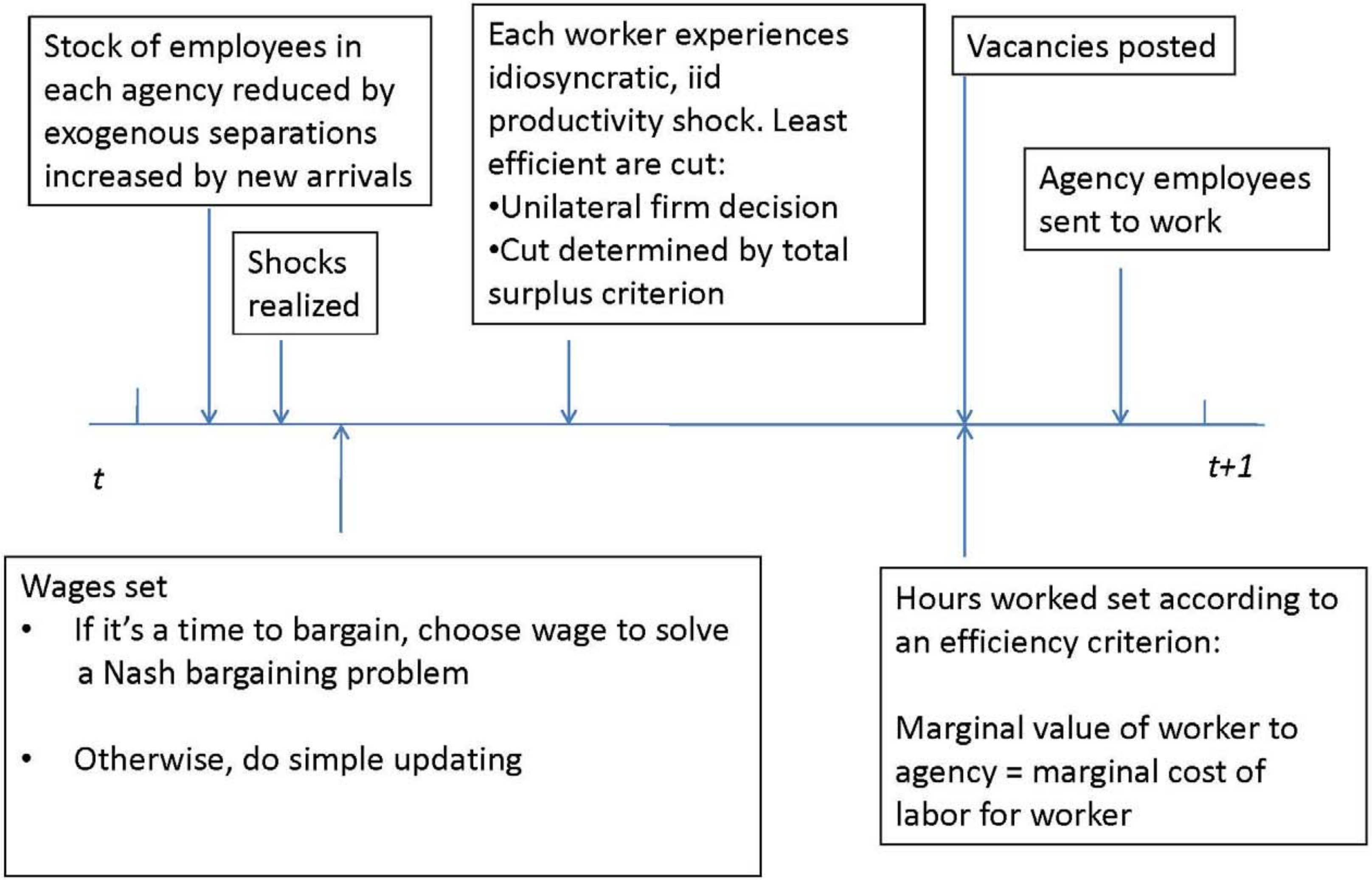
- Simple extension of standard model to unemployment runs into serious challenge.

- …unless there is a way to interpret the externality….

Adding Labor Market Frictions



Timeline – labor market



Details About the Labor Market

- Household Preferences

$$E_t \sum_{l=0}^{\infty} \beta^{l-t} \left\{ \log\left(C_{t+l} - bC_{t+l-1}\right) - \gamma_{t+l} A_L \left[\sum_{i=0}^{N-1} \frac{\left(h_{i,t+l}\right)^{1+\sigma_L}}{1+\sigma_L} \overbrace{\left(1 - F\left(\bar{a}^i_{t+l}\right)\right) l^i_{t+l}}^{\text{quantity of people working in cohort } i} \right] \right\},$$

hours per worker in cohort *i*

- Worker finances

$$\left(1 - L_t\right) P_t b^u z_t^{+} + \sum_{i=0}^{N-1} W_t^i \left(1 - F\left(\bar{a}_t^i\right)\right) l_t^i \, h_{i,t}$$

- # Value function of employed worker

earnings

Utility loss from working,
In currency units

$$V_t^i = \Gamma_{t-i,i} W_{t-i} h_{i,t} - \varsigma_t A_L \frac{h_{i,t}^{1+\sigma_L}}{1+\sigma_L}$$

$$+ \beta E_t \frac{\upsilon_{t+1}}{\upsilon_t} \left[\rho \left(1 - F_{t+1}^{i+1}\right) V_{t+1}^{i+1} + \left(1 - \rho\left(1 - F_{t+1}^{i+1}\right)\right) U_{t+1} \right]$$

Next period's value function in case the worker is employed in the next period

Next period's value function in case the worker is unemployed in the next period

- # Value function of unemployed worker

$$U_t = P_t z_t b^u + \beta E_t \frac{\upsilon_{t+1}}{\upsilon_t} \left[f_t V_{t+1}^x + (1 - f_t) U_{t+1} \right]$$

- Employment agency value function:
  - just after bargaining, in bargaining period
  - conditional on nominal wage, W_t
  - taking productivity cutoff, $\bar{a}^j_{t+j}$, as given

$$F\left(l_t^0, W_t\right) = \sum_{j=0}^{N-1} \beta^j E_t \frac{\upsilon_{t+j}}{\upsilon_t} \max_{v^j_{t+j}} \Bigg\{ \int_{\bar{a}^j_{t+j}} \left[P_{t+j} a - \Gamma_{t,j} W_t\right] l_{t+j} \overbrace{dF(a)}^{\text{'fraction' of } l^j_{t+j} \text{ with productivity } a}$$

$$- \overbrace{P_{t+j} \frac{\kappa_{t+j}}{2} \left(v^j_t\right)^2 \left(1 - F^j_{t+j}\right)}^{\text{costs are proportional to workforce after current period separations}} l^j_{t+j} \Bigg\} + \beta^N E_t \frac{\upsilon_{t+N}}{\upsilon_t} F\left(l^0_{t+N}, W_{t+N}\right),$$

Monetary Policy

- Taylor Rule:

$$\log\left(\frac{R_t}{R}\right) = \rho_R \log\left(\frac{R_{t-1}}{R}\right) + (1-\rho_R)\left(r_\pi \log\left(\frac{\pi_t}{\pi}\right) + r_y \log\left(\frac{y_{t-1}}{y}\right)\right) + \varepsilon_{R,t}.$$

Search and Matching

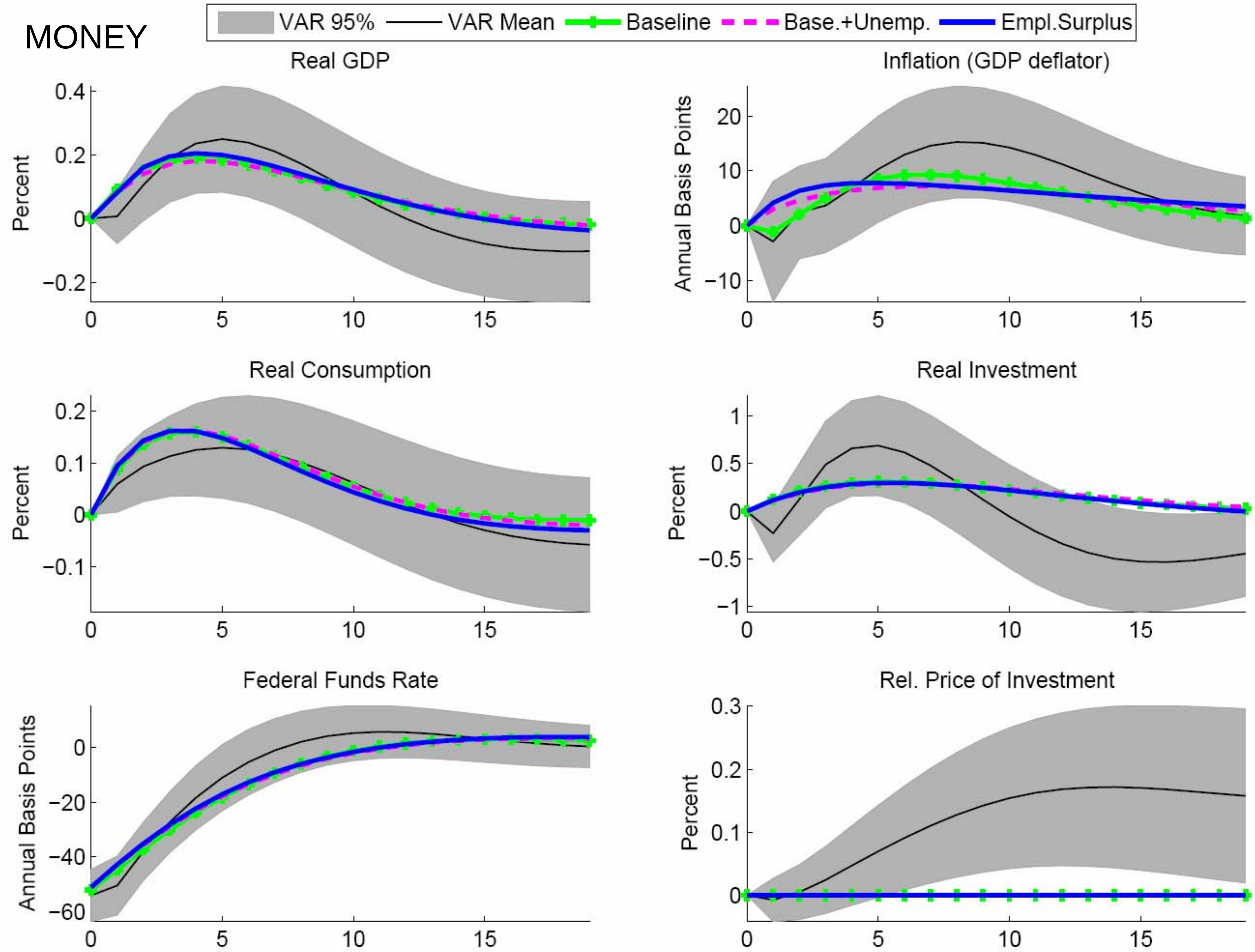
- Wealth effects on labor make people not want to work hard after positive monetary shock that drives up consumption.
- Wages rise a lot to satisfy expanded expenditures after monetary shock.
- Employment expands only a little.
- Model puts in a lot of price stickiness to compensate.
- Put in externality in labor supply, like in Gali model.

Results

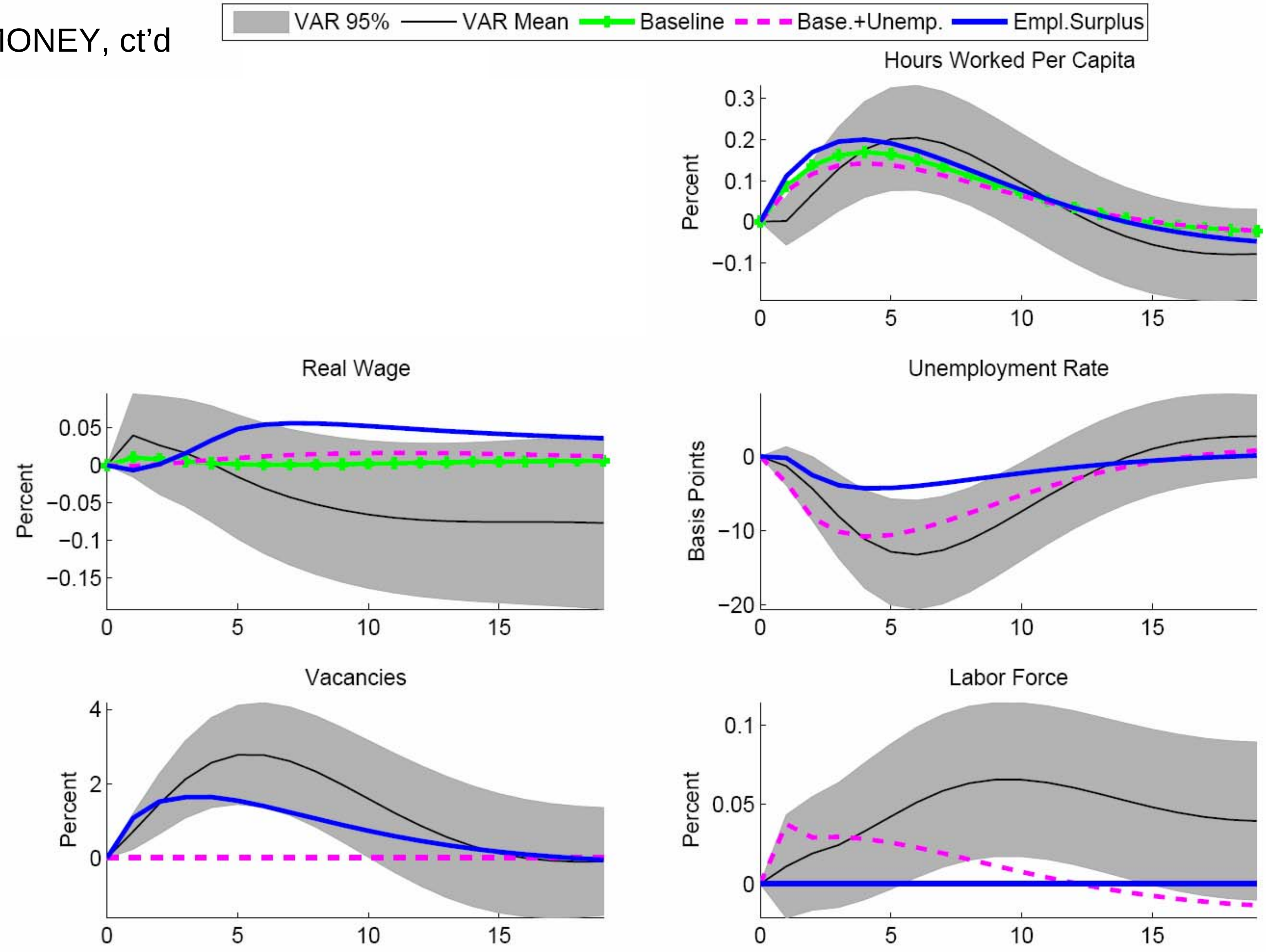
- Key parameters of search and matching model

replacement ratio	$\frac{b}{\text{flow utility}}$	0.7
separation rate (%)	100 [illegible]	0.4
recruitment costs/output (%)		0.5
share in matching function	[illegible]	0.6
bargaining power of workers	[illegible]	0.4
mean quarters between price reoptimization		9

A big problem!
Carlos Thomas might help us.

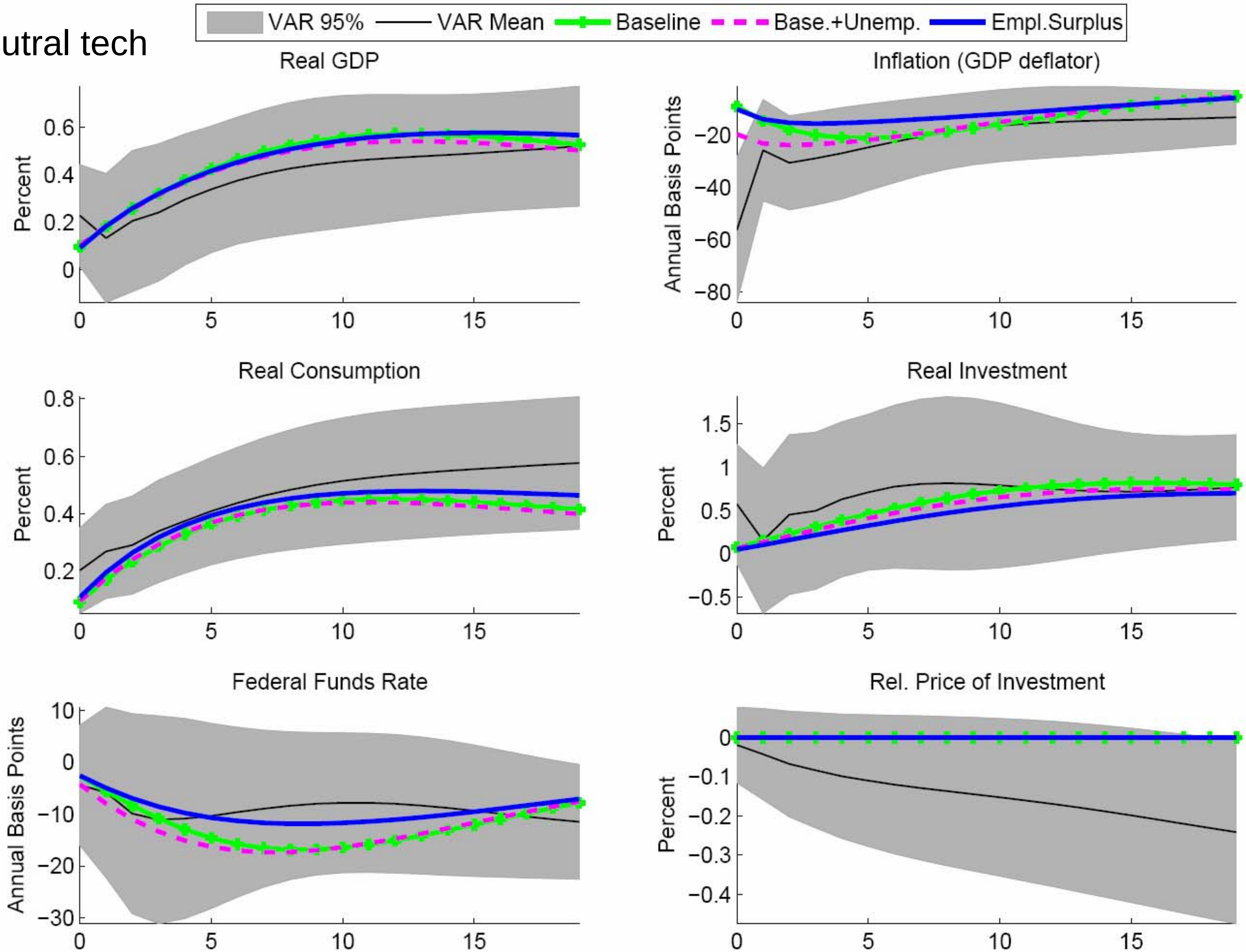

MONEY
VAR 95%
VAR Mean
Baseline
Base.+Unemp.
Empl.Surplus
Real GDP
Percent
Inflation (GDP deflator)
Annual Basis Points
Real Consumption
Percent
Real Investment
Percent
Federal Funds Rate
Annual Basis Points
Rel. Price of Investment
Percent

MONEY, ct'd

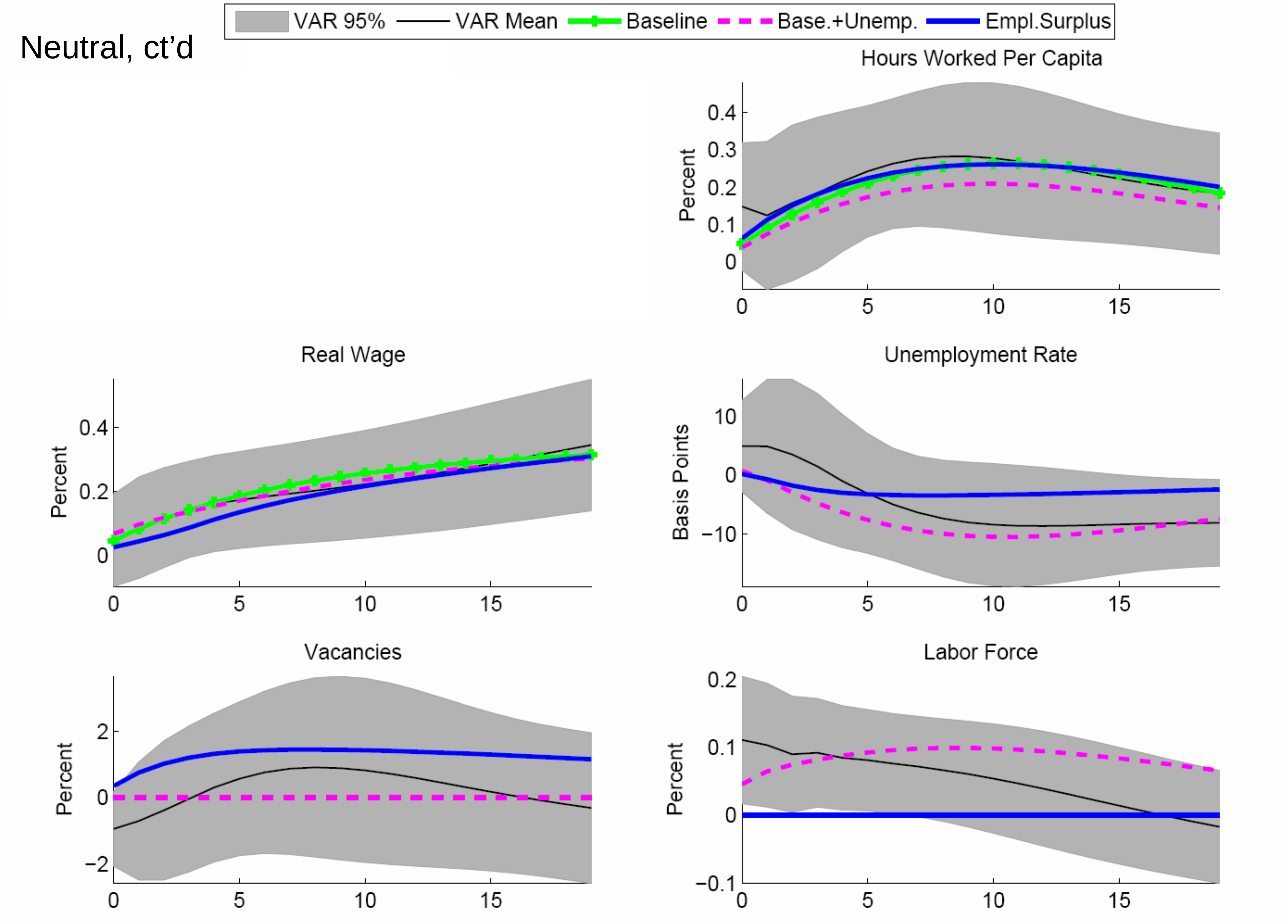


'money Beveridge curve', slope = 20

Neutral tech



Neutral, ct'd



VAR 95%
VAR Mean
Baseline
Base.+Unemp.
Empl.Surplus
Hours Worked Per Capita
Percent
Real Wage
Percent
Unemployment Rate
Basis Points
Vacancies
Percent
Labor Force
Percent

Summary

- There is a baseline DSGE model, that fits data nicely.

- It misses labor market variables.

- We tried to integrate such variables in two ways, but in each case needed to kill wealth effects to make the model work.

- When you integrate unemployment and the labor force into New Keynesian model, all the old problems with labor supply come back.