Involuntary (‘Unlucky’) Unemployment and the Business Cycle

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Background

• There is a class of models that has received a lot of attention in central banks.

• People have used the models to place structure on discussions about monetary policy.
  — Recent: Curdia-Woodford, Gertler-Kiyotaki.

• In recent years, there has been a push to introduce labor market variables like unemployment.
What We Do:

• We investigate a particular approach to modeling unemployment.
  – Hopenhayn and Nicolini (1997), Shavell and Weiss (1979)

• We explore the implications for monetary DSGE models.
  – Simple NK model without capital.
    • Okun’s law, natural rate of unemployment.
  – Standard empirical NK model (e.g., ACEL, CEE, SW)
    • Estimate the model.
    • Does well reproducing response of unemployment and labor force to three identified shocks.
Unemployment

• To be ‘unemployed’ in US data, must
  – be ‘willing and able’ to work.
  – recently, made efforts to find a job.

• Our presumption: a person has lower utility when unemployed than when employed.
  – consumption drops typically about 10 percent upon the loss of a job (Gruber, 1997, Chetty and Looney, 2006)
  – Some indicators of happiness (suicide, subjective sense of well being) deteriorate when the unemployment rate rises (Brenner, 1979; Ruhm, 2000; Schimmack et al, 2008)

• Current monetary DSGE models with ‘unemployment’:
  – Utility jumps when you lose your job.
  – Finding a job requires no effort.
  – US Census Bureau employee dropped into current monetary DSGE models would find zero unemployment.
What we do:

• Explore the simplest possible model of unemployment, which satisfies two key features of unemployment.

• To be unemployed:
  – Must have made recent efforts to find a job.
    • To find a job, household must make an effort, $e$, which increases the probability, $p(e)$, of finding a job.

  – Unemployed worse off than employed.
    • assume household search effort, $e$, is not publicly observable.

  • full insurance against household labor market outcomes is not possible.
    – under perfect consumption insurance, no one would make an effort to find a job.
Outline

• Insert our model of unemployment into

  – Simple Clarida-Gali-Gertler (CGG) NK model.

  – CEE model: evaluate model’s ability to match US macroeconomic data, including unemployment and labor force
CGG Model

• Goods Production:

\[ Y_t = \left[ \int_0^1 Y_{i,t}^{\lambda_f} \, di \right]^{\lambda_f}, \quad 1 \leq \lambda_f < \infty. \]

• Monopolists produce intermediate goods
  – Technology:
    \[ Y_{i,t} = A_t h_{i,t} \]
  
  – Calvo sticky prices:
    \[ P_{i,t} = \begin{cases} 
    P_{i,t-1} & \text{with prob. } \xi_p \\
    \text{chosen optimally} & \text{with prob. } 1 - \xi_p
    \end{cases} \]

  – Enter competitive markets to hire labor.
CGG 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:
  – \( \hat{x}_t \) output gap (percent deviation of output from efficient level)

• Efficient equilibrium:
  – Monopoly power and inflation distortions extinguished.
Households

• This is where the new stuff is........
Typical Household During Period

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

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

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

Household that stays out of labor market does not work and has utility $\log c_t$

$t$  

Household that joins labor force tries to find a job by choosing effort, $e$, and receiving ex ante utility

$$p(e_t) = \eta + ae_t$$

$$p(e_t) \left[ \log(c_t^w) - F - \zeta_l(1 + \sigma_L)l^{\sigma_L} - \frac{1}{2}e_t^2 \right] + (1 - p(e_t)) \left[ \log(c_t^u) - \frac{1}{2}e_t^2 \right]$$

$t+1$
Household Insurance

• They need it:
  – Idiosyncratic work aversion.
  – Job-finding effort, $e$, may or may not produce a job.

• Assume households gather into large families, like in Merz and Andolfatto
  – With complete information:
    • Households with low work aversion told to make big effort to find work.
    • All households given same consumption.
    • Not feasible with private information.

  – With private information
    • To give households incentive to look for work, must make them better off in case they find work.
Optimal Insurance

• Relation of family to household: standard principal/agent relationship.
  – family receives wage from working households
  – family observes current period employment status of household.

• For family with given $C, h$:
  – allocates consumption: $c_t^w, c_t^{nw}$
  – $c_t^w/c_t^{nw}$ must be big enough to provide incentives.
  – must satisfy family resource constraint:
    \[ h_t c_t^w + (1 - h_t) c_t^{nw} = C_t. \]
Family Indirect Utility Function

• Utility:

\[ u(C_t, h_t, \zeta_t) = \log(C_t) - z(h_t, \zeta_t) \]

• Where

\[ z(h_t, \zeta_t) = \log[h_t(e^{F+\zeta_t(1+\sigma_L)f(h_t, \zeta_t)^{\sigma_L}} - 1) + 1] \]
\[ - \frac{a^2 \zeta_t^2 (1 + \sigma_L) \sigma_L^2}{2\sigma_L + 1} f(h_t, \zeta_t)^{2\sigma_L+1} - \eta \zeta_t \sigma_L f(h_t, \zeta_t)^{\sigma_L+1}. \]

• Clarida-Gali-Gertler utility function:

\[ u(C_t, h_t, \zeta_t) = \log(C_t) - \zeta_t h_t^{1+\sigma_L} \]
Family Problem

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

— Subject to:

$$P_tC_t + B_{t+1} \leq B_t R_{t-1} + W_t h_t + \text{Transfers and profits}_t.$$ 

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

$$C_t z_h(h_t, \zeta_t) = \frac{W_t}{P_t}.$$
Observational Equivalence Result

• Because of the simplicity of the assumptions, the model is observationally equivalent to standard NK model, when represented in terms of output, interest rate, inflation:

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

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

\[ \hat{R}_t = \rho R \hat{R}_{t-1} + (1 - \rho R) [r_{\pi} \hat{\pi}_t + r_y \hat{x}_t] + \varepsilon_t, \]
Observational Equivalence Result

\( z \) function: disutility of labor for family

\[ \sigma_z \equiv \frac{z_{hh}h}{z_h} \]

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

\[ \hat{x}_t = E_t \hat{x}_{t+1} - (\hat{R}_t - \hat{\pi}_{t+1} - \hat{R}_t^*) \]

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

• Can express everything in terms of unemployment gap:

\[ \underline{u}_t^g = -\kappa^{okun} \hat{\chi}_t. \]

\[ \kappa^{okun} = \frac{a^2 \zeta \sigma_L^2 m^{\sigma_L}(1 - u)}{1 - u + a^2 \zeta \sigma_L^2 m^{\sigma_L}} > 0. \]

actual rate of unemployment

efficient level of unemployment

Non-accelerating rate of inflation level of unemployment, NAIRU

\[ \underline{u}_t^g = \underline{u}_t - \underline{u}_t^* \]
Properties of the Model

• Calibrated model first....
Calibration of the Model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>1.03^{-0.25}</td>
<td>Discount factor</td>
</tr>
<tr>
<td>$g_A$</td>
<td>1.0047</td>
<td>Technology growth</td>
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<tr>
<td>$\xi_p$</td>
<td>0.75</td>
<td>Price stickiness</td>
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<tr>
<td>$\lambda_f$</td>
<td>1.2</td>
<td>Price markup</td>
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<tr>
<td>$\rho_R$</td>
<td>0.8</td>
<td>Taylor rule: interest smoothing</td>
</tr>
<tr>
<td>$r_\pi$</td>
<td>1.5</td>
<td>Taylor rule: inflation</td>
</tr>
<tr>
<td>$r_y$</td>
<td>0.2</td>
<td>Taylor rule: output gap</td>
</tr>
<tr>
<td>$\eta_g$</td>
<td>0.2</td>
<td>Government consumption share on GDP</td>
</tr>
</tbody>
</table>

To parameterize preference and search function, set:

- labor force participation rate: $m=0.67$
- employment rate: $h=0.63$
- unemployment rate: $u=0.056$
Properties

• Replacement ratio

$$\frac{c^{nw}}{c^w} = 0.18$$

– Very low! In model with habit persistence in preferences, replacement ratio = 0.80.

• Cost of business cycles (in % of consumption)...

<table>
<thead>
<tr>
<th>Limited Information Model</th>
<th>Full Information Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Shock Only</td>
<td></td>
</tr>
<tr>
<td>0.52%</td>
<td>0.57%</td>
</tr>
<tr>
<td>Government Spending Shock Only</td>
<td></td>
</tr>
<tr>
<td>0.11%</td>
<td>0.13%</td>
</tr>
<tr>
<td>Monetary Policy Shock Only</td>
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</tr>
<tr>
<td>0.07</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Put this all into a medium-sized DSGE Model

- Habit persistence in preferences
- Variable capital utilization.
- Investment adjustment costs.
- Wage setting frictions as in Erceg-Henderson-Levin.
- Parameterization:
  - prices reoptimized on average every 2.7 quarters
  - wages reoptimized on average every 4 quarters.
Finding

• Model with unemployment fit to VAR-based impulse responses turns in same performance as CEE model without unemployment.

• When we add unemployment and labor force, model matches estimated responses in labor force and unemployment.
Figure 1: Dynamic Responses of Non-Labor Market Variables to a Monetary Policy Shock

- Real GDP
- Inflation (GDP deflator)
- Federal Funds Rate
- Real Consumption
- Real Investment
- Capacity Utilization
- Rel. Price of Investment
- Hours Worked Per Capita
- Real Wage

Legend:
- VAR 95%
- VAR Mean
- Standard Model
- Involuntary Unemployment Model
Figure 2: Dynamic Responses of Non–Labor Market Variables to a Neutral Technology Shock

- Real GDP
- Inflation (GDP deflator)
- Federal Funds Rate
- Real Consumption
- Real Investment
- Capacity Utilization
- Rel. Price of Investment
- Hours Worked Per Capita
- Real Wage

Key:
- VAR 95%
- VAR Mean
- Standard Model
- Involuntary Unemployment Model
Figure 4: Dynamic Responses of Labor Market Variables to Three Shocks

Unemployment Rate

Monetary Shock

Neutral Tech. Shock

Invest. Tech. Shock

Labor Force

VAR 95%  \text{ VAR Mean}  \text{ Involuntary Unemployment Model}
Micro Implications of Model

• Model: consumption premium higher in booms.
  – Have time series evidence on cross-household variance, $V$, of log consumption.
  – Heathcote, Perri and Violante (2010) show $V$ is procyclical in three of past 5 recessions.

\[ V_t = (1 - h_t)h_t \left( \log \left( \frac{c_t^w}{c_t^{nw}} \right) \right)^2. \]

• Model: search intensity lower in recessions
  – Consistent with evidence on ‘discouraged workers’
Conclusion

• Integrated a model of ‘involuntary unemployment’ into monetary DSGE model.

• Results:
  – Obtained a theory of the Okun’s gap, NAIRU
  – Able to match responses of unemployment and labor force to macro shocks.
  – Raises several empirical questions.

• Why introduce unemployment?
  – A policy variable of direct interest.
  – Can differentiate between labor markup shocks and labor supply shocks.
  – By bringing in more data, get a more precise read on output gap and ‘natural interest rate’ (Basistha and Startz (2004))
  – By bringing in more data, get a better read on unobserved shocks and may improve forecasts.