Involuntary Unemployment and the Business Cycle

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Background

• Much progress building DSGE models for the purpose of analyzing monetary policy.

• Consensus benchmark model: basic goods, labor markets, monetary policy.

• Extensions:
  – financial frictions.
    • Financing of investment, working capital, etc.
  – unemployment, labor force.
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 three equation NK model
    • NAIRU, Okun’s gap, 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.

• Empirical evidence: losing your job is a bad thing.
  – consumption drops typically about 10 percent upon the loss of a job (Gruber, 1997, Chetty and Looney, 2006)
  – Much discussion in the press about the hardship experienced by the unemployed in the current recession.

• 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.
  – Transition from employment to unemployment makes you worse off.
    • 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:

\[
F + \zeta_t (1 + \sigma_L) l^{\sigma_L}.
\]

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.

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

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

\[
p(e_t) = \eta + ae_t
\]

At time \( t + 1 \)
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

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

\[ - \frac{\zeta_t^2 (1 + \sigma_L)\sigma_L^2}{2\sigma_L + 1} f(h_t, \zeta_t)^{2\sigma_L+1} - \eta \zeta_t \sigma_L f(h_t, \zeta_t)^{\sigma_L+1}. \]

• Clarida-Gali-Gertler utility function:

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

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

– Subject to:

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

• 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

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

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

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

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

‘curvature of disutility of labor’:
Unemployment Gap

- Can express everything in terms of unemployment gap:

\[ u_t^g = -\kappa^{okun} \hat{x}_t, \quad \kappa^{okun} = \frac{a^2 \zeta \sigma_L^2 m^{\sigma_L} (1 - u)}{1 - u + a^2 \zeta \sigma_L^2 m^{\sigma_L}} > 0. \]

actual rate of unemployment \quad efficient level of unemployment

\[ u_t^g = \underbrace{u_t}_{u_t^g} - \underbrace{u_t^*}_{\text{Non-accelerating rate of inflation level of unemployment, NAIRU}} \]
Unemployment Gap

\[
\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} - \kappa u^g_t
\]

\[
u^g_t = \kappa^{\text{okun}} E_t u^g_{t+1} + \kappa^{\text{okun}} \left( \hat{R}_t - \hat{\pi}_{t+1} - \hat{R}_t^* \right)
\]

\[
\hat{R}_t = \rho_R \hat{R}_{t-1} + (1 - \rho_R) \left[ r_\pi \hat{\pi}_t - \frac{r_y}{\kappa^{\text{okun}}} u^g_t \right] + \varepsilon_t
\]

\[
\kappa \equiv \frac{(1 - \beta \xi_p)(1 - \xi_p)}{\xi_p} \frac{1 + \sigma_z}{\kappa^{\text{okun}}}
\]
Questions...

• A key distinguishing feature of the model is the limited information that prevents full insurance.

• What is the quantitative impact of limited information on the model?
Must Parameterize the Model

- Parameterization informal.
  - Subset of parameters standard.
  - Five parameters (search function and work aversion) novel.
Table 1: Structural Parameters of Small Model Held Fixed Across Numerical Experiments

<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>
</tr>
<tr>
<td>$\check{\xi}_P$</td>
<td>0.75</td>
<td>Price stickiness</td>
</tr>
<tr>
<td>$\lambda_f$</td>
<td>1.2</td>
<td>Price markup</td>
</tr>
<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>
‘New’ Parameters

• Disutility of work:

\[ F + \zeta_t (1 + \sigma_L) l^{\sigma_L} \]

• Probability of finding work:

\[ p(e_t) = \eta + ae_t \]

• Parameters:

\[ F, \zeta, a, \eta, \sigma_L. \]

• Pin down 5 parameters by imposing 5 properties of steady state:

\[ m, u, \sigma_z, k^{\text{okun}}, \bar{p} \]
Quantitative Impact of Limited Information

• Impact on:
  – total employment, labor force, welfare?

• What is the value of information?
Table 2: The Impact of Imperfect Information in the Small Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Involuntary Unemp. (Imperfect Info.)</th>
<th>Fixed Structural Params Full Info</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steady State Properties</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$m$</td>
<td>0.67</td>
<td>0.69</td>
<td>Labor force</td>
</tr>
<tr>
<td>$h$</td>
<td>0.63</td>
<td>0.68</td>
<td>Employment</td>
</tr>
<tr>
<td>$u$</td>
<td>0.056</td>
<td>0.015</td>
<td>Unemployment rate</td>
</tr>
<tr>
<td>$c^{nw}/c^w$</td>
<td>0.18</td>
<td>1.0</td>
<td>Replacement ratio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.189</td>
<td>Price (% of C) of info.$^a$</td>
</tr>
<tr>
<td>Structural Parameters$^d$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$a$</td>
<td>0.53</td>
<td>0.53</td>
<td>Slope, $p(e)$</td>
</tr>
<tr>
<td>$\eta$</td>
<td>0.86</td>
<td>0.86</td>
<td>Intercept, $p(e)$</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>4.64</td>
<td>4.64</td>
<td>Slope, labor disutility</td>
</tr>
<tr>
<td>$F$</td>
<td>1.39</td>
<td>1.39</td>
<td>Intercept, labor disutility</td>
</tr>
<tr>
<td>$\sigma_L$</td>
<td>13.31</td>
<td>13.31</td>
<td>Power, labor disutility</td>
</tr>
<tr>
<td>Welfare Cost of Business Cycles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology shock only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.520684131141325 0.566191290230633</td>
<td>% of consumption</td>
<td></td>
</tr>
<tr>
<td>Government consumption shock only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.112215458271869 0.125326644511370</td>
<td>% of consumption</td>
<td></td>
</tr>
<tr>
<td>Monetary policy shock only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.071331553871046 0.100111000086489</td>
<td>% of consumption</td>
<td></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.
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

Legend:
- VAR 95%
- VAR Mean
- Standard Model
- Involuntary Unemployment Model
Figure 3: Dynamic Responses of Non–Labor Market Variables to an Investment Specific 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

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

Unemployment Rate

Monetary Shock

Labor Force

Neutral Tech. Shock

Unemployment Rate

Labor Force

Invest. Tech. Shock

VAR 95%  VAR Mean  Involuntary Unemployment Model
Model Prediction that Consumption Premium for Employed Households is Bigger in Boom

• Don’t have direct evidence on this (but, could get it!)

• Have time series on cross section variance of log, household consumption.

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

• Heathcote, Perri and Violante (2010) show \( V \) is procyclical in three of past 5 recessions.
Another Question Raised by Analysis

• Does higher unemployment in recessions reflect reduced search intensity?
  
  – Maybe...
  
  – discouraged workers: people ‘available to work’ but are not currently looking because they think there are no jobs.
  
  – number jumped 70 percent, 2008Q1 to 2009Q1.
Conclusion

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

• Results:
  – Obtained a theory of the 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.
  – By bringing in more data, get a more precise read on output gap and real rate (Basistha and Startz (2004))
  – By bringing in more data, get a better read on unobserved shocks and may improve forecasts.