Uncertainty and the Business Cycle

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Motivation

- Empirical measures of uncertainty increase during recessions.
  - Volatility of stock and bond markets; volatility of output and exchange rates; measures of disagreement among professional forecasters, and their self-reported subjective forecast uncertainty.

- Higher uncertainty as a key contributor of the Great Recession and subsequent slow recovery.

- Which factors can explain the observed correlation?
Motivation

- Recent and growing research focuses on:

  1. Fluctuations in exogenous uncertainty (second-moment shocks) as a major driver of business cycles.
     - Investment irreversibilities; nominal rigidities; financial frictions.

  2. Measured uncertainty reflects the endogenous response of agents to first-moment shocks.
     - Imperfect information.
This Paper

- We propose an alternative explanation: hiring and wage-setting frictions.

- Starting point: substantial evidence suggests that wages do not fall during recessions.

  - Outside labor market conditions exert a stronger influence on wage setting during an upturn;
  
  - various theories can rationalize this outcome (implicit insurance, morale-based theories, effort, etc.);
  
  - we capture this notion with the existence of an occasionally binding constraint (OBC) on wage bargaining.
Main Idea

- Inability of freely adjusting wages in a recession implies one-sided risk.

- Concavity of the firm profit function increases when the economy operates close to the wage constraint.
  - Profit-risk premium

- This can have important consequences for:
  - the transmission of second-moment shocks;
  - the variance of the unforecastable component of future economic outcomes (measured uncertainty).
Model

- Search and matching model with an OBC on wage bargaining.

- First- and second-moment exogenous shocks.

- Penalty barrier methods to approximate the OBC.

- Third-order approximation of the model policy functions.
  - Relative to global solution methods: no constraints on the number of states.
    - Key issue: third-order polynomial for the penalty barrier must be accurate in regions of the state space that are of economic interest.
State-dependent propagation of exogenous uncertainty shocks: higher uncertainty triggers a large and persistent output loss during a recession but it has mild effect otherwise.

In a recession, measured uncertainty (the output forecast error variance) increases even when there is no change in exogenous uncertainty.

These results have implications for the empirical identification of the effects of uncertainty shocks.
Contribution

- Novel mechanism to understand the transmission of uncertainty shocks and the empirical behavior of measured uncertainty.
  - Uncover the role of one-sided risk implied by hiring and wage-setting frictions.
  - Does not rely on firm heterogeneity and/or nominal rigidities.

- Methodology: approximation of the OBC in a third-order approximation of the model policy function.
  - Novel implementation of the penalty barrier method.
Labor Market

- Representative perfectly competitive firm.
- Post vacancies, $V_t$, to hire a new worker, incurring a real cost $\kappa$.
- Unemployed workers, $U_t$, search for a job.
- Aggregate CRS matching technology: $M_t = \chi U_t \varepsilon V_t^{1-\varepsilon}$.
- Probability of filling a vacancy: $q_t \equiv M_t / V_t$.
- Probability of becoming employed: $p_t \equiv M_t / U_t$. 
Producers

- Production function: \( Y_t = e^{Z_t} L_t \).

  - \( L_t \equiv \) number of employed workers:
    \[
    L_t = (1 - \lambda) \left( L_{t-1} + q_{t-1} V_{t-1} \right),
    \]
    where \( \lambda \in (0, 1) \) is the exogenous probability of job destruction.

  - \( Z_t \equiv \) exogenous productivity:
    \[
    Z_t = \rho_Z Z_{t-1} + e^{\sigma_t} u_{zt},
    \]
    \[
    \sigma_t = \rho_\sigma \sigma_{t-1} + (1 - \rho_\sigma) \sigma + u_{\sigma t}.
    \]
Producers choose $V_t$ and $L_t$ to maximize:

$$E_t \sum_{s=t}^{\infty} \beta^{s-t} \left( \frac{C_{t+s}}{C_t} \right)^{-\gamma} \left( e^{Z_s L_s} - w_s L_s - \kappa V_s \right),$$

where $w_t$ is the real wage.

Standard job creation equation:

$$\frac{\kappa}{q_t} = (1 - \lambda) \beta E_t \left[ \left( \frac{C_{t+1}}{C_t} \right)^{-\gamma} \left( e^{Z_{t+1}} - w_{t+1} + \frac{\kappa}{q_{t+1}} \right) \right].$$
Unconstrained Wage Bargaining

- Unconstrained Nash bargaining:

\[ w_{nash}^t = \arg \max \left( J_t^{1-\eta} W_t^\eta \right), \]

where \( J_t \equiv \) firm surplus and \( W_t \equiv \) worker surplus; \( \eta \in (0, 1) \) is the bargaining power of the worker.

- Solution implies:

\[ w_{nash}^t = \eta \left( Z_t + \kappa \frac{p_t}{q_t} \right) + (1 - \eta) b, \]

where \( b \) is the flow value of unemployment.
Constrained Wage Bargaining

- Nash bargaining with the OBC

\[ w_t = \arg \max_{w_t \geq w_m} \left( J_t^{1-\eta} W_t^\eta \right), \]

where \( w_m \) is an exogenous lower-bound for wages.

- \( w_t \neq w_t^{\text{nash}} \) even when \( w_t > w_m \) since \( J_t \) and \( W_t \) are affected by the possibility that the constraint will be binding in the future.

- Policy functions become non-differentiable over some portions of the state space.
Building Intuition: Partial Equilibrium Model

- Make a number of simplifying assumptions.

1. Set $\lambda = 0$ and $\eta = 0.5$; abstract from discounting.

2. Jobs have fixed tenure of two periods ($t = 1, 2$) and vacancies are posted at $t = 0$.

3. $Z_t^{i.i.d.} \sim U(Z^a, Z^b) \implies$ no state variables.

- Solve the model by backward induction.
Building Intuition: Partial Equilibrium Model

- Unconstrained Nash bargaining: $w_t^{nash} = Z_t/2 \Rightarrow$ firm profits are linear in productivity in both periods:

$$E_1 [J_2 (Z_2)] = J_2 [E_1 (Z_2)].$$

- Same result holds true if wages are fully rigid: $w_t = w$.

- Constrained Nash bargaining:

$$w_2 = \begin{cases} w_1^{nash} & \text{if } w_1^{nash} > w_m \\ w_m & \text{otherwise} \end{cases},$$

$$w_1 = \begin{cases} \bar{w}^{nash} = w_1^{nash} + \frac{E_1(J_2-W_2)}{2} & \text{if } \bar{w}^{nash} > w_m \\ w_m & \text{otherwise} \end{cases}.$$

- OBC induces a profit risk premium:

$$E_1 [J_2 (s_2)] < J_2 [E_1 (s_2)].$$
Consider a mean preserving spread in the productivity distribution of $Z_2$.

- Unconstrained Nash bargaining or fixed wages: no effect on job creation.
  - Profits are linear in productivity.

- Constrained Nash bargaining:
  - Job creation falls provided that risk premium increases.
A Graphical Representation

Unconstrained Nash Wage Bargaining

Profit ($J$)

$J[E(Z)]$
$E[J(Z)|Z^a,Z^b]$
$E[J(Z)|Z^{a'},Z^{b'}]$

Productivity ($Z$)

$Z^a'$, $Z^a$, $Z^m$, $E(Z)$, $Z^b$, $Z^{b'}$
Constrained Nash Wage Bargaining

Profit \( (J) \)

\[ J[E(Z)] \]

\[ E[J(Z)|Z^a, Z^b] \]

\[ E[J(Z)|s^a', s^b'] \]

Productivity \( (Z) \)

Risk premium

Risk premium'
Back to General equilibrium: Wage Bargaining

- Transform the constrained problem into an unconstrained problem.
- Add to the objective function (the Nash surplus) a term that prescribes a high cost for violation of the constraint:

\[
wt = \arg \max \left( J_t^{1-\eta} W_t^\eta - \Gamma_t \right),
\]

where

\[
\lim_{\psi \to \infty} \Gamma(\psi, \cdot) = \begin{cases} 0 & w_t \geq w_m \\ \infty & w_t < w_m \end{cases}.
\]

- The solution implies

\[
w_t = w_t^{nash} - \Lambda_t + (1 - \lambda) (1 - p_t) E_t \left( \beta_{t,t+1} \Lambda_{t+1} \right),
\]

where \( \Lambda_t \equiv (\partial \Gamma_t / \partial w_t) J_t^{\eta} W_t^{1-\eta} \).

- The sequence of solutions to the approximate optimization problem converges to the solution of the original problem (Luenberger, 1977).
Wage Dynamics and the OBC: IRFs

Wages and TFP with OBC

Wages and TFP without OBC
Ergodic Wage Distribution: Unconstrained Nash Bargaining
Ergodic Wage Distribution: OBC
First-Moment Productivity Shock
Uncertainty Shock

Consumption

Employment

Output

Wage

TFP

TFP Volatility

Flexible

Hall
Uncertainty Shock: the role of the OBC
Uncertainty Multiplier

Employment: Uncertainty Multiplier

Initial Employment = -4.90%
Initial Employment = 0.00%
Initial Employment = 1.23%
Empirical Measures of Uncertainty and OCB

Figure: Figure 1
Conclusions

- Hiring and wage-setting frictions important to understand the transmission of uncertainty shocks and the behavior of measured uncertainty.
- State-dependent propagation of uncertainty shocks.
- Uncertainty in economic outcomes increases in recession even if there is no change in exogenous uncertainty.
- Methodological insight:
  - Penalty function approach can work well even in locally approximated models.