Understanding the Great Recession

Lawrence Christiano  Martin Eichenbaum  Mathias Trabandt

Conference in honor of Jim Hamilton,
Federal Reserve Bank of San Francisco, 2014
Background

- GDP appears to have suffered a permanent (10%?) fall since 2008.
- Trend decline in labor force participation accelerated after the ‘end’ of the recession in 2009.
- Unemployment rate persistently high
  - recent fall primarily reflects the fall in labor force participation.
- Employment to population ratio fell sharply with little evidence of recovery.
- Vacancies have risen, but unemployment has fallen relatively little (‘shift in Beveridge curve’, ‘mismatch’).
- Investment and consumption persistently low.
Questions

• What were the key forces driving U.S. economy during the Great Recession?

• Mismatch in the labor market?

• Why was the drop in inflation so moderate?
To answer our questions we need a model

- Model must provide empirically plausible account of key macroeconomic aggregates
  - employment, vacancies, labor force participation, job finding rate, unemployment rate, real wages
  - output, consumption, investment, ..

- Novel features of labor market
  - Endogenize labor force participation.
  - Derive wage inertia as an equilibrium outcome.

- Estimate model using pre-2008 data.

- Use estimated model to analyze post-2008 data.
Questions and Answers

• What forces drove real quantities in the Great Recession?
  – Shocks to financial markets key drivers, even for variables like labor force participation.
  – Government shocks not important: because of size and timing (consistent with ZLB literature).

• Mismatch in the labor market?
  – Not a first order feature of the Great Recession.
  – We account for ‘shift’ in the Beveridge curve without resorting to structural shifts in the labor market.
Questions and Answers

• Why was the drop in inflation so moderate?
  – Prolonged slowdown in TFP growth during the Great Recession.
  – Rise in cost of firms’ working capital as measured by spread between corporate-borrowing rate and risk-free interest rate.
  – Both forces exert countervailing pressure on inflation.
2.2. Household Maximization

Members of the household derive utility from a market consumption good and a good produced at home. The home good is produced using labor of individuals who are not in the labor force and unemployed individuals:

$$C^H_t = \beta^H_t (1 - L_t)$$

The term $F(L_t; L_t - 1; \beta L_t)$ captures the idea that it is costly to change the number of people who specialize in home production:

$$F(L_t; L_t - 1; \beta L_t) = 0$$

We assume $\beta < 1$, so that in steady state the unemployed contribute less to home production than do people who are out of the labor force. Finally, $\beta L_t$ and $\beta L_t - 1$ are processes that ensure balanced growth. We discuss these processes in detail below.

Because workers experience no disutility from working, they supply their labor inelastically. An employed worker brings home the wages that it earns. Unemployed workers receive government-provided unemployment compensation which they give to the household. Unemployment benefits are financed by lump-sum taxes paid by the household. Workers maximize their expected income. By the law of large numbers, this strategy maximizes the total income of the household. Workers maximize expected income in exchange for perfect consumption insurance from the household. All workers have the same concave preferences over consumption. So the optimal insurance arrangement involves allocating the same level of the market good and the home good to all members of the household.

The representative household maximizes the objective function:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(\tilde{C}_t)$$

$$\tilde{C}_t = \left[ (1 - \omega) (C_t)^x + \omega (C^H_t)^x \right]^{\frac{1}{x}}$$

$\tilde{C}_t$ denotes market consumption and the consumption of a good produced at home. The parameter, $\beta$, governs the substitutability between $C_t$ and $C^H_t$.

In the next draft of the paper we will report results for other values of $\beta$. The parameter $\beta$ controls the degree of habit formation in household preferences. We assume $0 \leq \beta < 1$.

Above variable indicates its economy-wide average value.
Labor Market

\[ E_0 \sum_{t=0}^{\infty} \beta^t U(\tilde{C}_t) \]

\[ \tilde{C}_t = \left[ (1 - \omega)(C_t)^x + \omega (C_t^H)^x \right]^{\frac{1}{x}} \]

\[ C_t^H = 1 - L_t \]

-Household labor force decision
-Split between U and E determined by job-finding rate.
Bargaining
Three types of worker-firm meetings:

i) E to E, ii) U to E, iii) N to E
Modified version of Hall-Milgrom

• Firms pay a fixed cost to meet a worker (must post vacancies, but these are costless).

• Then, workers and firms engage in alternating-offer bargaining.
  – Better off reaching agreement than parting ways.
  – Disagreement leads to continued negotiations.

• If bargaining costs don’t depend too sensitively on state of economy, neither will wages.
  – firms suffer cost, $\gamma$, when they reject an offer by the worker and make a counteroffer.
  – bargaining costs *somewhat* sensitive to state of business cycle:
    • protracted negotiations mean lost output/wages.
    • rejection of an offer risks, with probability $\delta$, that negotiations break down completely.

• After expansionary shock, rise in wages is relatively small.
Estimated Medium-Sized DSGE Model

- Standard empirical NK model (e.g., CEE, ACEL, SW):
  - Calvo price setting frictions, but no indexation.
  - Habit persistence.
  - Variable capital utilization.
  - Working capital.
  - Adjustment costs: investment, labor force.
  - Taylor rule.

- Our labor market structure.

- Estimation strategy: Bayesian impulse response matching.
  - Shocks to monetary policy, neutral and investment-specific technology.
  - Our model performs well relative to this metric.
Estimated Parameters, Pre-2008 Data

- Estimation by impulse response matching, Bayesian methods.

- Prices change on average every 4 quarters.

- $\delta$: roughly 0.1% chance of a breakup after rejection.

- $\gamma$: cost to firm of preparing counteroffer roughly 0.6 times one day’s production.

- Posterior mode of hiring cost: 0.5% of GDP; replacement ratio: 30% of wage.

- Elasticity of substitution between home and market goods: 3.
  - set a priori, see Aguiar-Hurst-Karabarbounis (2012).
The U.S. Great Recession

Figure 4: The Great Recession in the U.S.
Quantifying the Great Recession

• Want a quantitative characterization of the *Great Recession*
  – the part of the post-2008 data that did not simply involve an unwinding of pre-2008 forces.
  – we seek to understand the difference between what *would have happened* absent Great Recession shocks and *what did happen*.
  – want the procedure to be as simple and transparent as possible.

• For each variable, we fit a linear trend from date $x$ to 2008Q2, where $x \in \{1985Q1; 2003Q1\}$.

• We extrapolate the resulting trend lines for each variable from 2008Q3 to 2013Q2.

• We calculate the *target gaps* as the differences between the projected values of each variable and its actual value.
U.S. Great Recession: Target Gap Ranges
Two Financial Market Shocks

1. **Consumption wedge, \( \Delta^b_t \):** Shock to demand for safe assets ('Flight to safety', see e.g. Fisher 2014):

   \[
   1 = (1 + \Delta^b_t)E_t m_{t+1} R_t / \pi_{t+1}
   \]

2. **Financial wedge, \( \tilde{\Delta}^k_t \):** Reduced form of ‘risk shock’, Christiano-Davis (2006), Christiano-Motto-Rostagno (2014):

   \[
   1 = (1 - \tilde{\Delta}^k_t)E_t m_{t+1} R_{t+1}^k / \pi_{t+1}
   \]

   • Financial wedge also applies to working capital loans:
     - Interest charge on working capital: \( R_t (1 + \hat{\Delta}^k_t) \)
     - Estimated share of labor inputs financed with loans: 0.56.
     - Higher financial wedge directly increases cost to firms.
Measurement of Shocks

1. Financial wedge, $\tilde{\Delta}_t^k$, measured using GZ spread data.

2. Consumption wedge, $\Delta_t^b$, measured using the Euler equation for the risk-free asset and $E_t\pi_{t+1}$ and $R_t$ data.

3. Neutral technology shock based on TFP data.


- Stochastic simulation starting 2008Q3 (nonlinear model, no perfect foresight).
Exogenous Processes

G–Z Corporate Bond Spread (annualized p.p.)

Consumption Wedge (annualized p.p.)

Neutral Technology Level (%)

Government Consumption & Investment (%)

Data (Min–Max Range) — Data (Mean) — Model
Assessing model’s implication for TFP

Figure 5: Measures of Total Factor Productivity (TFP): 2001 to 2013

Notes: Linear trend from 2001Q1 to 2008Q2 (dashed-dotted). Forecast 2008Q3 and beyond based on linear trend (dotted).

- BLS (Private Business)
- BLS (Manufacturing)
- BLS (Total)
- Fernald (Raw)
- Fernald (Util. Adjusted)
- Penn World Tables
- Our Model

TFP (% Deviation from Trend)
Monetary Policy in the Great Recession

• From 2008Q3 to 2011Q2:
  – Taylor-type feedback rule subject to the ZLB.

• After 2011Q2: ‘forward guidance’
  – following 1 year transition, ‘Evans rule’
  – keep funds rate at zero until either unemployment falls below 6.5\% or inflation rises above 2.5\%.
The U.S. Great Recession: Data vs. Model

- GDP (%)
- Inflation (p.p., y-o-y)
- Federal Funds Rate (ann. p.p.)
- Unemployment Rate (p.p.)
- Employment (p.p.)
- Labor Force (p.p.)
- Investment (%)
- Consumption (%)
- Real Wage (%)
- Vacancies (%)
- Job Finding Rate (p.p.)

Data (Min–Max Range) — Data (Mean) — Model
The U.S. Great Recession: Data vs. Model

Data (Min–Max Range) — Data (Mean) — Model

GDP (%)

Inflation (p.p., y–o–y)

Federal Funds Rate (ann. p.p.)

Unemployment Rate (p.p.)

Employment (p.p.)

Labor Force (p.p.)

Investment (%)

Consumption (%)

Real Wage (%)

Vacancies (%)

Job Finding Rate (p.p.)
Decomposing What Happened into Shocks

- Our shocks roughly reproduce the actual data.

- We investigate the effect of a shock by shutting it off.
  - Resulting decomposition is not additive because of nonlinearity.

- Results:
  - *Financial wedge* - accounts for the biggest effects on real quantities.
  - *Consumption wedge* - less important than financial wedge.
  - *Government spending* - relatively small role.
  - *TFP* - plays an important role in preventing drop in inflation.
Phillips Curve

- Widespread skepticism that NK model can account for modest decline in inflation during the Great Recession.

- One response: Phillips curve got flat or always was very flat (e.g. Christiano, Eichenbaum and Rebelo, 2011).

- Alternative: standard Phillips curve misses sharp rise in costs
  - Unusually high cost of credit to finance working capital.
  - Fall in TFP.
    \[\Rightarrow \text{Both raise countervailing pressure on inflation.}\]
Decomposition for Inflation

Baseline Model

Inflation (p.p., y-o-y)

Constant TFP

No Spread on working capital
Beveridge Curve

• Much attention focused on ‘sharp’ rise in vacancies and relatively small fall in unemployment

  – It is argued that ‘fish hook’ shape is evidence of a ‘shift’ in matching function.

  – Argument based on assumption that unemployment is at steady state – misleading in the context of the Great Recession.

• In our model, no shift occurs in the matching technology.

  – Still, our model accounts for the ‘fish hook’ shape of the Beveridge curve.
The Beveridge Curve: Data vs. Model

Figure 9: Beveridge Curve: Data vs. Model
Model Predicts Fish Hook, Why?

• Simplest DMP style model

\[ U_{t+1} - U_t = (1 - \rho)(1 - U_t) - f_t U_t \]

solving for \( f_t \):

\[ f_t = (1 - \rho) \frac{(1 - U_t)}{U_t} - \frac{U_{t+1} - U_t}{U_t} \]

matching function

\[ \sigma_t \left( \frac{V_t}{U_t} \right)^{\alpha} \]

solving for \( V_t \):

\[ V_t = \left[ (1 - \rho) \frac{(1 - U_t)}{\sigma_t U_t^{1-\alpha}} - \frac{\hat{U}_{t+1} - \hat{U}_t}{\sigma_t U_t^{1-\alpha}} \right]^{1/\alpha} \]

• Naturally implies a 'fish hook' pattern (Pissarides).
Magnitude of Fish Hook in DMP Model

U.S. Beveridge Curve

-JOLTS Data (Dec 2000−Jan 2014)
-Red: Stylized Model, Steady State Condition $\Delta U = 0$ Imposed
-Black: Stylized Model, Steady State Condition Not Imposed

$\rho = 0.97, \alpha = 0.6, \sigma = 0.84$, monthly
Conclusion

• Bulk of movements in economic activity during the Great Recession due to financial frictions interacting with the ZLB.
  – ZLB has caused negative spending shocks to push the economy into a prolonged recession.

• Findings based on looking through lens of a NK model:
  – firms face moderate degrees of price rigidities,
  – no sticky wages.
  – endogenous labor force participation, standard labor market variables.

• No (or little) evidence for ‘mismatch’ in labor market.

• Modest fall in inflation is not a puzzle once fall in TFP and risky working capital channel are taken into account.