Search with Wage Posting Under Sticky Prices

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Introduction

After Great Recession, Sluggish Labor Market with Low Inflation
Importance of Frictions in Pricing Behavior – Nominal Rigidities
Importance of Frictions in Labor Market – Search Models
Interest in Interaction Between Pricing and Labor Market Frictions
  • Many Papers Include these Two
  • Typical Assumption for Tractability: Split Frictions
We Address this Assumption, Show it Matters
  • Changes in Unemployment Benefits
  • Response to Shocks
  • Volatility of the Labor Market
Our Model versus an Alternative

- **Objective:** Compare and Contrast Models
- **Alternative:** Separates Frictions (*Walsh (2005), Trigari (2006))*
  - Wholesaler Firms: Act in Labor Market, Produce Competitive Good
  - Retailer Firms: Buy Wholesale Good Competitively, Act in Product/Pricing Market with Power
  - Firms Don’t Internalize the Effects of Other Friction
- **Baseline Model:** Develop a Framework Where Firms...
  - Post Vacancies
  - Offer Workers an Hours-Compensation Contract
  - Make Pricing Decisions
  - Internalize the Effects of All Frictions
Importance of Our Environment

- Once Combine Frictions, What is Bargained Over Changes
  - Firm has Market Power
  - Worker Input into Price Setting? Firm Size?
  - Perfect Consumption Insurance in Household
  - Result: Contracts Look Very Different, Introducing Many Channels not Present in the Standard Model
- Benefits of Wage Posting
  - Contracts Identical in Both Models
  - Eliminate Representative Household Assumption
- Other Features of Wage Posting
  - Severs Link Between Compensation and Agg. Labor Market Tightness
  - Posting at Least as Common as Bargaining (Hall and Krueger (2012))
Model Overview

- Individuals: Consume, Work, Save, Search for Employment
- Final Goods Firms: Aggregate Intermediate Goods
- Intermediate Goods Firms
  - Post Vacancies and Wages
  - Monopolistically Competitive with Sticky Prices
- Policy: Taylor Rule, Lump-Sum Taxes
- Alternative Model Splits Producing Firms
  - Wholesale Firms: Post Vacancies and Wages, Competitive Markets
  - Retail Firms: Purchase Wholesale Good, Sticky Prices
- Calibrate to Match Same Steady State Targets
Individuals

- Utility Function

\[ U(c_{i,t}, h_{i,t}) = \frac{\left(c_{i,t} - \varphi h_{i,t}^{1+1/\psi}\right)^{1-\gamma} - 1}{1 - \gamma} \]

- Benefits of GHH Preferences (and Assumption on Initial Condition)
  - Simplifies Contracting Environment
  - Prevents Counterfactual Asset/Wage Behavior (Mustre-del-Rio (2014))
  - Dispatch with Large Household Assumption
    - No Consumption Insurance
    - Hours Optimal from Individual’s Perspective
    - Still Get Nice Aggregation
Individuals

- Unemployed Individual

\[ W_{i,t}^{u} = \max_{c_{i,t}^{u}, B_{i,t}^{u}} \left\{ U \left( c_{i,t}^{u}, 0 \right) + \beta \mathbb{E}_t \left[ s_t W_{i,t+1}^{e} + \left( 1 - s_t \right) W_{i,t+1}^{u} \right] \right\} \]

s.t. \( P_t c_{i,t}^{u} + B_{i,t}^{u} + P_t T_t = P_t b + R_{t-1} B_{i,t-1} + D_t \)

- Employed Individual

\[ W_{i,t}^{e} = \max_{c_{i,t}^{e}, B_{i,t}^{e}} \left\{ U \left( c_{i,t}^{e}, h_{i,t}^{e} \right) + \beta \mathbb{E}_t \left[ \left( 1 - \delta_t \right) W_{i,t+1}^{e} + \delta_t W_{i,t+1}^{u} \right] \right\} \]

s.t. \( P_t c_{i,t}^{e} + B_{i,t}^{e} + P_t T_t = P_t \omega_{i,t} + R_{t-1} B_{i,t-1} + D_t \)
Intermediate Goods Firms

- **Production**
  \[ Y_{j,t}^s = Z_t h_{j,t} \]

- **Take-it-or-leave-it Contract**
  \[ Y_{j,t} = (\omega_{j,t}, h_{j,t}) \]

- **Optimal Contract**: Worker Indifferent Between Working and Not
  \[ \omega_{j,t} = b + \varphi h_{j,t}^{1 + \frac{1}{\psi}} = b + \varphi \left( \left( \frac{P_{j,t}}{P_t} \right)^{-\epsilon} \frac{Y_t}{Z_t n_t} \right)^{1 + \frac{1}{\psi}} \]

- **Dispersion of** \((\omega_{j,t}, h_{j,t})\) **via Prices**
**Price Setting**

- **Value Function of Firm**

\[
J_t (P_{j,t}) = \left( \frac{P_{j,t}}{P_t} \right) Y_{j,t}^d - \omega_{j,t} \\
+ \beta (1 - \delta_t) \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} [\zeta J_{t+1} (P_{j,t}) + (1 - \zeta) J_{t+1} (P_{t+1}^*)] \\
= \left( \frac{P_{j,t}}{P_t} \right)^{1-\epsilon} Y_t \frac{n_t}{Z_t n_t} - b - \varphi \left( \left( \frac{P_{j,t}}{P_t} \right)^{-\epsilon} \frac{Y_t}{Z_t n_t} \right)^{1+\frac{1}{\psi}} \\
+ \beta (1 - \delta_t) \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} [\zeta J_{t+1} (P_{j,t}) + (1 - \zeta) J_{t+1}^*]
\]

- **Re-optimizers**

\[
P_t^* = \arg \max J_t (P_{j,t})
\]
Alternative Model

- Wholesale Firms
  \[ Y_t^w = Z_t h_t \]
  \[ J_t^w = \max_{h_t} \frac{P_t^w}{P_t} Z_t h_t - b - \varphi h_t^{1+1/\psi} + \beta (1 - \delta_t) \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} J_{t+1}^w \]

- Retail Firms
  \[ Y_{j,t}^s \geq Y_{j,t}^d = \left( \frac{P_{j,t}}{P_t} \right)^{-\epsilon} Y_t \]
  \[ J_t^r (P_{j,t}) = \left( \frac{P_{j,t}}{P_t} - \frac{P_t^w}{P_t} \right) Y_{j,t}^d + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \left[ \zeta J_{t+1}^r (P_{j,t}) + (1 - \zeta) J_{t+1}^r \right] \]
Model Comparison

- **Free Entry Condition: Wholesaler versus Baseline (Market Power)**

\[ \kappa = q_t \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} J^w_{t+1} \]

\[ \kappa = q_t \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} [\zeta J_{t+1} (P_t) + (1 - \zeta) J_{t+1} (P^*_t)] \]

- **First Order Condition: Retailer versus Baseline (Shocks)**

\[ \sum_{k=0}^{\infty} (\beta \zeta)^k \frac{\lambda_{t+k}}{\lambda_t} \left[ \frac{P^*_t}{P_{t+k}} - \mu \frac{P^w_{t+k}}{P_{t+k}} \right] Y_{t+k} P^e_{t+k} = 0 \]

\[ \sum_{k=0}^{\infty} (\beta \zeta)^k \prod_{i=1}^{k} (1 - \delta_{t+k-i}) \frac{\lambda_{t+k}}{\lambda_t} \left[ \frac{P^*_t}{P_{t+k}} - \mu \frac{\varphi (1 + 1/\psi) h_{j,t+k}^{1/\psi}}{Z_{t+k}} \right] \frac{Y_{t+k}}{n_{t+k}} P^e_{t+k} = 0 \]
Calibration

- Most Parameters Standard From Literature
- Set of Parameters to Match Consistent Targets Across Models

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Target</th>
<th>Baseline</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varphi$</td>
<td>Disutility of labor</td>
<td>$h_{j,ss} = 1/3$</td>
<td>2.7</td>
<td>2.7</td>
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<tr>
<td>$b$</td>
<td>Unemployment benefits</td>
<td>$b/\omega_{ss} = 1/2$</td>
<td>0.1</td>
<td>0.1</td>
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<tr>
<td>$\sigma_m$</td>
<td>Matching efficiency</td>
<td>$u_{ss} = 0.11$</td>
<td>0.7526</td>
<td>0.7526</td>
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<tr>
<td>$\kappa$</td>
<td>Vacancy posting</td>
<td>$q_{ss} = 0.70$</td>
<td>0.8895</td>
<td>0.6671</td>
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</tbody>
</table>
Results Overview

- Compare and Contrast Baseline and Alternative Models
- Show a Subset of Results
- Steady State Effect of Changing Unemployment Benefits
  - Matters via Free Entry Condition
  - Highlights Market Power
- Impulse Responses
  - Baseline Model: All Shocks hit Same Firm
  - Alternative: Shocks Hit Different Firms
  - Highlight Sticky Prices by Considering Flexible Prices
- Labor Market Ratios
  - In Aggregate and Decompose Effects of Each Shock
  - Highlight Sticky Prices by Considering Flexible Prices
Changing Unemployment Benefits

Output (%)

Unemployment Benefits

Average Hourly Wage (%)

Unemployment Rate (pp)

Vacancies Rate (pp)

V/U Ratio (pp)

Baseline Model  Alternative Model
TFP Shock: Sticky Prices

Output (%)

Avg Hours per Worker (%)

Avg Hourly Wage (%)

Inflation (pp)

Nominal Rate (pp)

Markup (%)

Unemployment (pp)

Vacancies (pp)

V/U Ratio (pp)

Baseline Model

Alternative Model
Separation Rate Shock: Flexible Prices

![Graphs showing the impact of separation rate shocks on various economic indicators, comparing Baseline Model and Alternative Model.](graph.png)
Separation Rate Shock: Sticky Prices
## Labor Market Ratios: Flexible versus Sticky Prices

<table>
<thead>
<tr>
<th></th>
<th>$\frac{\text{std} (v/u)}{\text{std} (Y)}$</th>
<th>$\text{corr} (u, v)$</th>
<th>$\frac{\text{std} (n)}{\text{std} (Y)}$</th>
<th>$\frac{\text{std} (h)}{\text{std} (Y)}$</th>
<th>$\frac{\text{std} (w)}{\text{std} (Y)}$</th>
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<tbody>
<tr>
<td><strong>Flexible Prices</strong></td>
<td></td>
<td></td>
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<tr>
<td>Baseline</td>
<td>11.9971</td>
<td>-0.5344</td>
<td>0.7724</td>
<td>0.3176</td>
<td>0.2858</td>
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<tr>
<td>Alternative</td>
<td>12.9331</td>
<td>-0.5688</td>
<td>0.7880</td>
<td>0.3113</td>
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<td><strong>Sticky Prices</strong></td>
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<tr>
<td>Baseline</td>
<td>7.1798</td>
<td>-0.1872</td>
<td>0.5373</td>
<td>0.8405</td>
<td>1.0325</td>
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<tr>
<td>Alternative</td>
<td>11.2575</td>
<td>-0.5469</td>
<td>0.6932</td>
<td>0.5480</td>
<td>0.4932</td>
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</tbody>
</table>
## Labor Market Ratios: Sticky Prices

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<tr>
<th></th>
<th>$\frac{\text{std}(v/u)}{\text{std}(Y)}$</th>
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<th>$\frac{\text{std}(w)}{\text{std}(Y)}$</th>
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<tr>
<td><strong>All Shocks</strong></td>
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<td>Baseline</td>
<td>7.1798</td>
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<td>0.5480</td>
<td>0.4932</td>
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<td><strong>Tech Shock Only</strong></td>
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<tr>
<td>Baseline</td>
<td>7.5317</td>
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<td>0.3928</td>
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<td><strong>MP Shock Only</strong></td>
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<td>Baseline</td>
<td>2.0559</td>
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<td>Alternative</td>
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<td>-0.0101</td>
<td>0.0458</td>
<td>1.1230</td>
<td>1.0107</td>
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<td><strong>Sep Shock Only</strong></td>
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<tr>
<td>Baseline</td>
<td>7.6067</td>
<td>0.5928</td>
<td>0.8159</td>
<td>1.1353</td>
<td>1.0281</td>
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<td>Alternative</td>
<td>17.4045</td>
<td>-0.2365</td>
<td>1.6273</td>
<td>0.9610</td>
<td>0.8649</td>
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</table>
Conclusion

- Develop a Model of Search with Wage Posting under Sticky Prices
- Compare and Contrast with Alternative Model
- Contracts Identical in Two Models
- Show Combining Frictions has Important Effects
  - Sensitivity to Unemployment Benefits
  - Response to Shocks
  - Volatility of the Labor Market
- Implications for Estimating Models