Incomplete Cost Pass-Through
Under Deep Habits

M. Ravn    S. Schmitt-Grohé    M. Uribe

December 2007
Stylized Facts We Wish To Address

- Innovations in marginal costs are associated with less than proportional increases in prices (incomplete cost pass-through).

- Prices are less volatile than marginal costs.

- Markup adjustments explain a significant fraction of incomplete cost pass-through.

• **Observation:** Most existing structural estimations of cost pass-through using micro-level data are based on static models.

• **Limitations of Static Models:**
  
  – Cannot distinguish between effects of permanent versus transitory cost shocks.
  
  – Cannot distinguish between effects of anticipated versus unanticipated cost shocks.

• **This Paper:** Dynamics take center stage.
Habit Formation

Period Utility Function: $U(x_t)$

**Superficial Habit Formation:** Habits are formed at the level of a composite good

$$x_t = \frac{c_t}{c_{t-1}^\theta} \quad \text{with} \quad c_t = \left[ \int_0^1 c_{it}^{1-\frac{1}{\eta}} di \right]^{\frac{1}{1-\frac{1}{\eta}}}$$

**Deep Habit Formation:** Habits are formed at the level of individual goods

$$x_t = \left[ \int_0^1 \left( \frac{c_{it}}{c_{it-1}^\theta} \right)^{1-\frac{1}{\eta}} di \right]^{\frac{1}{1-\frac{1}{\eta}}}$$
A Model of Incomplete Pass-Through

Household $j$ minimizes

$$\int_0^1 P_{it} c_{it}^j di,$$

subject to

$$\left[ \int_0^1 \left( \frac{c_{it}^j}{c_{it-1}^{\theta}} \right)^{1 - 1/\eta} di \right]^{1/(1 - 1/\eta)} \geq x_t^j$$

$\theta = \text{deep-habit parameter}$

$c_{it-1} = \text{External habit stock, taken as given by households.}$
Aggregate demand for good $i$

$$c_{it} = \left( \frac{P_{it}}{P_t} \right)^{-\eta} \theta(1-\eta) c_{it-1} x_t$$

- Short-Run Price Elasticity $= \eta$
- Long-Run Price Elasticity $= \frac{\eta}{1-\theta(1-\eta)} > \eta$
- Habit elasticity $= \theta(1-\eta) \in (0, 1)$
- Empirical support: Houthakker and Taylor, 1970; Chintagunta, Kyriazidou, and Perktold, 2001;
The Firm

- Maximize present value of expected profits

\[
\sum_{t=0}^{\infty} \beta^t E_0(P_{it} - MC_{it})c_{it},
\]

subject to

\[
c_{it} = A_t P_{it}^{-\eta} c_{it-1}^\theta (1-\eta)
\]

→ Pricing problem of the firm becomes dynamic

- First-order condition:

\[
P_{it} \left(1 - \frac{1}{\eta}\right) + \beta \frac{1-\eta}{\eta} E_t P_{it+1} \frac{c_{it+1}}{c_{it}} = MC_{it}
\]
The Markup

- Define the markup as

\[ \mu_{it} \equiv \frac{P_{it}}{MC_{it}} \]

Then, the firm’s FOC implies

\[ \mu_{it} = \frac{1}{\left(1 - \frac{1}{\eta}\right) \left[1 - \beta \theta E_{t} \frac{P_{it}c_{it+1} + 1}{P_{it}c_{it}}\right]} \]

- The markup is time varying.

- The markup is decreasing in the expected growth of sales.
• Steady state markup

\[ \mu = \left( \frac{\eta}{\eta - 1} \right) \left( \frac{1}{1 - \beta \theta} \right) < \frac{\eta}{(\eta - 1)}. \]
A Law of Motion for Marginal Costs

\[
\widehat{MC}_{it+1} = \lambda \widehat{MC}_{it} + \epsilon_{t+1}
\]

Calibration of the Model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.99</td>
</tr>
<tr>
<td>$\eta$</td>
<td>6</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0</td>
</tr>
<tr>
<td>$\theta$</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

Implied markup is 9 %
Impulse Response to a One-Percent Increase in Marginal Cost

<table>
<thead>
<tr>
<th>period</th>
<th>price</th>
<th>marg.costs</th>
<th>markup</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.81</td>
<td>1</td>
<td>-0.19</td>
</tr>
<tr>
<td>1</td>
<td>-0.11</td>
<td>0</td>
<td>-0.11</td>
</tr>
<tr>
<td>2</td>
<td>-0.04</td>
<td>0</td>
<td>-0.04</td>
</tr>
</tbody>
</table>

Units: percent deviations from the steady state.

⇒ Incomplete Cost Pass-Through
Price-Cost Volatility Ratio

\[
\frac{\text{var}(P_{it})}{\text{var}(MC_{it})} = 0.66
\]

⇒ Prices are less volatile than marginal cost
Anticipated Marginal-Cost Shocks

<table>
<thead>
<tr>
<th>period</th>
<th>price</th>
<th>marg.costs</th>
<th>markup</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.29</td>
<td>0</td>
<td>0.29</td>
</tr>
<tr>
<td>1</td>
<td>0.77</td>
<td>1</td>
<td>-0.23</td>
</tr>
<tr>
<td>2</td>
<td>-0.12</td>
<td>0</td>
<td>-0.12</td>
</tr>
</tbody>
</table>

Units: percent deviations from the steady state.

⇒ About 1/3 of the future expected increase in costs is passed onto prices upon arrival of information. Consequently, a smaller fraction of the cost shock is passed onto prices upon realization of the shock ⇒ Measured pass-through is more incomplete, \( \Delta \log P_t = 0.48 \).
Persistence of Cost Shocks and Incomplete Pass-Through

\[ \log \left( \frac{\mu_t}{\mu_{ss}} \right) \Rightarrow \] Pass-through increases with the persistence of marginal cost shocks.
$\sigma_P^2 / \sigma_{MC}^2 \Rightarrow$ Prices remain less volatile than costs even for highly persistent cost shocks.
Conclusions

- Deep habit formation gives rise to a theory of time-varying markups.
- The markup is a decreasing function of expected revenue growth.
- Deep habit formation induces incomplete pass-through of marginal cost shocks.
- Anticipation of cost shocks exacerbates the incompleteness of cost pass-through.
- Incomplete pass-through is more severe the more transitory the cost shocks are.
$\log \left( \frac{\mu_t}{\mu_{ss}} \right)$

$|\theta|$
\[ \log \left( \frac{\mu_t}{\mu_{ss}} \right) \]