SOME EVIDENCE ON THE IMPORTANCE OF STICKY PRICES

Written by:
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broader evidence on price rigidities
- Calvo & Teylor pricing model

Employing the sticky-price model
- Rigidity's consequences for the behavior of persistency and volatility
  - Goods market
  - Labor market

behavior of inflation in frequent and infrequent goods
- Bureau of Labor Statistics (BLS)
  - 350 categories
  - 70% of consumer expenditures
  - 70,000 to 80,000 non-housing goods

- NBER Productivity Database

- Non comparable substitution rate
  - High: Women's dresses, Girls' coats and jackets, Boys' active sportswear
  - Low: Apples; Lettuce

- Price quote:
  - Net of the Item Substitution
  - Price Changes
Frequent cat: The prices of gasoline, tomatoes, and airfares change more than 70% of months

Rigid cat: seldom change Prices of newspapers, men's haircuts, and taxi fares change less than 5% of months

Several papers have shown that certain wholesale and retail prices often go unchanged for many months

much more frequent price changes, with half of prices lasting 4.3 months or less

The BLS data suggests much more frequent price adjustment than has been found in other studies
### Monthly Frequency of Price Changes

<table>
<thead>
<tr>
<th>Year</th>
<th>Median Frequency</th>
<th>Median Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>21.3 %</td>
<td>4.2 months</td>
</tr>
<tr>
<td>1996</td>
<td>20.8</td>
<td>4.3</td>
</tr>
<tr>
<td>1997</td>
<td>19.9</td>
<td>4.5</td>
</tr>
<tr>
<td>1998</td>
<td>20.7</td>
<td>4.3</td>
</tr>
<tr>
<td>1999</td>
<td>22.4</td>
<td>3.9</td>
</tr>
<tr>
<td>2000</td>
<td>24.0</td>
<td>3.6</td>
</tr>
<tr>
<td>2001-02</td>
<td>23.1</td>
<td>3.8</td>
</tr>
</tbody>
</table>

**Introduction**

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**Market Structure and Price Flexibility**

- General equilibrium
- Sticky price

**Time-Series Patterns**

**Inflation and realistic marginal cost processes**

**Conclusion**
# Price Stickiness Consumption Categories

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## Monthly Frequency of Price Changes for Selected Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>% of Price Quotes with Price Changes</th>
<th>% of Price Quotes with Price Changes Net of the Item Substitution %</th>
</tr>
</thead>
<tbody>
<tr>
<td>All goods and services</td>
<td>26.1 (1.0)</td>
<td>22.7 (1.0)</td>
</tr>
<tr>
<td>Durable Goods</td>
<td>29.8 (2.5)</td>
<td>21.5 (2.5)</td>
</tr>
<tr>
<td>Nondurable Goods Services</td>
<td>29.9 (1.5)</td>
<td>26.6 (1.5)</td>
</tr>
<tr>
<td>Food</td>
<td>20.7 (1.5)</td>
<td>19.1 (1.5)</td>
</tr>
<tr>
<td>Home Furnishings</td>
<td>25.3 (1.9)</td>
<td>23.7 (1.9)</td>
</tr>
<tr>
<td>Apparel</td>
<td>26.4 (1.8)</td>
<td>23.7 (1.8)</td>
</tr>
<tr>
<td>Transportation</td>
<td>29.2 (3.0)</td>
<td>20.2 (3.0)</td>
</tr>
<tr>
<td>Medical Care</td>
<td>39.4 (1.8)</td>
<td>34.2 (1.8)</td>
</tr>
<tr>
<td>Entertainment</td>
<td>9.4 (3.2)</td>
<td>8.2 (3.2)</td>
</tr>
<tr>
<td>Other</td>
<td>11.3 (3.5)</td>
<td>8.2 (3.5)</td>
</tr>
<tr>
<td>Raw Goods</td>
<td>11.0 (3.3)</td>
<td>9.9 (3.3)</td>
</tr>
<tr>
<td>Processed Goods</td>
<td>54.3 (1.9)</td>
<td>52.9 (1.7)</td>
</tr>
<tr>
<td></td>
<td>20.5 (0.8)</td>
<td>16.7 (0.7)</td>
</tr>
</tbody>
</table>
Market Structure and Price Flexibility

- greater frequency of price changes in markets with more competition
- relation between the concentration ratio and the frequency of price changes
### Predicting Price Changes Across Goods

**Dependent Variable = Frequency of Price Changes across ELIs**

<table>
<thead>
<tr>
<th>Regressors</th>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-firm Concentration Ratio</td>
<td>-0.30</td>
<td>-0.30</td>
<td>-0.002</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td></td>
</tr>
<tr>
<td>Wholesale Markup</td>
<td></td>
<td>-1.20</td>
<td>-0.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.12)</td>
<td>(0.13)</td>
<td></td>
</tr>
<tr>
<td>Noncomparable Substitution Rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.25</td>
<td>2.17</td>
<td>2.86</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.33)</td>
<td>(0.26)</td>
<td>(0.29)</td>
<td></td>
</tr>
<tr>
<td>Raw Good</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>34.1</td>
<td>37.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.7)</td>
<td>(1.8)</td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.15</td>
<td>0.36</td>
<td>0.63</td>
<td>0.56</td>
</tr>
<tr>
<td>Number of goods (ELIs)</td>
<td>231</td>
<td>221</td>
<td>221</td>
<td>350</td>
</tr>
</tbody>
</table>
Objective:
- how flexible-price goods and sticky-price goods can differ in their responses to shocks.

monopolistically competitive firms
- staggered price setting of a fixed duration multiple consumer goods
- 1/2 the flexible sector firms set their prices before a period, the other half before the next period
general equilibrium sticky-price model

- **Model characteristic:**
  - Using c, m, I like DSGE model as a CES function
  - Production needs just labor
  - $c_s, w_s, l_s$ related to sticky-price: 15 period
  - $c_f, w_f, l_f$ related to flexible-price: 2 period
  - Money growth shock:

  \[
  \mu_t = \frac{m_t}{m_{t-1}} \\
  \log \mu_t = \rho_m \log \mu_{t-1} + \epsilon_t
  \]
general equilibrium sticky-price model

Household:

\[ U(c, m, l) = \left( (\omega c^{1-1/\eta} + (1-\omega)m^{1-1/\eta})^{\eta/(\eta-1)} (1-l)^{\psi} \right)^{1-\sigma} / (1-\sigma) \]

\[ c = \left[ \omega_f \left( \int_0^1 c_f(i)^{\theta} \, di \right)^{\rho/\theta} + \omega_s \left( \int_0^1 c_s(j)^{\theta} \, dj \right)^{\rho/\theta} \right]^{1/\rho} \]

Production:

\[ c_f(i) = a \, l_f(i) \, \forall i, \quad c_s(j) = a \, l_s(j) \, \forall j. \]

\[ \int_0^1 l_f(i) \, di + \int_0^1 l_s(j) \, dj = l. \]
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Time-Series Patterns

- time series on prices and consumption from BEA (Bureau of Economic Analysis)
  - 1959-2000
  - 123 goods 350 categories
    - Covering 63.3% consumer spending

- Calvo model: more volatility and more persistency
  - measure of volatility: standard error
  - Measure of persistency: serial correlation
## Time-Series Patterns

### Observed Inflation for Flexible-Price and Sticky-Price Goods

<table>
<thead>
<tr>
<th>Variable</th>
<th>From 1995-2000 data</th>
<th>From 1959-2000 data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(A)</td>
<td>(B)</td>
</tr>
<tr>
<td></td>
<td>(C)</td>
<td>(D)</td>
</tr>
<tr>
<td><strong>Flexible-price good</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.01</td>
<td>-0.34</td>
</tr>
<tr>
<td>$\sigma_\epsilon$</td>
<td>1.54</td>
<td>2.63</td>
</tr>
<tr>
<td><strong>Sticky-price good</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\rho$</td>
<td>-0.11</td>
<td>0.15</td>
</tr>
<tr>
<td>$\sigma_\epsilon$</td>
<td>0.19</td>
<td>0.78</td>
</tr>
<tr>
<td><strong>Flexible versus sticky</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\rho_{flexible} - \rho_{sticky}$</td>
<td>0.12 (0.04)</td>
<td>-0.49 (0.07)</td>
</tr>
<tr>
<td>$\sigma_{\epsilon,flexible} - \sigma_{\epsilon,sticky}$</td>
<td>1.35 (0.13)</td>
<td>1.85 (0.33)</td>
</tr>
</tbody>
</table>

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## Time-Series Patterns

### Inflation from a Staggered Pricing Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Only Aggregate Shocks</th>
<th>Aggregate and Sector Shocks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(A)</td>
<td>(B)</td>
</tr>
<tr>
<td></td>
<td>Price Inflation</td>
<td>Growth of Real Consumption</td>
</tr>
<tr>
<td>Flexible-price good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \rho )</td>
<td>0.48 (0.03)</td>
<td>(-0.30 (0.04))</td>
</tr>
<tr>
<td>( \sigma_\varepsilon )</td>
<td>0.68 (0.02)</td>
<td>0.67 (0.02)</td>
</tr>
<tr>
<td>Sticky-price good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \rho )</td>
<td>0.91 (0.02)</td>
<td>0.01 (0.05)</td>
</tr>
<tr>
<td>( \sigma_\varepsilon )</td>
<td>0.11 (0.01)</td>
<td>0.86 (0.03)</td>
</tr>
</tbody>
</table>
price stickiness (Calvo model):
- Firm change price with prob. $\lambda_i$
- Goods price related to future marginal cost
- Adjusting future MC

$$\pi_{it} = (1 - \lambda_i) \pi_{it-1} + \lambda_i \varepsilon_{it}$$
Inflation and realistic marginal cost processes

Figure 5: Predicted vs. Actual Inflation Persistence (Calvo model; 1959-2000, 123 consumption categories)

Serial Correlation of Monthly Inflation

Frequency of Price Changes

-0.5 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8

Actual
Predicted

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(Calvo model; 1959-2000, 123 consumption categories)
persistence in innovations to marginal cost

Using Bils (1987) framework;
- labor market as main product parameter

Results:
- growth rate of unit labor cost is actually positively serially correlated, but not significantly so
- For long term this becomes greater
persistence and volatility of unit labor cost

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conclusion

- more frequent price changes
- Calvo & Teylor model:
  - predict inflation rates that are much more persistent and much less volatile
- Suggest:
  - A model with synchronized price changes
  - Temporary price reductions
- Just focused on popular Calvo model

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