International Competition and Inflation:  
A New Keynesian Perspective

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Federal Reserve Board

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The Debate: How important are foreign factors for domestic inflation?

• The Protagonists:


• Ball (2006): but... ”Research is needed on how and why relative prices influence inflation. And this work must improve on current techniques for estimating these effects.”
Our Question

• In spirit of Dornbusch and Fischer (1985), we develop a model in which variations in desired markups arise in response to foreign competition.

• In an open economy, a reduction in the prices of foreign competitors can induce domestic firms to lower their desired markups and prices.

• Estimate model to quantify the importance of this foreign competitiveness channel for domestic price inflation.

• Our focus is on how the domestic price set by a U.S firm is affected by foreign competitors.
Our Approach

• To model variations in desired markups, we use a Kimball aggregator.

• Developed Modified New Keynesian Phillips curve for domestic price inflation (not CPI inflation).

• Show that domestic inflation depends not only real marginal cost but on the ratio of foreign (import) prices to domestic prices.

• Show how open economy can be useful in separately identifying variation in the markup coming from nominal rigidities and variation from real rigidities.
Our Empirical Approach

• Focus on inflation dynamics using limited information approach: GMM-IV using data from 1983-2006.

• In spirit of Fukac and Pagan (2007), choose limited information estimation to guard against model misspecification.

• Which Inflation Measure? Traded goods price is the appropriate measure. Why?

1. Theoretically consistent.

2. The main candidate to evaluate the effects of foreign competition.
Model Features

- **Final Goods Producers**
  
  1. Produce final tradable good, $A_t$, according to a Kimball (1995) aggregator.
  
  2. Demand $A_{Dt}(i)$ from domestic good producers and $A_{Mt}(i)$ from foreign producers.

- **Intermediate Goods Producers**
  
  1. Set price in domestic market subject to Calvo contracts with partial indexation to past inflation.
Demand Curve

<table>
<thead>
<tr>
<th>Percent</th>
<th>100 log(P_D(i)/P_D)</th>
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</thead>
<tbody>
<tr>
<td>-50</td>
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<td>-40</td>
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Desired Markup

<table>
<thead>
<tr>
<th>Percent</th>
<th>100 log(P_D(i)/P_D)</th>
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<tbody>
<tr>
<td>-5</td>
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<tr>
<td>-4</td>
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<td>-3</td>
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<td>4</td>
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<td>5</td>
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Inflation Dynamics: Identifying Nominal and Real Rigidities

\[ \hat{\pi}_t - \delta_D \hat{\pi}_{t-1} = \beta E_t[\hat{\pi}_{t+1} - \delta_D \hat{\pi}_t] + \kappa_D \left[ (1 - \Psi) \hat{s}_t + \Psi \omega \frac{\epsilon A}{\epsilon} \hat{p}_{Mt} + \varphi \hat{\gamma}_t \right], \]

- Real Rigidity from VES (Ψ): identify through variations in \( \hat{p}_{Mt} \)

- Nominal Rigidity Index: \[ \kappa = \frac{(1 - \beta \theta)(1 - \theta)}{\theta} \]

- Firm Specific Capital: \[ \kappa_D = \kappa \gamma_D \quad \gamma_D = \frac{1}{(1 + \frac{\alpha}{1 - \alpha} \epsilon (1 - \Psi))} \]

- Special Cases:
  - CES: \( \Psi = 0 \)
  - Closed economy model: \( \omega = 0 \)
  - No Indexation: \( \delta_D = 0 \)
Empirical Methodology: Present-value Approach

- Forward Solution:

\[
\hat{\pi}_t = \delta_D \hat{\pi}_{t-1} + \kappa_D \sum_{k=0}^{\infty} \beta^k E_t \left[ (1 - \Psi) \hat{s}_{t+k} + \Psi \omega \frac{\epsilon A}{\epsilon} \hat{p}_{Mt+k} + \varphi \hat{\gamma}_{t+k} \right].
\]

- Let \( X_t \) be a vector of variables that includes \( s_t \) and \( p_{Mt} \). Write a VAR (companion form) as:

\[
X_t = AX_{t-1} + u_t,
\]

- We use VAR to forecast \( s_t \) and \( p_{Mt} \).
Baseline forecast-model (restricted VAR):

\[
\hat{\pi}_t = \delta D\hat{\pi}_{t-1} + \kappa_D \left[ \frac{1 - \Psi}{1 - \beta \rho_s} \hat{s}_t + \omega \frac{\epsilon_A}{\epsilon} \frac{\Psi (1 + \beta \phi_2 L)}{1 - \beta \phi_1 - \beta^2 \phi_2} \hat{p}_{Mt} \right] + \epsilon_{\pi t}
\]

\[
\hat{s}_t = \rho_s \hat{s}_{t-1} + u_{st}
\]

\[
\hat{p}_{Mt} = \phi_1 \hat{p}_{Mt-1} + \phi_2 \hat{p}_{Mt-2} + u_{Mt}
\]

- \(\epsilon_{\pi t}\), iid markup shock, generates endogeneity problem.
- We jointly estimate this system using GMM allowing for correlation between \(\epsilon_{\pi t}, u_{st}, u_{Mt}\).
- Approach avoids breaking cross-equation restrictions implied by a DGE model.
- Robustness: Alternative VAR specifications and moment conditions.
## Estimates of Open Economy Calvo Model

<table>
<thead>
<tr>
<th></th>
<th>VES with indexation</th>
<th>VES without indexation</th>
<th>CES with indexation</th>
<th>CES without indexation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \theta )</td>
<td>0.75 (0.03)</td>
<td>0.74 (0.03)</td>
<td>0.83 (0.03)</td>
<td>0.80 (0.04)</td>
</tr>
<tr>
<td>( \psi )</td>
<td>0.73 (0.11)</td>
<td>0.72 (0.12)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>( \delta_D )</td>
<td>0.10 (0.08)</td>
<td>0</td>
<td>0.34 (0.08)</td>
<td>0</td>
</tr>
<tr>
<td>Q-Statistic(4)</td>
<td>3.93 [0.42]</td>
<td>6.87 [0.14]</td>
<td>11.34 [0.02]</td>
<td>44.33 [0.00]</td>
</tr>
<tr>
<td>( g_{min} )</td>
<td>71.64</td>
<td>62.03</td>
<td>72.30</td>
<td>62.33</td>
</tr>
</tbody>
</table>
Interpreting the Estimate of $\psi$

When $\psi = 0.73$

- If price of good $i$ is 2%↑, demand 14% ↓, desired markup 6 PPt ↓.
- If price of good $i$ is 5%↑, demand 45% ↓, desired markup 12 PPt ↓.
- If import prices 10%↓, domestic desired markup 2 PPt ↓.

CKM use $\psi = 0.98$

- If price of good $i$ is 2%↑, demand 78% ↓.

If price of good $i$ is 2.3%↑, demand 100% ↓.
Actual and Predicted Inflation

- Observed Goods Price Inflation
- Predicted Inflation (VES, no indexation)
- Predicted Inflation (CES, no indexation)
Comparison of Benchmark Estimates and Calibrated Demand Curves in the Literature

<table>
<thead>
<tr>
<th></th>
<th>$\epsilon$</th>
<th>$\mu$</th>
<th>$\frac{\partial \epsilon(i)}{\partial pp(i)} \frac{1}{\epsilon}$</th>
<th>$\Psi$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benchmark Estimates</strong></td>
<td>6</td>
<td>1.2</td>
<td>13.7</td>
<td>0.73</td>
</tr>
<tr>
<td>Chari et al. (2000)</td>
<td>10</td>
<td>1.11</td>
<td>300</td>
<td>0.97</td>
</tr>
<tr>
<td>Coenen et al. (2004)</td>
<td>5–20</td>
<td>1.05-1.25</td>
<td>10–33</td>
<td>0.47–0.89</td>
</tr>
<tr>
<td>Eichenbaum and Fisher (2007)</td>
<td>11</td>
<td>1.1</td>
<td>10–33</td>
<td>0.5–0.77</td>
</tr>
<tr>
<td>Dossche et al. (2007)</td>
<td>1.4</td>
<td>3.5</td>
<td>0.8</td>
<td>0.67</td>
</tr>
<tr>
<td>Dotsey and King (2005)</td>
<td>10</td>
<td>1.11</td>
<td>60</td>
<td>0.87</td>
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<tr>
<td>Gust et al. (2006)</td>
<td>6</td>
<td>1.2</td>
<td>18.30</td>
<td>0.78</td>
</tr>
<tr>
<td>Bouakez (2005)</td>
<td>11</td>
<td>10</td>
<td>216</td>
<td>0.96</td>
</tr>
</tbody>
</table>
Monte Carlo Sampling Distribution of Estimates ($\psi = 0.67$)

Indexation, $\delta_D$

True value of $\psi = 0.67$

Calvo Probability, $\theta$

VES Specification
mean = 0.17
std = 0.10

CES Specification
mean = 0.26
std = 0.11

VES Specification
mean = 0.71
std = 0.06

CES Specification
mean = 0.79
std = 0.02

True Value = 0.16

True Value = 0.75
True value of $\psi = 0.67$

- Indexation, $\delta_D$
  - True Value = 0.16
  - VES Specification
    - mean = 0.17
    - std = 0.10
  - CES Specification
    - mean = 0.26
    - std = 0.11

- Calvo Probability, $\theta$
  - True Value = 0.75
  - CES Specification
    - mean = 0.79
    - std = 0.02
  - VES Specification
    - mean = 0.71
    - std = 0.06

True value of $\psi = 0.9$

- Indexation, $\delta_D$
  - True Value = 0.16
  - VES Specification
    - mean = 0.16
    - std = 0.09
  - CES Specification
    - mean = 0.47
    - std = 0.15

- Calvo Probability, $\theta$
  - True Value = 0.67
  - CES Specification
    - mean = 0.80
    - std = 0.04
  - VES Specification
    - mean = 0.59
    - std = 0.08
Alternative Estimation Approaches

Single-Equation Estimation:

\[ \hat{\pi}_t - \delta_D \hat{\pi}_{t-1} = \beta E_t[\hat{\pi}_{t+1} - \delta_D \hat{\pi}_t] + \kappa_D \left[ (1 - \Psi) \hat{s}_t + \Psi \omega \frac{\epsilon_A}{\epsilon} \hat{p}_{Mt} \right] + \epsilon_{\pi t}, \]

Closed-Form Estimation:

\[ \hat{\pi}_t = \delta_D \hat{\pi}_{t-1} + \kappa_D \left[ \frac{1 - \Psi}{1 - \beta \rho_s} \hat{s}_t + \omega \frac{\epsilon_A}{\epsilon} \frac{\Psi(1 + \beta \phi_2 L)}{1 - \beta \phi_1 - \beta^2 \phi_2} \hat{p}_{Mt} \right] + \epsilon_{\pi t} \]

\[ \hat{s}_t = \rho_s \hat{s}_{t-1} + u_{st} \]

\[ \hat{p}_{Mt} = \phi_1 \hat{p}_{Mt-1} + \phi_2 \hat{p}_{Mt-2} + u_{Mt} \]
Small-Sample Properties of GMM

Degree of Real Rigidity, $\psi$

True Value = 0.67
Closed-Form Estimates
mean = 0.76
std = 0.17

Indexation, $\delta_p$

True Value = 0.16
Closed-Form Estimates
mean = 0.17
std = 0.10
Single-Equation Estimates
mean = 0.20
std = 0.11

Calvo Probability, $\theta$

True Value = 0.75
Single-Equation Estimates
mean = 0.73
std = 0.09
Closed-Form Estimates
mean = 0.71
std = 0.06
Conclusions

• Foreign competition plays an important role in accounting for inflation dynamics.

• Neglecting foreign competition:

  1. 1 ppt. overestimate of goods price inflation over the period 2000-2006.

  2. Changes in foreign competition account for \( \frac{1}{3} \) of volatility of domestic goods price inflation.

• Estimates provide support for calibrated values of VES demand curves used in literature.

Future Work: Extend analysis to aggregate inflation dynamics.