Inflation Dynamics and the Cost Channel of Monetary Transmission

Ibrahim Chowdhury\textsuperscript{1,2} Mathias Hoffmann\textsuperscript{1,2} Andreas Schabert\textsuperscript{1,3}

\textsuperscript{1)University of Cologne, 2)Centre for Financial Research, 3)University of Amsterdam}
Introduction (1/4)

• Inflation dynamics within the New Keynesian approach

• Price rigidities are the *main* source for monetary non-neutrality

• Monetary policy affects inflation dynamics via changes in unit labour costs

→ predicting synchronous responses of output & prices to interest rate shocks

• Evidence for the NKPC (Galí & Gertler, 1999; Galí et al., 2001; Sbordone, 2002; Benigno and López-Salido, 2002)
Introduction (2/4)

- Structural changes in inflation solely rely on the aggregate ‘demand channel’ (Goodfriend and King, 1997)

- **Open question**: Role of financial market frictions for inflation dynamics

- Additional channel for monetary policy effects
  - interest rate changes affect the cost of working capital
  - interest rate hike with *ambiguous* effects on inflation:
    1) conventional demand channel lowers inflation
    2) rising costs of working capital tend to raise inflation
Introduction (3/4)

• ‘Cost channel’ amplifies the output contraction and mitigates the inflation response

• Evidence for the cost channel in the US
  → Barth & Ramey (2001) provide evidence for industrial data
  → Christiano et al. (2001) fit a general equilibrium model with a cost channel
  → Ravenna & Walsh (2003) estimate a forward looking Phillips curve
Introducing (4/4)

- This Paper:
  - re reassesses the role of the cost channel compared to the demand channel
  - estimates hybrid Phillips curves that allow for the cost channel
  - finds significant evidence in favour of a cost channel for the majority of G7 countries

- Existence of the cost channel burdens common monetary policy
The Model (1/3)

• Sticky price model augmented by a cost channel of monetary transmission

• Firms:

→ Monopolistically competitive firms: \( y_{it} = a l_{it}^{1-\alpha} x_{it}^{\alpha} \)

→ \( l_{it} \) is the firm specific labour input; \( a \) is the productivity level

→ \( x_{it} \) denotes raw material or commodities (exogenously given)

→ liquidity constraint on the factor markets: \( Z_{it} \geq P_t w_t l_{it} + P_t q_t x_{it} \)

→ Cost minimization implies

\[
R_t^l w_t = m c_{it} (1-\alpha) a l_{it}^{-\alpha} x_{it}^{\alpha} \implies m c_{it} = (1-\alpha)^{-1} R_t^l s_{it}
\]

→ where \( s_{it} = w_t l_{it} / y_{it} \)
The Model (2/3)

• Calvo's staggered price setting with backward indexation

\[ \hat{\pi}_t = \gamma_f E_t \hat{\pi}_{t+1} + \gamma_b \hat{\pi}_{t-1} + \chi m \hat{c}_t \]

• Financial Intermediaries

→ take deposits from households at the risk-free rate \( R_t = 1 + i_t \)
→ supply loans to firms at the lending rate \( R_t^l = 1 + i_t^l \)
→ gross return: \( R_t^l [1 - \Psi (R_t)] Z_t \)
→ interpretation: Likelihood of default increases with \( R_t \)
→ profit maximization then leads to

\[ \hat{R}_t^l = (1 + \psi_R) \hat{R}_t \quad \text{where} \quad \psi_R = \Psi_R R / \Psi \]
The supply side of the model can be summarized by an interest-rate-augmented Phillips curve:

\[
\hat{\pi}_t = \gamma_f E_t \hat{\pi}_{t+1} + \gamma_b \hat{\pi}_{t-1} + \chi \hat{S}_t + \chi (1 + \psi_R) \hat{R}_t
\]

- Increase in the central bank interest rate above its steady state value, induces firms to raise their prices such that the current inflation rate exceeds its steady state value.
Empirical Evidence (1/8)

• Our benchmark empirical specification takes the following form:

\[ \hat{\pi}_t = \gamma_f E_t \hat{\pi}_{t+1} + \gamma_b \hat{\pi}_{t-1} + \gamma_s \hat{s}_t + \gamma_R \hat{R}_t + \nu_t \]

• Estimations are carried out for G7 countries; 1980:1 - 1997:4

• OECD Business Sector database, the IMF's IFS database, & BLS

• Inflation is measured by the GDP deflator and CPI

• Real unit labour costs are constructed as the ratio of total real compensation to GDP; interest rates are measured by three-month t-bill rates

• Estimation technique: Generalized Method of Moments (GMM)
Empirical Evidence (2/8)

<table>
<thead>
<tr>
<th>Country</th>
<th>$\hat{\gamma}_f$</th>
<th>$\hat{\gamma}_b$</th>
<th>$\hat{\gamma}_s$</th>
<th>$\hat{\gamma}_R$</th>
<th>$\hat{\gamma}_R/\hat{\gamma}_s$</th>
<th>$J - Test$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>0.71 (0.016)</td>
<td>0.27 (0.015)</td>
<td>0.015 (0.005)</td>
<td>0.017 (0.002)</td>
<td>1.1</td>
<td>0.56</td>
</tr>
<tr>
<td>France</td>
<td>0.54 (0.009)</td>
<td>0.33 (0.007)</td>
<td>0.099 (0.008)</td>
<td>0.024 (0.008)</td>
<td>0.2</td>
<td>0.53</td>
</tr>
<tr>
<td>Germany</td>
<td>0.53 (0.057)</td>
<td>0.47 (0.033)</td>
<td>0.012 # (0.008)</td>
<td>0.005 # (0.022)</td>
<td>—</td>
<td>0.40</td>
</tr>
<tr>
<td>Italy</td>
<td>0.48 (0.001)</td>
<td>0.50 (0.001)</td>
<td>0.010 (0.001)</td>
<td>0.015 (0.001)</td>
<td>1.5</td>
<td>0.62</td>
</tr>
<tr>
<td>Japan</td>
<td>0.77 (0.082)</td>
<td>0.18 (0.065)</td>
<td>0.005 # (0.010)</td>
<td>0.024 # (0.066)</td>
<td>—</td>
<td>0.74</td>
</tr>
<tr>
<td>UK</td>
<td>0.48 (0.041)</td>
<td>0.33 (0.059)</td>
<td>0.058 (0.024)</td>
<td>0.076 (0.022)</td>
<td>1.3</td>
<td>0.31</td>
</tr>
<tr>
<td>US</td>
<td>0.39 (0.016)</td>
<td>0.53 (0.013)</td>
<td>0.024 (0.012)</td>
<td>0.030 (0.009)</td>
<td>1.3</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Notes: (..) standard errors, # not significant at the 10% level
Empirical Evidence (3/8)

• Conventional part: Significant coefficients on
  - future and lagged inflation (backward lookingness more pronounced in the US than in Europe, as in Gali et al., 2001)
  - real unit labor costs (exceptions: Germany and Japan)

• Direct interest rate effects measured by $\gamma_R$
  - significant in Canada, France, Italy, the UK and the US
  - no significant interest rate effects in Germany and Japan

• Pass-through and acceleration effects: ratio of coefficients $\gamma_R/\gamma_S$
  - Canada, Italy, UK and US: Acceleration $\gamma_R/\gamma_S >1$
  - imperfect pass-through in France $\gamma_R/\gamma_S = 0.2$
### Empirical Evidence (4/8)

#### Table 2: Estimates of the Interest-rate-augmented Phillips-Curve (CPI-based)

<table>
<thead>
<tr>
<th>Country</th>
<th>$\tilde{\gamma}_f^{cpi}$</th>
<th>$\tilde{\gamma}_b^{cpi}$</th>
<th>$\tilde{\gamma}_s^{cpi}$</th>
<th>$\tilde{\gamma}_R^{cpi}$</th>
<th>$\tilde{\gamma}_R^{cpi}/\tilde{\gamma}_s^{cpi}$</th>
<th>$J - T_{est}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>0.48 (0.049)</td>
<td>0.46 (0.039)</td>
<td>0.029 #</td>
<td>0.049 *</td>
<td>1.7</td>
<td>0.13</td>
</tr>
<tr>
<td>France</td>
<td>0.46 (0.002)</td>
<td>0.50 (0.010)</td>
<td>0.027</td>
<td>0.013 *</td>
<td>0.5</td>
<td>0.63</td>
</tr>
<tr>
<td>Germany</td>
<td>0.31 (0.001)</td>
<td>0.68 (0.002)</td>
<td>0.010</td>
<td>0.004</td>
<td>0.4</td>
<td>0.27</td>
</tr>
<tr>
<td>Italy</td>
<td>0.41 (0.026)</td>
<td>0.56 (0.029)</td>
<td>0.006 #</td>
<td>0.031 #</td>
<td>—</td>
<td>0.62</td>
</tr>
<tr>
<td>Japan</td>
<td>0.65 (0.036)</td>
<td>0.40 (0.027)</td>
<td>0.005 #</td>
<td>0.003 #</td>
<td>—</td>
<td>0.80</td>
</tr>
<tr>
<td>UK</td>
<td>0.44 (0.004)</td>
<td>0.48 (0.006)</td>
<td>0.048</td>
<td>0.077</td>
<td>1.6</td>
<td>0.61</td>
</tr>
<tr>
<td>US</td>
<td>0.31 (0.009)</td>
<td>0.62 (0.008)</td>
<td>0.036</td>
<td>0.030</td>
<td>0.8</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Notes: (..) standard errors, * significant at the 10% level, # not significant.
Empirical Evidence (5/8)

• Similar results for CPI-based estimates
  - direct interest rate effects in Canada, the UK, and the US
  - imperfect pass-through in France and Germany
  - insignificant direct interest rate effects for Japan and Italy

• Conclusions from the results in table 1 and 2:
  - significant cost channel effects in the majority of G7 countries
  - small or insignificant cost channel in France, Germany & Japan
Empirical Evidence (6/8)

- Three alternative specifications:
  1. standard (hybrid) New Keynesian Phillips curve
  2. simultaneous estimation with an interest rate feedback rule
  3. inclusion of commodity prices in the Phillips curve

- Alternative hypothesis for significant interest rate effects
  - reverse causality: monetary policy rate is raised with inflation
  - do short-term interest rates serve as a proxy for future inflation?
Empirical Evidence (7/8)

Table 3: Estimates of the standard (hybrid) New Keynesian Phillips-Curve (GDP-deflator)

<table>
<thead>
<tr>
<th>Country</th>
<th>$\hat{\gamma}_{fn}^k$</th>
<th>$\hat{\gamma}_b^k$</th>
<th>$\hat{\gamma}_{sn}^k$</th>
<th>$J - Test$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>0.54 (0.021)</td>
<td>0.45 (0.016)</td>
<td>0.017* (0.009)</td>
<td>0.21</td>
</tr>
<tr>
<td>France</td>
<td>0.63 (0.029)</td>
<td>0.47 (0.014)</td>
<td>0.021 (0.004)</td>
<td>0.45</td>
</tr>
<tr>
<td>Germany</td>
<td>0.67 (0.090)</td>
<td>0.35 (0.062)</td>
<td>0.075 (0.023)</td>
<td>0.25</td>
</tr>
<tr>
<td>Italy</td>
<td>0.37 (0.023)</td>
<td>0.58 (0.013)</td>
<td>0.018 (0.003)</td>
<td>0.54</td>
</tr>
<tr>
<td>Japan</td>
<td>0.64 (0.003)</td>
<td>0.36 (0.004)</td>
<td>0.012 (0.001)</td>
<td>0.22</td>
</tr>
<tr>
<td>UK</td>
<td>0.59 (0.044)</td>
<td>0.35 (0.051)</td>
<td>0.031* (0.022)</td>
<td>0.31</td>
</tr>
<tr>
<td>US</td>
<td>0.38 (0.018)</td>
<td>0.54 (0.016)</td>
<td>0.068 (0.005)</td>
<td>0.54</td>
</tr>
</tbody>
</table>

Notes: (..) standard errors, * significant at the 10% level, ≠ not significant.
Empirical Evidence (8/8)

• Pass-through of changes in the monetary policy rate to short-run market rates and bank lending rates is essential:

• The cost channel evidence relates to financial structures:
  1) “Market-based systems” (Canada, UK, and US)
  2) “Bank-based systems” (Germany, France, and Japan)

Monetary Policy and the Cost Channel (1/2)

• The model is completed by a specification of optimising households and a public sector, setting the interest rate according to a simple Taylor-rule.

• A rational expectations equilibrium for the log-linear model satisfies

\[ \hat{\pi}_t = \gamma_f E_t \hat{\pi}_{t+1} + \gamma_b \hat{\pi}_{t-1} + \gamma_y \hat{y}_t + \gamma_R \hat{R}_t \quad \gamma_y > 0, \gamma_R > 0 \]

\[ \sigma \hat{\gamma}_t = \sigma E_t \hat{y}_{t+1} - \hat{R}_t + E_t \hat{\pi}_{t+1} \]

\[ \hat{R}_t = \rho_\pi \hat{\pi}_t + \epsilon_t \]
Monetary Policy and the Cost Channel (2/2)

- Cost channel (CC) introduces a wedge between $\pi$ and $y$ responses
- Suppose that the economy is hit by a contractionary monetary policy shock:
  → Then the decline in inflation is mitigated and the decline in output is accelerated by higher values for $\gamma_R$
  → The impact of the cost channel is more pronounced for higher values of the elasticity $\psi_R$
  → Inflation can even rise in response to higher interest rates, if there is a strong CC and a weak demand channel, which requires
    (1) a high degree of risk aversion (high $\sigma$) or,
    (2) a high degree of labour supply elasticity (low $\sigma_l$)
Simulations (1/5)

• Idea: To quantify the contribution of the cost channel to inflation dynamics

• Impulse responses of inflation to interest rate shocks are computed
  → by using the point estimates of the aggregate supply constraint;
  → by setting $\beta = 0.99$; $1-\alpha = 0.67$; $\rho_\pi = 1.5$.
  → we consider three alternative settings:
    1) $\sigma = \sigma_1 = 1$; benchmark specification
    2) $\sigma = 2$, $\sigma_1 = 1$; degree of household’s risk aversion is raised
    3) $\sigma = 2$, $\sigma_1 = 0$; labour supply elasticity equals infinity
• Case 1: $\sigma = \sigma_l = 1$: Cost channel dampens the decline of inflation
Simulations (3/5)

- Case 2: $\sigma = 2; \sigma_1 = 1$: Cost channel becomes even more pronounced
• Case 3: $\sigma = 2; \sigma_1 = 0$: A positive interest rate innovation can now even lead to a rise in inflation – also known as price puzzle
Simulations (5/5)

- When the cost channel is associated with a less pronounced demand channel, inflation might even rise in response to monetary tightening.
- The price puzzle has broadly been viewed as being particular to inappropriate VAR identifications schemes (see Sims, 1991).
- According to recent evidence for the US, the inverse price response does not fully vanish (see Christiano et al., 1999).
- Barth and Ramey (2001) suggest the cost channel of monetary transmission as a solution for the price puzzle
- Positive price responses to interest rate hikes are an implication of pronounced direct interest rate effects on firms' costs.
Conclusion

• Interest rate policy can have a direct bearing on prices via the so-called cost channel of monetary transmission.

• Structural approach, i.e., a marginal cost based Phillips curve

• Broad evidence in favour of the cost channel in the majority of G7 countries

• The strength of the cost channel is related to differences in financial structure.

• The simulation analysis revealed that the estimated direct interest rate effects can substantially mitigate the inflation response, and are even able to account for the price puzzle.