The views expressed should not be interpreted as reflecting the views of the Federal Reserve System or its staff.
Classic balance-of-payment crisis:

▶ The mix of overvalued RERs and cheap credit fueled by economic optimism led to over- and mal-investment.
▶ After the Global Financial Crisis came a sudden stop.

Resolution of the crisis:

▶ Realignment of overvalued RERs.
▶ The mix of deflation in the “south” and reflation in the “north.”
▶ Surprisingly hard to achieve—why?
Empirics:
- Firms with strong balance sheets slashed prices.
- Firms with weak balance sheets raised prices.

Theory:
- Develops a GE model that can replicate such patterns.
- Emphasizes the interaction between financial market frictions and firms’ pricing decisions in customer markets.
Producer Price Inflation

Exhibit 1: Introduction

- What accounts for the resilience of inflation in the face of significant and long-lasting economic slack?
- The question is difficult to square with the Phillips curve common to most macroeconomic models.

Cyclical Dynamics of Producer Prices and Industrial Production

-24 -16 -8 0 8 16 24
-30
-25
-20
-15
-10
-5
0
5
Percentage points

Core producer prices*

Peak: Jan1980
Peak: Jul1981
Peak: Jul1990
Peak: Mar2001
Peak: Dec2007

Months to and from business cycle peaks

Industrial production*

Peak: Jan1980
Peak: Jul1981
Peak: Jul1990
Peak: Mar2001
Peak: Dec2007

Months to and from business cycle peaks

* Deviations from a linear trend estimated over the 24 months preceding the specified recession.

Economic forces that dampen the response of inflation to adverse demand or financial shocks reflect the interaction between customer markets and financial frictions:

- Customer markets: markets in which customer base is "sticky" and an important determinant of firm's assets and firm's ability to generate profits
- Financial frictions: systematic countercyclical wedge between the cost of external and internal finance due to asymmetric information or moral hazard problems in financial markets
Relative Inflation
Financially unconstrained vs constrained firms

Note: Weighted average monthly inflation relative to industry (2-digit NAICS) inflation.
Quantile regression estimates

Quantile

Estimate

95% confidence interval

OLS estimate
Inflation Response to EBP

Exhibit 4: Is This a One-Off Event?

- Use detailed industry-level PPIs to examine the sensitivity of inflation to changes in aggregate financial conditions during the 1973 - 2013 period.

- Current and lagged inflation
- Current and lagged growth in industry-level industrial production
- Current commodity price inflation measured by GSCI

- Coefficients on EBP and commodity price inflation vary across 4-digit industry groups.
- Is variation in industry-specific EBP coefficients related to the likelihood of financial constraints across industries?

Empirical approach

Regress industry-specific year-ahead inflation on

Indicator of current financial conditions - excess bond premium (EBP)

Use industry-specific size-age index to identify the likelihood of financial constraints

Coefficient on EBP (4-digit NAICS)

Median Size-Age Index (4-digit NAICS)

\[ \beta = 1.11 \]

\[ |t| = 4.88 \]

\[ R^2 = 0.29 \]

Note: Smaller values of the size-age index indicate a smaller likelihood of financial constraints.

12-month PPI inflation and financial conditions

By industry-specific indicator of financial constraints

Coefficients on EBP and commodity price inflation

Coefficient on GSCI (4-digit NAICS)

Median Size-Age Index (4-digit NAICS)

\[ \beta = 0.01 \]

\[ |t| = 1.39 \]

\[ R^2 = 0.03 \]

Note: Smaller values of the size-age index indicate a smaller likelihood of financial constraints.
Output Response to EBP

Figure 7: Sensitivity of Industry-Level Output to Financial Conditions, 1973–2013
(By Industry-Specific Indicator of Financial Constraints)

Coefficient on EBP

p < .10
p >= .10

β = -1.88
|t| = -3.77
R-sq = 0.22

Note: No. of (4-digit NAICS) industries = 52. The figure shows the relationship between the median SA-index of financing constraints at the 4-digit NAICS level during the 1973–2013 period and the corresponding industry-specific estimates of the coefficient on the EBP; the dependent variable is ∆log IP, the log-difference of IP in (5- or 6-digit NAICS) industry from t to t + 12 (see the text and notes to Table 3 for details). Observations plotted as diamonds (♦) indicate coefficients that are different from zero at the 10-percent, or lower, significance level; observations plotted as stars (*) are statistically not different from zero at the 10-percent level. Smaller values of the size-age index indicate a smaller likelihood of financial constraints.

3.1.1 Subsample Stability

The results reported in Table 2 are based on the behavior of producer prices from 1973 to 2013, a period encompassing several distinct inflation regimes. This period also saw significant changes in the conduct of monetary policy, which—in addition to breaking the inflationary spiral of the 1970s—have ultimately led to the stabilization of inflation expectations, a crucial determinant of the firms’ pricing behavior. To ensure that our results are robust to this change in inflation expectations, this section repeats the above analysis for post-1985 period.

As shown in Table 4, the effect of changes in financial conditions on the subsequent behavior of producer prices during the 1985–2013 period is very similar to that estimated over the full sample period. Imposing a restriction of a common coefficient on the EBP (Panel (a)) yields estimates that...
### Inflation and Output Dynamics in the Eurozone

#### Panel-version of the NK Phillips curve:

\[
\pi_{it} = 0.449 \left( E_t \pi_{i,t+1} + 0.533 \pi_{i,t-1} + 0.104 (y_{it} - \bar{y}_{it}) + \hat{\eta}_i + \hat{\epsilon}_{it} \right)
\]

- CORE, DEU, BEL, FIN, FRA, NLD, GRC, IRL, ITA, ESP, PRT
- Annual data: 1970–2014 (unbalanced panel, Obs. = 429)
- Is lack of deflationary pressures related to financial strains?
Inflation and Output Dynamics in the Eurozone

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\]

- AUT, DEU, BEL, FIN, FRA, NLD, GRC, IRL, ITA, ESP, PRT
- Annual data: 1970–2014 (unbalanced panel, Obs. = 429)

### Summary of Inflation and Output Gap (\%):

<table>
<thead>
<tr>
<th></th>
<th>1992-2008</th>
<th></th>
<th>2009-2014</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Core</td>
<td>GIIPS</td>
<td>Core</td>
<td>GIIPS</td>
</tr>
<tr>
<td>Avg. inflation (%)</td>
<td>1.58</td>
<td>3.34</td>
<td>1.22</td>
<td>0.66</td>
</tr>
<tr>
<td>Avg. output gap (%)</td>
<td>0.32</td>
<td>0.81</td>
<td>-1.38</td>
<td>-4.88</td>
</tr>
</tbody>
</table>

- Is lack of deflationary pressures related to financial strains?
Inflation Dynamics and Financial Strains
Sample Period: 2008-2014

Sovereign (5-year) CDS Spreads at $t$ (pps., log scale)
Inflation Residuals at $t+1$ (pct.)

GIIPS
Core
0.5 1 5 10 20
In this paper, we extend the theoretical framework to two-country GE.

Study the consequences of forming a currency union among countries with heterogeneous financial conditions.

**Price War**

- During periphery’s liquidity crisis, core has a strong incentive to slash markup to gain market share both home and abroad.
- In contrast, periphery is forced to raise prices to secure cashflow, cannibalizing its own future market share.

**Self-Reinforcing Crisis**

- Possibility of RERs to appreciate for periphery rather than for core, a feedback loop that reinforces the liquidity crisis of periphery.
**Policy Options**

- **Fiscal Union:**
  - Trading state-contingent bonds among heterogeneous countries.
  - Highly beneficial to periphery but requires large transfers from core.
  - Are the costs of fiscal union bearable by core countries?

- **Fiscal Devaluation:**
  - Certain mixes of fiscal instruments replicate the devaluation.
  - When can a unilateral fiscal devaluation be beneficial to core?
  - Depends on the strength of externality created by financial friction.
Two countries: home \((h = \text{south})\) and foreign \((f = \text{north})\)

Continuum of households in each country: \(j \in N_c \equiv [0, 1]\)

Two types of goods:

- Home goods \((h)\): \(c_{i,h,t}^j, i \in N_h \equiv [1, 2]\)
- Foreign goods \((f)\): \(c_{i,f,t}^j, i \in N_f \equiv [2, 3]\)

CRRA in habit-adjusted consumption basket \(x_t^j\): \[E_t \sum_{s=0}^{\infty} \beta^s U(x_{t+s}^j, h_{t+s}^j); \ j \in [0, 1]\]

- Labor \((h)\) is immobile
Armington-Ravn-Schmitt-Grohe-Uribe aggregator:

\[ x_t^j = \left[ \sum_{k=h,f} \omega_k \left[ \int_{N_k} (c_{i,k,t}^j s_{i,k,t-1}^\theta)^{1-1/\eta} \, dk \right]^{\frac{1-1/\epsilon}{1-1/\eta}} \right]^{1/(1-1/\epsilon)} \]

- \( \eta \) = elasticity of substitution within a type of goods
- \( \epsilon \) = elasticity of substitution between types of goods
- \( \theta > 0 \) governs the strength of deep habits
- \( 0 < \omega_k < 1 \) governs the degree of home bias in consumption

Law of motion for deep habits:

\[ s_{i,k,t} = \rho s_{i,k,t-1} + (1 - \rho) \int_{N_c} c_{i,k,t}^j \, dj; \quad k = h, f \]

- “Keeping up with the Joneses” at the good level.
Armington-Ravn-Schmitt-Grohe-Uribe aggregator:

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\]

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\]

- “Keeping up with the Joneses” at the good level.
Continuum of monopolistically competitive firms producing variety of differentiated goods of type \( h \) and type \( f \).

Production function (labor input, fixed operating costs):

\[
y_{it} = c_{i,h,t} + c^*_{i,h,t} = \left( \frac{A_t}{a_{it}} h_{it} \right)^{\alpha} - \phi; \quad i \in N_h \ (0 < \alpha \leq 1)
\]

- \( A_t \) = persistent aggregate technology shock
- \( a_{it} \) = i.i.d. idiosyncratic shock w/ \( \log a_{it} \sim N(-0.5\sigma^2, \sigma^2) \)
- \( \phi \) = servicing cost of fixed coupon long-term debt

Heterogeneity in financial capacity: \( \phi > \phi^* = 0 \)
Financial frictions: costly external equity financing

- New shares sold at a discount because of asymmetric information
  - €1 claim raises only €\((1 - \varphi_t)\) of funds
- “Lemons premium” \(\varphi_t \sim \text{AR}(1)\) \(\Rightarrow\) financial shock
  - Makes expected shadow value of internal funds, \(\mathbb{E}_t^{a}[\zeta_{it}] > 1\)

Nominal rigidities: quadratic cost of adjusting nominal prices

Local currency pricing: law of one price does not apply
Deep habits make investment in market share profitable:
  ▶ Investment takes the form of low markups, which exposes firms to liquidity risk.
  ▶ Optimal pricing strategy strikes the right balance.

Price war:
  ▶ Liquidity crisis in the South is a good time for firms in the North to steal market share by undercutting competitors’ prices in the south.

“Mr. Marchionne and other auto executives accuse Volkswagen of exploiting the crisis to gain market share by offering aggressive discounts. “It’s a bloodbath of pricing and it’s a bloodbath on margins,” he said.”

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Assume flexible prices and no customer markets.

When $\alpha = 1$, optimal pricing (home market) $\Rightarrow$

$$p_{i, h, t} = \frac{\eta}{\eta - 1} \times \frac{\mathbb{E}_{t}[\xi_{it}a_{it}]}{\mathbb{E}_{t}[\xi_{it}]} \times \frac{w_{t}/p_{h, t}}{A_{t}}$$

- accounting markup
- economic markup
- real marginal cost

Financial frictions $\Rightarrow$

$$\frac{\mathbb{E}_{t}[\xi_{it}a_{it}]}{\mathbb{E}_{t}[\xi_{it}]} = 1 + \text{Cov}[\xi_{it}a_{it}] \geq 1$$
Optimal Pricing with Deep Habits

- Bring back customer markets (still flexible prices!)
- Growth-adjusted, compounded discount rate:

\[
\tilde{\beta}_{t,s} \equiv m_{s,s+1} \frac{s_{h,s+1}/s_{h,s} - \rho}{1 - \rho} \\
\times \prod_{j=1}^{s-t} \left[ \rho + \chi \frac{s_{h,t+j}/s_{h,t+j-1} - \rho}{1 - \rho} \right] m_{t+j-1,t+j}
\]

- Optimal pricing \(\Rightarrow\)

\[
p_{i,h,t} = \frac{\eta}{\eta - 1} \left[ \frac{\mathbb{E}_t^a[\xi_{it}\alpha_{it}]}{\mathbb{E}_t^a[\xi_{it}]} \left[ \frac{w_t/p_{h,t}}{A_t} \right] \\
- \frac{\chi}{\eta - 1} \mathbb{E}_t \left[ \sum_{s=t+1}^{\infty} \tilde{\beta}_{t,s} \frac{\mathbb{E}_s^{a[\xi_{i,s}]}/\mathbb{E}_t^{a[\xi_{i,t}]} (p_{h,s} - w_s/p_{h,s})}{A_s} \right] \right]
\]
Optimal Pricing with Deep Habits

- Bring back customer markets (still flexible prices!)

- Growth-adjusted, compounded discount rate:

\[
\tilde{\beta}_{t,s} \equiv m_{s,s+1} \frac{s_{h,s+1}/s_{h,s} - \rho}{1 - \rho} \\
\times \prod_{j=1}^{s-t} \left[ \rho + \chi \frac{s_{h,t+j}/s_{h,t+j-1} - \rho}{1 - \rho} \right] m_{t+j-1,t+j}
\]

- Optimal pricing ⇒

\[
p_{i,h,t} = \frac{\eta}{\eta - 1} \frac{\mathbb{E}^a_t[\zeta_{it}a_{it}]}{\mathbb{E}^a_t[\zeta_{it}]} \left[ \frac{w_t/p_{h,t}}{A_t} \right] \\
- \frac{\chi}{\eta - 1} \mathbb{E}_t \left[ \sum_{s=t+1}^{\infty} \tilde{\beta}_{t,s} \frac{\mathbb{E}^a_s[\zeta_{i,s}]}{\mathbb{E}^a_t[\zeta_{i,t}]} \left( p_{h,s} - \frac{w_s/p_{h,s}}{A_s} \right) \right]
\]
## Calibration

<table>
<thead>
<tr>
<th>Key Model Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferences &amp; Technology</strong></td>
<td></td>
</tr>
<tr>
<td>deep habit ((\theta))</td>
<td>0.90</td>
</tr>
<tr>
<td>persistence of deep habit ((\rho))</td>
<td>0.90</td>
</tr>
<tr>
<td>elasticity of substitution b/w and w/in goods ((\eta, \epsilon))</td>
<td>2.00, 1.50</td>
</tr>
<tr>
<td>fixed operating costs ((\phi, \phi^*))</td>
<td>0.08, 0.00</td>
</tr>
<tr>
<td><strong>Nominal Rigidities</strong></td>
<td></td>
</tr>
<tr>
<td>price adjustment cost ((\gamma_p))</td>
<td>10.0</td>
</tr>
<tr>
<td>wage adjustment cost ((\gamma_w))</td>
<td>30.0</td>
</tr>
<tr>
<td><strong>Financial Frictions</strong></td>
<td></td>
</tr>
<tr>
<td>equity dilution cost ((\varphi), \mathbb{E}^a[\xi_i] = 1.12,)</td>
<td>0.30</td>
</tr>
<tr>
<td>idiosyncratic volatility, a.r. ((\sigma))</td>
<td>0.10</td>
</tr>
<tr>
<td>persistence financial shock ((\rho_{\varphi}))</td>
<td>0.90</td>
</tr>
</tbody>
</table>
Implications of a Financial Shock in the South

In a monetary union \( (\phi = 0.08, \phi^* = 0.00) \)

Red = Foreign (North), Blue = Home (South)

NER (\(\cdot\cdot\cdot\)) and RER (\(-\)) are Home/Foreign
Implications of a Financial Shock in the South
Under floating exchange rates ($\phi = 0.08$, $\phi^* = 0.00$)

Red = Foreign (North), Blue = Home (South)

NER (- - -) and RER (-) are Home/Foreign
Figure: Financial Shock, Relative Prices and Market Shares

(a) relative price
home markets, pct

(c) market share,
home markets, pct

(e) wage inflation, pp

(b) relative price
foreign markets, pct

(d) market share
foreign markets, pct

(f) markup, pct

- home, floating
- foreign, floating
- home, union
- foreign, union
Some Evidence: Market Share Dynamics During the Crisis

2010Q1 = 1.0

Figure 8: Euro-zone Market Share Dynamics

Portugal Export to Germany GDP
Germany Export to Portugal GDP

Italy Export to Germany GDP
Germany Export to Italy GDP

Greece Export to Germany GDP
Germany Export to Greece GDP

Spanish Export to German GDP
German Export to Spanish GDP

Note: Blue lines show the ratios of nominal values of export from Portugal, Italy, Greece and Spain to Germany relative to Germany’s nominal GDP. Red lines show the ratios of nominal values of German exports to these countries relative to these countries’ nominal GDPs. Export exclude energy, commodities and agricultural products. The ratios are normalized to one in 2010Q1.

The first and second rows of table 4 show that the welfare levels of both home and foreign countries deteriorate by adopting a common currency. To put this result in perspective, we also report the consumption equivalent in the third column of the table, which is formally defined as the required increase in average consumption per period to make the agent living in an economy with the common currency indifferent with transitioning to an economy with the floating exchange rate. While the sign of the certainty equivalent change in consumption is intuitive, the degree of
Heterogeneity As a Propagation Mechanism

In a monetary union

- Alternative calibration: $\phi = \phi^* = 0.08$
- Financial shocks in both North and South.

![Graphs showing the response of GDP and consumption to financial shocks](image)

Alternative = (●●●) and Baseline = (−)
- Dramatic reduction in consumption volatility
- Requires large wealth transfers from the north to the south.

Figure: Financial Shock, Monetary Union and Complete Risk Sharing
### Gains vs Losses of Fiscal Union

#### Table: Costs and Benefits of Complete Risk Sharing

<table>
<thead>
<tr>
<th></th>
<th>Welfare</th>
<th>Con Equiv</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MU (A)</td>
<td>Risk Sharing (B)</td>
<td>Percent</td>
</tr>
<tr>
<td>Home country</td>
<td>−274.86</td>
<td>−253.21</td>
<td>10.28</td>
</tr>
<tr>
<td>Foreign country</td>
<td>−217.86</td>
<td>−236.96</td>
<td>−9.13</td>
</tr>
<tr>
<td>Joint welfare</td>
<td>−492.82</td>
<td>−490.17</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: The consumption equivalent is the required minimum increase in average consumption per period holding labor hours constant to make the representative agent living in the economy under the floating exchange rate regime no worse off by transitioning to the currency union.
We consider a simple VAT-payroll subsidy swap rule:

\[ \text{VAT}(\tau^V_t) + \text{payroll subsidy}(\varsigma^P_t) \]

FD rules that are linear in the resource gap of the home country:

\[ \tau^V_t = \alpha^{FD} \times \log \left( \frac{y_t}{\bar{y}} \right) \]

Is there a parameter region that is mutually beneficial to both home and foreign countries?
Fiscal Devaluation vs Flexible Exchange Rates

\[ \alpha^{FD*} = \arg \max_{\alpha^{FD}} \left\{ U(x_t - \delta_t, h_t) + \beta E_t[V(s_{t+1})] \right\} \]

**Figure:** Monetary Union w/ and w/o optimal FD vs Floating
Welfare for the Core

As financial frictions in the periphery change

(a) The effect of fixed cost

\[ \Delta W^* \]

- \( \phi = 0.00 \)
- \( \phi = 0.05 \)
- \( \phi = 0.10 \)
- \( \phi = 0.15 \)

(a) The effect of issuance cost

\[ \Delta W^* \]

- \( \varphi = 0.00 \)
- \( \varphi = 0.10 \)
- \( \varphi = 0.20 \)
- \( \varphi = 0.30 \)
When firms engage in market share competitions, differences in financial capacity across countries imply strong amplification mechanism: “beggar-thy-neighbor” at the micro-level.

Monetary union impedes adjustment of RERs and exacerbates the downturn in response to an adverse financial shock.

Unilateral fiscal devaluation by periphery may be welfare improving for both periphery and core.