Questions

- Is pass-through of exchange rates into import prices asymmetric? Is it non-linear?
- If these asymmetries or non-linearities exist, do they tell us something about market structure or the nature of demand?
We show that this pass-through is asymmetric: foreign appreciations tend to pass through faster.

- This result is unlikely to stem from a selection effect causing product exit, but price stickiness may be important in some cases.

The importance of this asymmetry varies by sector, suggesting that the nature of competition and price setting plays a role.

We find no statistically significant non-linearities.

Using trade value data, implied trade quantity response is stronger for foreign depreciations after 1 year.
Existing literature

- The standard pass-through regression (everything in logs):

\[ \Delta p_t = \alpha + \beta \Delta e_t + \delta \Delta c_t + \epsilon_t \]  

- \( e \) defined as dollar per foreign currency.

- What has been established in the literature?
  - Pass-through of exchange rates into U.S. import prices is incomplete and fairly low.
    - Aggregate long-run pass-through elasticity around 0.4 (Campa and Goldberg 2005); product-level elasticity is similar (Gopinath and Itskhoki, 2010).
    - Pass-through is low even conditional on a price change. (Gopinath and Itskhoki, 2010)
  - Pass-through has been declining secularly since the 70s. (Marazzi, 2005)

More literature
Data

- We use monthly product-level prices from the BLS International Price Program (IPP) for years 1994-2014.
- Other data: foreign CPI, exchange rates (IFS), commodity prices (IMF)
BLS data

- Probability proportionate to size sampling at the reporter/item level
- Reported prices
  - Raw data includes list prices, transaction prices, estimated prices, including intrafirm prices.
- Net prices
  - Reflect dollar-denominated transaction prices, by making any necessary adjustments to reported prices.
  - Missing prices are estimated using various methods.
- Excluded from this study - estimated, non-usable, intrafirm, services, petroleum, dollar pegs.
Asymmetries in pass-through

- We augment a standard pass-through regression to separately respond to bilateral exchange rate appreciations and depreciations. For product $i$ in country $j$ at time $t$ (monthly), we estimate:

$$\Delta p_{i,j,t} = \sum_{k=0}^{18} \{ \beta_k^+ \Delta e^+_{j,t-k} + \beta_k^- \Delta e^-_{j,t-k} \} + [...] + \epsilon_{i,j,t} \quad (2)$$

- Country x stratum dummies, monthly time dummies, foreign CPI are controls.

- The impulse response of a price at horizon $h$ after an exchange rate shock is simply $\sum_{k=0}^{h} \beta_k^+$ or $\sum_{k=0}^{h} \beta_k^-$
Asymmetry results

- Across all goods, pass-through for foreign appreciations (+) is faster than for foreign depreciations (−), but the pass-through at 18 months is the same:

95% confidence bands plotted for difference.
Asymmetry results (cont.)

- Across sectors for goods that Rauch (1999) identifies as differentiated goods, asymmetries are more pronounced:

95% confidence bands plotted for difference.
Issue 1: Nominal rigidities

- Differences in the speed of pass-through suggest that they may be caused by differences in price adjustment.
- If foreign appreciations cause foreign firms to adjust prices faster, the pass-through would be faster.
Controlling for price stickiness: MRPT

Following Gopinath, et al. (2010), we can eliminate the effect of nominal price rigidities on pass-through estimates by focusing on what they call medium-run pass-through (MRPT), where subscript $c$ denotes the cumulative change between time $t$ and the last price change $t-k$ for good $i$ from country $j$:

$$\Delta p_{i,j,c} = \beta^+ \Delta e^+_{j,c} + \beta^- \Delta e^-_{j,c} + \Delta Z_c + \epsilon_{i,t}$$  \hspace{1cm} (3)$$

Unfortunately, this makes time dummies fairly unnatural, and so we include other explanatory variables $\Delta Z$ like the U.S. CPI and a measure of global non-oil commodity prices. Country/strata fixed effects are still included.
### MRPT results

<table>
<thead>
<tr>
<th></th>
<th>Depreciation</th>
<th>Appreciation</th>
<th>Difference</th>
<th>N</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All goods</td>
<td>0.228***</td>
<td>0.247***</td>
<td>0.019</td>
<td>133,928</td>
<td>0.076</td>
</tr>
<tr>
<td>Differentiated (stricter def)</td>
<td>0.172***</td>
<td>0.315***</td>
<td>0.143***</td>
<td>38,370</td>
<td>0.119</td>
</tr>
<tr>
<td>Differentiated (looser def)</td>
<td>0.183***</td>
<td>0.269***</td>
<td>0.085**</td>
<td>57,958</td>
<td>0.116</td>
</tr>
</tbody>
</table>

*By end-use:*

1. Foods, feeds, bev.  
   - Depreciation: 0.128***  
   - Appreciation: 0.167***  
   - Difference: 0.039  
   - N: 23,826  
   - $R^2$: 0.028
2. Industrial supplies  
   - Depreciation: 0.370***  
   - Appreciation: 0.178**  
   - Difference: -0.192***  
   - N: 47,256  
   - $R^2$: 0.072
3. Capital goods ex auto  
   - Depreciation: 0.265***  
   - Appreciation: 0.220***  
   - Difference: -0.045  
   - N: 12,344  
   - $R^2$: 0.196
4. Automotive products  
   - Depreciation: 0.116  
   - Appreciation: 0.408***  
   - Difference: 0.292*  
   - N: 1,085  
   - $R^2$: 0.218
5. Consumer goods  
   - Depreciation: 0.098***  
   - Appreciation: 0.239**  
   - Difference: 0.141*  
   - N: 11,392  
   - $R^2$: 0.150

► Conditioning on a price change, some evidence that pass-through is still asymmetric, but only for differentiated goods.
Issue 2: Selection

- Foreign appreciations might also induce products to exit the market, as the desired dollar price rises and the foreign firm stops selling it rather than letting the price increase through.
- This would bias the foreign appreciation pass-through towards zero, potentially understating the true asymmetry of pass-through.
We look for evidence of this selection effect by estimating a linear probability model of exit:

$$\text{prob}(\text{exit}_{i,j,t}) = \sum_{k=0}^{18} \{ \beta_k^+ \Delta e_{j,t-k}^+ + \beta_k^- \Delta e_{j,t-k}^- \} + \ldots + \epsilon_{i,j,t} \quad (4)$$

We take into account the reason for item exit as listed in the BLS survey.
Selection results: Selected exits

Figure 1: Selected exits

- 95% confidence bands plotted for difference.

- Focusing on exits likely to be endogenous, there is no evidence of selection driving the asymmetric pass-through results.
Non-linearities in pass-through

- Many theories of asymmetric pass-through also imply non-linear pass through: larger shocks may have higher pass-through than smaller shocks.
- Adding square and cube terms to a standard pass-through regression allows for differential pass-through depending on the size of the shock.

\[
\Delta p_{i,j,t} = \sum_{k=0}^{h} \left\{ \beta^+_k (\Delta e^+)_{j,t-k} + \gamma^+_k (\Delta e^+)_{j,t-k}^2 + \delta^+_k (\Delta e^+)_{j,t-k}^3 \right\}
\]

(5)

\[
+ \sum_{k=0}^{h} \left\{ \beta^-_k (\Delta e^-)_{j,t-k} + \gamma^-_k (\Delta e^-)_{j,t-k}^2 + \delta^-_k (\Delta e^-)_{j,t-k}^3 \right\}
\]

(6)

\[
+ \delta P_{j,t} + \alpha_t + s_t + \epsilon_{i,j,t}
\]

(7)
Non-linearity results

Figure 2: Non-linearity in pass-through

95% confidence bands plotted for difference.

- Large exchange rate changes pass through a bit faster than smaller ones, but any difference is not statistically significant.
Quantity responses

- We can take this a step further and use sectoral data on trade values to back out an implied trade quantity response.
- Start with estimating the same basic relationship but replacing prices with trade values on the LHS:

\[ \Delta p_{qi,j,t} = \sum_{k=0}^{6} \left\{ \beta_k^+ \Delta e^+_{j,t-k} + \beta_k^- \Delta e^-_{j,t-k} \right\} + [...] + \epsilon_{i,j,t} \quad (8) \]

- Then, because the estimating relationship is log-linear, subtract the trade price response from the trade value response to obtain the implied trade quantity response.
Figure 3: Import value responses for foreign currency depreciations (−) and appreciations (+) using Rauch (1999) differentiated goods
Implied quantity response

Figure 4: Implied import quantity responses for foreign currency depreciations (-) and appreciations (+) using Rauch (1999) differentiated goods
Conclusion

- Foreign appreciations pass through faster than depreciations.
- Asymmetries are still present conditional on a price change.
- Non-linearities are negligible.
- Selection does not appear to be strongly asymmetric.
- Implied trade quantity responses are symmetric and zero in the short run, but foreign depreciations have a stronger response after 1 year.
Theory

Flow profit has two key elements:

\[ \Pi(p', a, e) = \frac{p' q(p')}{e} - \frac{\bar{c}}{a} q(p') \]

\[ - \mathbb{I}[q(p') > q(p)] \phi \bar{c} (q(p') - q(p))^2 \]

1. \( q(p) \) is a Klenow-Willis (2006) demand curve, inducing firms to want to price closer to the sectoral price \( \bar{P} \). generating incomplete pass-through, even in the long run:

\[ q(p) = \left(1 - \epsilon \ln \frac{p}{\bar{P}}\right)^{\frac{\theta}{\epsilon}} \]

this generates an effective demand elasticity

\[ \tilde{\theta} = \frac{\theta}{1 - \epsilon \ln \left(\frac{p}{\bar{P}}\right)} \]

2. Convex adjustment costs \( \phi \) if increasing quantity produced \( (q(p') > q(p)) \).
### Parameterization

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta$</td>
<td>4</td>
<td>Elasticity of substitution</td>
</tr>
<tr>
<td>$\epsilon$</td>
<td>3</td>
<td>Super-elasticity</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.5</td>
<td>Probability of price change</td>
</tr>
<tr>
<td>$\phi$</td>
<td>10</td>
<td>Convex adjustment cost</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.94$\frac{1}{12}$</td>
<td>Discount factor</td>
</tr>
<tr>
<td>$\rho_a$</td>
<td>0.96</td>
<td>AR(1) coefficient for productivity</td>
</tr>
<tr>
<td>$\sigma_a$</td>
<td>0.001</td>
<td>Shut down</td>
</tr>
<tr>
<td>$\rho_e$</td>
<td>0.99</td>
<td>AR(1) coefficient for exchange rates</td>
</tr>
<tr>
<td>$\sigma_e$</td>
<td>0.03</td>
<td>Standard deviation for exchange rates</td>
</tr>
</tbody>
</table>
Preliminary results

- Numerical exercise to see if these mechanisms can generate similar pass-through patterns
Preliminary results
Existing literature on asymmetries and non-linearities

- Pollard and Coughlin (2004)
  - Industry-level study
  - Existence and size of asymmetry varies across industries.
  - Large movements in exchange rates are associated with higher pass-through.

- Bussiere (2013)
  - Aggregate-level study of G7 countries, including the U.S.
  - Non-linearities vary from country to country.
  - Evidence is stronger for asymmetries than for non-linearities.
Existing literature on asymmetries and non-linearities

- Razafindrabe (2017)
  - French firm-level data
  - Depreciations pass through faster than appreciations
  - Largely the result of price stickiness
Price changes

95% confidence bands plotted for difference.

- Exchange rate appreciations significantly raise the probability of a price change, while appreciations do not affect the probability.