Trade Adjustment and the Composition of Trade

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Motivation

• Substantial interest in assessing the economic forces that might induce U.S. trade adjustment, and in the implications for imports, exports, and the exchange rate.

• Considerable discussion of appropriate policy response:
  – U.S. fiscal consolidation (IMF)
  – Stimulate consumption abroad (U.S. Treasury)

• We show that taking appropriate account of the high investment content of U.S. trade is critical for assessing how different shocks/policy choices affect trade and the real exchange rate.
Background

- U.S. Imports and Exports are heavily concentrated in capital goods and consumer durables.
  - About 3/4 of nonfuel imports and exports fall under these two categories, while their share of total absorption is around 1/4.
### Non-Energy Merchandise Trade and Expenditure Components

<table>
<thead>
<tr>
<th>1. Consumer Nondurables</th>
<th>28</th>
<th>25</th>
<th>61</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Consumer Durables</td>
<td>32</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>3. Producer Durables</td>
<td>30</td>
<td>45</td>
<td>8</td>
</tr>
<tr>
<td>4. Non-energy industrial supplies used in producing durables</td>
<td>10</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>100</td>
<td>100</td>
<td>77</td>
</tr>
</tbody>
</table>
Background (con’t)

- Empirical studies using aggregate trade data usually ignore differences; typically imports depend on GDP or absorption.

- Open economy DSGE models typically ignore compositional differences; imports depend on absorption.
  - e.g.: Backus, Kehoe, Kydland (1994); Chari, Kehoe and McGrattan (2002).
Methodology

We embed two alternative trade specifications in an open economy DSGE model (SIGMA):

1) Absorption-based trade (AT) specification

- final consumption and investment goods have same import intensity.
- activity variable driving imports puts a weight of about 1/4 on investment (its share in domestic expenditure).

2) Disaggregated trade (DT) specification

- allows for investment goods to be much more import-intensive than consumption goods.
- activity variable driving imports puts a weight of about 3/4 on investment (its share in imports)
Key Findings

• DT specification provides a better fit of observed U.S. import behavior given theoretical constraints of our DSGE framework.

• Under AT specification, shocks that affect foreign consumption or investment have similar effects on U.S. trade and the exchange rate.

• Under DT specification, foreign investment shocks much stronger catalyst for trade adjustment, while implying much smaller movement in exchange rates.
Key Findings (con’t)

- Similarly, shocks that reduce domestic investment can provide a stronger catalyst for trade adjustment than consumption shocks, with smaller exchange rate depreciation.

- Overall, our analysis suggests that movements in the interest-sensitive components of domestic expenditure may play a significant role in trade adjustment.

- Emphasis on investment changes as a catalyst for trade adjustment consistent with empirical work of Freund (2000) and Croke, Kamin, and LeDuc (2005).
Structure of SIGMA

- DSGE model with two countries; each produces a single final good by aggregating a continuum of domestically-produced intermediate goods.

- Nominal and Real Rigidities:
  - staggered wage and price contracts
  - habit persistence in consumption
  - investment adjustment costs
  - costs of adjusting import shares

- Exports are priced in the currency of the buyer (local currency pricing).
Optimizing Households

- Maximize an intertemporal utility functional; the period utility function depends on a composite consumption good, leisure, and real balances.

- Accumulate capital by purchasing a composite investment good.

- Monopolistically competitive sellers of differentiated labor services.

- Face shocks to the return to capital, and taste shocks to aggregate consumption.

- The consumption and investment goods are a composite of the domestically-produced good and the imported good (possibly in different proportions).
Optimizing Households

Period utility:

\[
\frac{1}{1 - \sigma} \left( C_t (h) - \kappa \frac{C_{t-1}}{\zeta} - \varphi_{Ct} \right)^{1 - \sigma} + \frac{\chi_0}{1 - \chi}(1 - N_t (h))^{1 - \chi} + \frac{\mu_0}{1 - \mu} \left( \frac{MB_{t+1} (h)}{P_{Ct}} \right)^{1 - \mu}
\]

Budget constraint:

\[
P_{Ct}C_t (h) + P_{It}I_t (h) + MB_{t+1} (h) - MB_t (h) + \int_{s}^{\xi_{t+1}} B_{Dt+1} (h) - B_{Dt} (h) +
\]

\[
P_{Bt}B_{Gt+1} - B_{Gt} + \frac{e_t P_{Bt}^* B_{Ft+1} (h)}{\phi_{bt}} - e_t B_{Ft} (h) = W_t (h) N_t (h)
\]

\[
+(1 - \tau_{Kt})R_{Kt}K_t (h) + TR_t (h) - T_t (h) - \phi_{It} (h)
\]
Costs of adjustments

Intermediation costs for foreign bonds

$$\phi_{bt} = \exp \left( -\phi_b \left( \frac{e_t B_{Ft+1}}{P_t Y_t} \right) + \varphi_{bt} \right)$$

Costs of adjustment for capital

$$\phi_{It}(h) = \frac{1}{2} \phi_{IPD} \frac{(I_t(h) - \mu z I_{t-1}(h))^2}{I_{t-1}(h)}$$
Wage Setting

Wages determined by Calvo contracts (allow for dynamic wage indexation, log-linearized FOC):

\[
\hat{\pi}_{wt} = (1 - \lambda_w)\hat{\pi}_{wt-1} + \lambda_w \hat{\pi}_{wt+1|t} + \kappa_w (m\hat{r}_t - \hat{w}_ct)
\]

Full backward indexation: \( \lambda_w = \frac{\beta}{1+\beta} \).
"Hand-to-Mouth" Agents

Fraction of households purely "Keynesian":

\[ P_{C,t}C_t(h) = (1 - \tau_N)W_t(h)N_t(h) + TR_t(h) - T_t(h) \]

"Hand-to-Mouth" agents set their wage at the average wage of optimizing households.
Firm Behavior

- There are three types of producers in each country: intermediate-goods producers, producers of the aggregate domestic good, and distributors.

- Producers of the intermediate-goods are monopolistically competitive and set prices in both the home and foreign markets in Calvo-style contracts. They rent capital and labor from households.

- Producers of a composite domestic good bundle the continuum of intermediate goods, taking prices as given in input and product markets (similarly for the foreign intermediate goods).

- Distributors purchase both the domestically-produced good and the imported good, and resell the final consumption and investment goods to households (N.B.: these goods are identical in the AT specification).
Intermediate Goods Firms

Monopolistic competitors who hire capital and labor from households in competitive factor markets.

Technology given by:

\[ Y_t(i) = \left( \omega_{K}^{\frac{\rho}{1+\rho}} K_t(i)^{\frac{1}{1+\rho}} + \omega_{L}^{\frac{\rho}{1+\rho}} (Z_t L_t(i))^{\frac{1}{1+\rho}} \right)^{1+\rho} \]

K-L elasticity of substitution \( \frac{\rho+1}{\rho} \)

Sticky domestic prices (log-linearized FOC):

\[ \hat{\pi}_t = (1 - \lambda_p) \hat{\pi}_{t-1} + \lambda_p \hat{\pi}_{t+1|t} + \kappa_p \hat{m}_ct \]

Local currency pricing for export prices (log-linearized FOC):

\[ \hat{\pi}^*_M t = (1 - \lambda_p) \hat{\pi}^*_{M t-1} + \lambda_p \hat{\pi}^*_{M t+1|t} + \kappa_{x,p} (\hat{m}_ct - (\hat{e}_t + \hat{P}^*_{M t} - \hat{P}_t)) \]
AT Distributor

Technology for production of final good \((A_t \equiv C_t + I_t)\):

\[
A_t = \left(\frac{\rho_A}{\omega_A^{1+\rho_A}} A_{D,t}^{1+\rho_A} + (1 - \omega_A)^{1+\rho_A} (\varphi_{At} M_t)^{1+\rho_A}\right)^{1+\rho_A}
\]

where the adjustment cost \(\varphi_{At}\) is given by:

\[
\varphi_{At} = \left[1 - \frac{\varphi_{MA}}{2} \left(\frac{M_t}{A_{D,t}^{AD,t}} - 1\right)^2\right]
\]

Distributors minimize the discounted expected cost of producing the final good (N.B.: \(P_{At} = P_{Ct} = P_{It}\)).
Consumption DT Distributor

Technology for production of consumption good:

\[ C_t = \left( \frac{\rho_A}{\omega_c} \left( \frac{C_{D,t}}{1+\rho_A} \right)^{1+\rho_A} + (1 - \omega_c) \left( \frac{\rho_A}{\varphi_{ct}M_{ct}} \right)^{1+\rho_A} \right)^{1+\rho_A} \]

where the adjustment cost \( \varphi_{ct} \) is given by:

\[ \varphi_{ct} = \left[ 1 - \frac{\varphi_{M_c}}{2} \left( \frac{M_{C,t}}{C_{D,t}} - 1 \right) \right]^2 \]

Distributors minimize the discounted expected cost of producing the consumption good.
Investment DT Distributor

Technology for production of investment good:

\[ I_t = \left( \omega_I^{1+\rho_A} I_{D,t}^{1+\rho_A} + (1 - \omega_I)^{1+\rho_A} (\varphi_{It} M_{I,t})^{1+\rho_A} \right)^{1+\rho_A} \]

where the adjustment cost \( \varphi_{It} \) is given by:

\[ \varphi_{It} = \left[ 1 - \frac{\varphi M_I}{2} \left( \frac{M_{I,t}}{I_{D,t}} - 1 \right) \right]^2 \]

Distributors minimize the discounted expected cost of producing the investment good.
Fiscal and Monetary Policy

- Govt purchases domestic goods only.

- Transfers and govt spending determined exogenously.

- Govt spending is nonproductive.

- Finances its expenditures with lump-sum taxes, seignorage, and debt issuance.

- Monetary policy follows a modified Taylor rule of the form:

  \[ i_t = \gamma_i i_{t-1} + \bar{\pi} + \pi_t + \gamma_\pi (\pi_t^{(4)} - \bar{\pi}) + \gamma_y (y_t - y_{t-4} - g_y) + \epsilon_{it}. \]
Calibration

Home country is half as large as foreign.

$\kappa_w$ and $\kappa_p$ consistent with 4 quarter contracts (with full indexation); $\kappa_x$ consistent with 2 quarter contracts.

Consumption elasticity $\sigma = 2$; habit persistence parameter $\varsigma = 0.8$.

Trade elasticity of substitution is 1.5 ($\rho_A = 2$).

Adjustment costs for investment set to match peak response of investment following a monetary innovation, $\phi_I = 3$, and elasticity of substitution between capital and labor in production function is 0.5.

Baseline case for interest rate rule: $\gamma_i = 0.8$, $\gamma_\pi = 0.4$, $\gamma_y = 0.28$, and $\gamma_{g_y} = 0$.

In the AT specification $\omega_A$ is set to 0.15, to be consistent with an import share of 12%.

In the DT specification $\omega_C$ is set to 0.052 and $\omega_I$ is set to 0.36. The import share remains at 12%.
Comparing Linearized Trade Specifications

AT specification:

\[
\tilde{M}_t = \tilde{A}_t - \frac{\lambda}{\varphi_{MA}(1 - \beta \lambda \rho \psi)(1 - \lambda L)} \tilde{\psi}_t. \tag{1}
\]

\[
\tilde{A}_t = \left( \frac{C}{A} \right) \tilde{C}_t + \left( \frac{I}{A} \right) \tilde{I}_t. \tag{2}
\]

DT specification:

\[
\tilde{M}_t = \tilde{A}_{DT} - \frac{\lambda}{\varphi_{MA}(1 - \beta \lambda \rho \psi)(1 - \lambda L)} \tilde{\psi}_{DT}. \tag{3}
\]

\[
\tilde{A}_{DT} = \left( \frac{M_C}{M} \right) \tilde{C}_t + \left( \frac{M_I}{M} \right) \tilde{I}_t. \tag{4}
\]
Table 4: Mean Squared Error of Predicted Imports (1975-2005)\textsuperscript{a,b}

<table>
<thead>
<tr>
<th>Experiment</th>
<th>AT Specification</th>
<th>DT Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Benchmark Calibration ((\epsilon_A = 1.5), (\varphi_{MA} = 15), (\rho_\psi = 0.9))</td>
<td>2.62</td>
<td>2.13</td>
</tr>
<tr>
<td>2. Activity Measure Only</td>
<td>3.07</td>
<td>2.45</td>
</tr>
<tr>
<td>3. Minimized MSE\textsuperscript{c}</td>
<td>2.53</td>
<td>2.11</td>
</tr>
<tr>
<td>4. Alternative Trade-Price Elasticity\textsuperscript{d}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\epsilon_A = 1)</td>
<td>2.68</td>
<td>2.11</td>
</tr>
<tr>
<td>(\epsilon_A = 3)</td>
<td>2.67</td>
<td>2.37</td>
</tr>
<tr>
<td>5. Alternative Adjustment Cost Parameter\textsuperscript{d}</td>
<td></td>
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</tr>
<tr>
<td>(\varphi_{MA} = 5)</td>
<td>2.98</td>
<td>2.34</td>
</tr>
<tr>
<td>(\varphi_{MA} = 30)</td>
<td>2.59</td>
<td>2.14</td>
</tr>
<tr>
<td>6. Alternative Relative Import Price Persistence\textsuperscript{d}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\rho_\psi = 0.75)</td>
<td>2.65</td>
<td>2.12</td>
</tr>
<tr>
<td>(\rho_\psi = 0.999)</td>
<td>2.74</td>
<td>2.30</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Entries report the square root of the mean squared error.

\textsuperscript{b}AT and DT specifications refer to absorption-based and disaggregated trade specifications implied by equations (12) and (13), respectively.

\textsuperscript{c}In this case, \(\rho_\psi = 0.9\) and the parameters \(\epsilon_A\) and \(\varphi_{MA}\) are chosen to minimize the mean-squared error. For the AT specification, \(\epsilon_A = 3.05\) and \(\varphi_{MA} = 28.44\), and for the DT specification, \(\epsilon_A = 1.08\) and \(\varphi_{MA} = 15.00\).

\textsuperscript{d}The parameter values are the same as in the benchmark calibration except for the alternative parameter under consideration.
Figure 1: U.S. Real Imports of Goods and Alternative Activity Measures

Figure 1A: AT Specification
- Real Nonoil Imports (data)
- Private Absorption (AT)
- Real Imports Implied by Benchmark Calibration

Figure 1B: DT Specification
- Real Nonoil Imports (data)
- Private Absorption (DT)
- Real Imports Implied by Benchmark Calibration
Figure 2: Real Imports and the Relative Price of Imports
Model simulations

1. Rise in foreign investment share of GDP that peaks at 1 percentage point (due to lower capital tax rate abroad).

2. Rise in foreign consumption share of GDP that peaks at 1 percentage point (due to taste shock).

3. Similar shocks to domestic economy (reverse sign).
Figure 3: A Foreign Investment Demand Shock

- **Foreign Investment Rate**: Over time, the foreign investment rate increases, peaking around the 24th period, and then gradually decreases.

- **Investment Rate**: The investment rate shows a similar pattern, with a peak around the 24th period, indicating a period of high investment.

- **Real Exports**: Real exports also peak around the 24th period, with a significant increase in the intermediate periods.

- **Exchange Rate**: The exchange rate decreases over time, reaching a minimum around the 24th period, indicating a depreciation.

- **Real Imports**: Real imports show a similar trend to real exports but lag slightly behind.

- **Trade Balance (GDP share)**: The trade balance peaks around the 24th period, indicating a surplus in trade with GDP.

Legend:
- **Absorption Trade**
- **Disaggregated Trade**
Figure 4: A Foreign Consumption Demand Shock

- **Foreign Consumption Rate**
- **Investment Rate**
- **Real Exports**
- **Exchange Rate**
- **Real Imports**
- **Trade Balance (GDP share)**

Legend:
- **Absorption Trade**
- **Disaggregated Trade**
Figure 5: A Domestic Investment Demand Shock

- Investment Rate
- Consumption Rate
- Real Exports
- Exchange Rate
- Real Imports
- Trade Balance (GDP share)

Legend:
- Black line: Absorption Trade
- Red dashed line: Disaggregated Trade
Figure 6: A Domestic Consumption Demand Shock

Investment Rate

Consumption Rate

Real Exports

Exchange Rate

Real Imports

Trade Balance

- Absorption Trade
- Disaggregated Trade
Figure 7: A Technology Shock that Boosts Real GDP by 1% in the Long Run
Figure 8: A Persistent Increase in Foreign Demand (Disaggregated Trade Specification)
Conclusions

- Investment shocks may serve as catalyst for trade adjustment with minimal exchange rate movement.

- Changes that boost investment abroad could improve trade balance by stimulating exports directly.

- Changes that boost consumption abroad would have smaller effects on the trade balance, and mainly operate through domestic currency depreciation.
Future Work

1. Introduce features that allow for low long-run passthrough from exchange rates to import prices.

2. Estimate model using full information maximum likelihood.