Lecture 1:
Aggregate Analysis; Trade Deficits

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Two Striking Features of the International Economy

- **Rise of China (% of world manufacturing exports):**

- **Deficit of the United States ($ billions in 2006):**
  857 (current account), 764 (goods and services), 836 (goods), 271 (petroleum).

- Look in more detail at manufacturing in 2004.
Table 2: Trade in Manufactures

<table>
<thead>
<tr>
<th>Country</th>
<th>exports</th>
<th>imports</th>
<th>overall balance</th>
<th>balance with US</th>
<th>balance with China</th>
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<tbody>
<tr>
<td>ChinaHK</td>
<td>816.8</td>
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<td>United States</td>
<td>673.7</td>
<td>1158.3</td>
<td>-484.6</td>
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<td>-166.6</td>
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</tbody>
</table>
Today’s Goal)

- Calculate consequences of eliminating all current account imbalances for: (i) relative wages and relative GDP’s, (ii) real wages, (iii) welfare, (iv) bilateral trade balances, and (v) manufacturing share of GDP.

- Chance to demonstrate what new quantitative work in trade has to say about a very topical issue.

- Quantitative Methods: (i) use a 2-country model to get the story right, (ii) how to map precisely from the model to the data, (iii) deal with identification issue, trade frictions vs. absolute advantage, (iv) use Alvarez-Lucas algorithm.
The “Transfer Problem” debated by Keynes, Ohlin and others.

Dornbusch, Fischer, and Samuelson (1977) analysis in a 2-country Ricardian model (DFS).

Series of papers by Obstfeld and Rogoff (2000, ..., 2005).

Popular writings voicing concern that an adjustment of U.S. current account could be devastating.
Intuition from DFS

- Continuum of goods $z \in [0, 1]$, Cobb Douglas preferences.
- US and ROW(*), labor endowments $L, L^*$, wages $w, w^*$.
- Relative labor productivity in US $A(z)$, goods ordered so $A'(z) < 0$.
- Perfect competition.

- Produce $z$ in US iff $z \leq \bar{z}$ where

$$A(\bar{z}) = \frac{w}{w^*} = \omega.$$
Neutrality

► Closing the model.

► Equate US imports \((1 - \bar{z})wL\) to US exports \(\bar{z}w^*L^*\), or:

\[
\omega = \frac{\bar{z}}{1 - \bar{z}} \frac{L^*}{L}.
\]

► Equilibrium pair \((\omega, \bar{z})\) solve the equation above together with \(A(\bar{z}) = \omega\).

► But, get same equilibrium with a US trade deficit of \(D\):

\[
(1 - \bar{z})(wL + D) = \bar{z}(w^*L^* - D) + D.
\]
A source of home bias: share $\alpha < 1$ spent on tradables.

Goods market clearing condition becomes:

$$\alpha(1 - \bar{z})(wL + D) = \alpha \bar{z}(w^*L^* - D) + D.$$  

Yields an upward sloping curve, which shifts up with $D$:

$$\omega = \frac{\bar{z} L^*}{1 - \bar{z} L} + \frac{(1 - \alpha)D}{\alpha(1 - \bar{z})w^*L}.$$  

Reduction in $D$ results in lower US relative wage $\omega$ and broader range $\bar{z}$ of tradables produced in US.

Production of tradables as a share of US GDP rises:

$$\lambda = \frac{\alpha \bar{z}(wL + w^*L^*)}{wL} = \alpha \bar{z} \left(1 + \frac{L^*}{\omega L}\right).$$
What Does Model Suggest?

- Find value of $\alpha$ that makes sense of GDP’s and US imports and exports.

- GDP’s $Y = 13.2$, $Y^* = 34.0$, US exports $X = 1.4$, US imports $I = 2.2$, and deficit $D = 0.8$ ($\$ trillions$) in 2006.

- Share of US exports in ROW spending on tradables:

$$ \bar{z} = \frac{X}{\alpha(Y^* - D)} = 0.04/\alpha $$

- Share of ROW exports (US imports) in US spending on tradables:

$$ 1 - \bar{z} = \frac{I}{\alpha(Y + D)} = 0.16/\alpha. $$

- Logic of the model implies $\alpha = 0.2$. 
What is Tradable? (Value added shares of GDP)

<table>
<thead>
<tr>
<th>US INDUSTRY</th>
<th>1977</th>
<th>2005</th>
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<tbody>
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<td>1.0</td>
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<td>1.9</td>
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<td>Construction</td>
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<td>Utilities</td>
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<td>2.0</td>
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<tr>
<td>Wholesale</td>
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<td>6.0</td>
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<td>Retail</td>
<td>7.8</td>
<td>6.6</td>
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<td>Transportation</td>
<td>3.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Information</td>
<td>3.5</td>
<td>4.5</td>
</tr>
<tr>
<td>FIRE</td>
<td>15.0</td>
<td>20.4</td>
</tr>
<tr>
<td>Bus. Serv.</td>
<td>6.0</td>
<td>11.7</td>
</tr>
<tr>
<td>Educ. and Health</td>
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<tr>
<td>Entertainment</td>
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<tr>
<td>Other Serv.</td>
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<td>2.3</td>
</tr>
<tr>
<td>Government</td>
<td>14.4</td>
<td>12.6</td>
</tr>
</tbody>
</table>
Parameterization

- Parameterize $A(z)$ as in Eaton and Kortum (2002):

\[ A(z) = \left( \frac{T}{T^*} \right)^{1/\theta} \left( \frac{1 - z}{z} \right)^{1/\theta}. \]

- Thus,

\[ \bar{z} = \frac{T \omega^{-\theta}}{T \omega^{-\theta} + T^*}. \]

- For price implications specify labor requirements, $[A(z) = \frac{a^*(z)}{a(z)}]$, as:

\[ a^*(z) = T^*^{-1/\theta} (1 - z)^{1/\theta}, \]

and

\[ a(z) = T^{-1/\theta} z^{1/\theta}. \]
Price Level

- Exact price index for tradables derived from Cobb-Douglas preferences

\[ p = \exp \left( \int_0^1 \ln p(z) \, dz \right). \]

- US perspective: if \( z \leq \bar{z} \) then \( p(z) = wa(z) \) while if \( z \geq \bar{z} \) then \( p(z) = w^* a^*(z) \).

- Plugging in the results for individual prices

\[ p = \exp \left( \int_0^{\bar{z}} \left[ \ln w + \ln a(z) \right] \, dz + \int_{\bar{z}}^1 \left[ \ln w^* + \ln a^*(z) \right] \, dz \right). \]

- Integrating across goods, price index for tradables in the US is:

\[ p = e^{-1/\theta} \left[ T w^{-\theta} + T^* w^*^{-\theta} \right]^{-1/\theta}. \]
Counterfactual

- Exogenous change of $D$ to $D' = 0$. Given $w^*$, what happens to $w$? i.e to

$$\hat{w} = \frac{w'}{w} = \frac{\omega'}{\omega} = \hat{\omega}.$$  

- Note that counterfactual GDP is $Y' = w'L = Y\hat{\omega}$ while $Y^{*'} = Y^*$.  

- Trick to calculate counterfactual threshold good:

$$\bar{z}' = \frac{T \omega'^{-\theta}}{T \omega'^{-\theta} + T^*} = \frac{\bar{z} \hat{\omega}^{-\theta}}{\hat{\omega}^{-\theta} + (1 - \bar{z})}.$$  

- Note that we didn’t need to know $T$, $T^*$, or $w$ (hence, don’t need to know the skill of a nation’s labor force).  

- We then just solve for $\hat{\omega}$ in

$$(1 - \bar{z}') Y\hat{\omega} = \bar{z}' Y^*.$$
Counterfactual (continued)

- Plugging in the expression for $\bar{z}'$ yields

$$
(1 - \bar{z}) Y \hat{\omega} = \bar{z} \hat{\omega}^{-\theta} Y^*.
$$

- Solving it out:

$$
\hat{\omega} = \left( \frac{\bar{z} Y^*}{(1 - \bar{z}) Y} \right)^{1/(1+\theta)} = \left( \frac{E Y^* \bar{Y}^*-D Y^*}{Y+D Y} \right)^{1/(1+\theta)}.
$$

- The change in the US tradables price index can be written as

$$
\frac{p'}{p} = \hat{p} = \left[ \bar{z} \hat{\omega}^{-\theta} + (1 - \bar{z}) \right]^{-1/\theta}.
$$

- The change in the US overall price index is

$$
\hat{P} = (\hat{p})^\alpha (\hat{\omega})^{1-\alpha}.
$$
Results

- Remember: \( Y = 13.2, \ Y^* = 34.0, \ E = 1.4, \ I = 2.2, \) and \( D = 0.8 (\text{\$ trillions}) \) in 2006.

- Implies \( \alpha = 0.2, \bar{z} = 0.21, \) and

\[
\lambda = \alpha \bar{z} \frac{Y + Y^*}{Y} = 0.15.
\]

- Set \( \theta = 8.28 \) (from EK (2002)).

- We then just solve for \( \hat{\omega} = 0.96, \) i.e. a 4% decline in the US relative wage.

- The change in the US price index is \( \hat{\rho} = 0.99 \) so that the change in the US real wage is \( (\hat{\omega}/\hat{\rho})^\alpha = 0.99. \)

- The counterfactual share of tradables in US GDP is \( \lambda' = 0.18, \) a 3 percentage point increase.
Shutting Down Labor Mobility

- Suppose labor $L^T$ is stuck in the tradables sector and $L^N$ in nontradables (with the same situation in ROW).
- We have to allow a sector specific wage, so that GDP is $Y = wL^T + w^N L^N$.
- A country’s spending on tradables equals its income in the tradables sector plus the deficit: $\alpha(Y + D) = wL^T + D$ and $\alpha(Y^* - D) = w^* L^{T*} - D$.
- Plugging these expressions into the goods market clearing condition,

$$\alpha(1 - \bar{z})(wL + D) = \alpha\bar{z}(w^* L^* - D) + D$$

yields

$$(1 - \bar{z})wL^T = \bar{z}w^* L^{T*}.$$ 

which is invariant to the deficit.
Immobile Labor: the Nontradables Sector

- With no home bias in tradables and no labor mobility, the relative wage and threshold good are invariant to the deficit.
- Income generated in the tradables sector is fixed at
  \[ Y^T = wL^T = \alpha Y - (1 - \alpha)D. \]
- A decline in \( D \) must translate into a decline in \( Y \), via a decline in \( Y^N \).
- Income generated in the nontradables sector is
  \[ Y^N = (1 - \alpha)(Y + D) = (1 - \alpha)(Y^N + Y^T + D) \]
  or
  \[ Y^N = w^NL^N = \frac{1 - \alpha}{\alpha}(Y^T + D). \]
Immobile Labor: Quantitative Results

▶ With a counterfactual deficit $D'$, the change in $w^N$ is

$$\hat{w}^N = \frac{Y^T + D'}{Y^T + D}.$$

▶ This change can be substantial. We have $Y^T = .2 \ast (13.2 + .8)$ and hence

$$\hat{w}^N = \frac{14/5}{14/5 + .8} = \frac{14}{18} = 0.78.$$ i.e. a 22% decline.

▶ A slightly smaller adjustment, in the opposite direction, will take place in the rest of the world

$$\hat{w}^{*N} = \frac{33.1/5}{33.1/5 - .8} = \frac{33.1}{29.1} = 1.14.$$
Immobile Labor: The Real Exchange Rate

- Overall price levels changes are $\hat{P} = (\hat{w}^N)^{1-\alpha}$, with a parallel formula for ROW.

- Defining $q = P^*/P$ to be the real exchange rate, i.e. the price of a foreign consumption basket in terms of US consumption baskets, it changes by $\hat{q} = \hat{P}^*/\hat{P} = 1.36$.

- One scenario: suppose $w^N$ and $w^{N*}$ are fixed in local currencies, so that a 32% decline in the dollar against the foreign currency $-100(1/1.36 - 1)$ achieves the necessary adjustment.

- Since the law of one price holds for tradables, we’ll see the price of tradables rise by the factor $1/.78$ (or 28%) in the US and fall by the factor $1/1.14$ in ROW.
Beyond the 2-Country World

- Apply what we’ve learned from the analysis of bilateral trade among the countries of the world.
  - Unlike gravity tradition, ignore the usual suspects (distance, common language).
  - Instead, extract bilateral resistance parameters directly from bilateral trade shares.
  - Advantages: (i) clean and non-parametric and (ii) doesn’t impose bilateral balance as would symmetric proxies.
- Demonstrate the critical distinction between adjustments in relative wages (potentially large) and adjustment to real wages (tiny).
Important Caveats

- Our exercise is pure comparative statics: we don’t model how, why, or when adjustment of current accounts occurs.

- No attempt to model dynamics, with lower elasticities in the short run, as in Ruhl (2005).

- No attempt to introduce nominal rigidities, which play a major role in much of the current literature.

- Manufacturing does all the work: we hold fixed any non-manufacturing trade imbalances.
Basic Equations

- A world of $N$ countries with $n$ indexing an importer and $i$ and exporter.

- Now have bilateral iceberg costs $d_{ni} \geq 1$ in shipping from $i$ to $n$.

- Gravity equation (for example from Frechet distribution of efficiencies)

\[
\pi_{ni} = \frac{T_i(c_i d_{ni})^{-\theta}}{\sum_{k=1}^{N} T_k(c_k d_{nk})^{-\theta}}
\]

- Goods Market Clearing condition

\[
Y_i^M = \sum_{n=1}^{N} \pi_{ni} X_n^M,
\]

- Acknowledge deficits in manufacturing: $X_i^M = Y_i^M + D_i^M$, 
Trade in Intermediates

- Let $\beta < 1$ be the value added share in producing manufactures.

- Assume a CES aggregator (with parameter $\sigma$) for manufactured goods used either as intermediates or as final consumption.

- Price index (in country $n$) for manufactures:

$$p_n = \gamma \left[ \sum_{i=1}^{N} T_i (w_i^\beta p_i^{1-\beta} d_{ni})^{-\theta} \right]^{-1/\theta},$$

- New trade share equation:

$$\pi_{ni} = \frac{T_i (w_i^\beta p_i^{1-\beta} d_{ni})^{-\theta}}{\sum_{k=1}^{N} T_k (w_k^\beta p_k^{1-\beta} d_{nk})^{-\theta}},$$
Manufactures Within the Overall Economy

- Manufactures Share $\alpha < 1$ in the final consumption good.

- Aggregate expenditure:

  \[ X_i = Y_i + D_i = w_i L_i + D_i. \]

- Acknowledge trade in non-manufactured goods (oil, services) so that $D_i$ need not equal $D_i^M$.

- Spending on manufactures:

  \[ X_n^M = \alpha X_n + (1 - \beta) Y_n^M. \]
Equilibrium

- Factor market clearing

\[ w_i L_i + D1_i = \sum_{n=1}^{N} \pi_{ni} [w_n L_n + D2_n] \]

\[ D1_i = D_i - \frac{1}{\alpha} D^M_i \]

\[ D2_n = D_n - \frac{1 - \beta}{\alpha} D^M_n \]

- Price levels

\[ p_n = \gamma \left[ \sum_{k=1}^{N} T_k (w_k p_k^{1-\beta} d_{ni})^{-\theta} \right]^{-1/\theta} \]
Equations for Counterfactual

- Factor market clearing

\[ \hat{w}_i Y_i + D1'_i = \sum_{n=1}^{N} \frac{\pi_{ni} \hat{w}_i - \theta \beta \hat{p}_i}{\sum_{k=1}^{N} \pi_{nk} \hat{w}_k - \theta \beta \hat{p}_k - \theta (1 - \beta)} (\hat{w}_n Y_n + D2'_{n}) \]

\[ D1'_i = D'_i - \frac{1}{\alpha} D_i^{M'} \]

\[ D2'_{n} = D'_n - \frac{1 - \beta}{\alpha} D_n^{M'} \]

- price levels

\[ \hat{p}_n = \left( \sum_{k=1}^{N} \pi_{nk} \hat{w}_k - \theta \beta \hat{p}_k - \theta (1 - \beta) \right)^{-1/\theta} \]
Implementation

- Set $\alpha = 0.188$, $\beta = 0.312$, and $\theta = 8.28$.

- Alvarez and Lucas (2006) prove there is a unique solution, and motivate a numerical algorithm to find it.

- Wage changes are normalized so that world GDP remains constant.
Table 1: Trade Imbalances

<table>
<thead>
<tr>
<th>Country</th>
<th>current account</th>
<th>manufacturing trade balance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ billions</td>
<td>% of GDP</td>
</tr>
<tr>
<td>China HK</td>
<td>85.6</td>
<td>4.1</td>
</tr>
<tr>
<td>France</td>
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<td>-0.3</td>
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<td>Germany</td>
<td>103.0</td>
<td>3.8</td>
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<tr>
<td>Japan</td>
<td>173.3</td>
<td>3.7</td>
</tr>
<tr>
<td>United States</td>
<td>-664.0</td>
<td>-5.7</td>
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</table>
Table 3: Changes that Eliminate Current Account Imbalances

<table>
<thead>
<tr>
<th>Country</th>
<th>initial CA (% of GDP)</th>
<th>implied changes</th>
<th></th>
<th></th>
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<td></td>
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<td>welfare</td>
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<td>1.03</td>
<td>1.00</td>
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<td>Japan</td>
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<td>1.04</td>
<td>1.00</td>
<td>1.04</td>
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<td>0.93</td>
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</table>
### Table 4: Actual and Counterfactual Bilateral Imbalance

<table>
<thead>
<tr>
<th>Country</th>
<th>balance with U.S.</th>
<th>balance with China</th>
</tr>
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<tbody>
<tr>
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<td>counterfactual</td>
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<tr>
<td>ChinaHK</td>
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<td>64.9</td>
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<td>France</td>
<td>1.2</td>
<td>-22.5</td>
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<td>Germany</td>
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<tr>
<td>Japan</td>
<td>84.4</td>
<td>-3.5</td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lessons

▶ Moderate changes in wages.

▶ Tiny changes in real wages.

▶ Substantial changes in trade flows and manufacturing shares.

▶ Some bilateral deficits persist.