Industrial Structure and Financial Capital Flows

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Presentation for ESSIM 2010

May 25, 2010
Introduction

- “Two Engines of Integration”:
  - commodity trade
  - financial capital flows

This paper: develops a framework that combines factor-proportions trade and financial capital flows

Investigate how their *interplay* determines:
- Sectoral and Aggregate Asset Prices
- Capital flows
A Multi-country, Multi-sector Setup

- Two Countries: Home and Foreign
- Two Commodities: Cotton and Steel
- Two Factors: Capital (K) and Labor (N)
- Labor: immobile internationally
- Capital: mobile internationally
- Adjustment costs break FPE
What changes with multiple sectors?

Consider a permanent labor force increase in Foreign:

- **Two forces** at work in determining capital flows:
  - Standard: “convergence effect” — (Home to Foreign)
  - New: “composition effect” — (Foreign to Home)

If composition effect dominates:

- “Reverse Capital Flows”
- Investment comovement
- Asset Price comovement

⇒ With basic ingredients, sharp and surprising results.
In a multi-sector model, 3 cases are encompassed:

- No factor-intensity differences: *convergence force*
- Multiple sectors: *convergence + composition effect*
- Multiple sectors where most labor-intensive sector uses only labor as an input: *composition effect*
Relationship to the Literature

- Hecksher-Ohlin-Mundell (1965) tradition
- Benchmark model: Two-Country stochastic investment model
  - one good: Backus Kehoe and Kydland (1992)
  ⇒ Departure of this paper: factor-proportions trade

- Models with sectors that differ in factor intensities:
  ⇒ Departure of this paper: financial capital flows

- Trade and Capital flows: Ju and Wei (2007), Antras and Caballero (2009)
When Do Multi-Sectors Become Essential?

- When shocks alter a country’s **comparative advantage**

- Empirically relevant “shocks”:
  - Globalization
  - Labor Force/Productivity
  - Demographic heterogeneity
Main Predictions

• **Current account**
  ► *deficit* in industrialized core *surplus* in emerging periphery

• **Lucas Puzzle Revisited**
  ► South to North flows *despite* low complementary factors in South

• **Demographics and Asset Prices:**
  ► Young and fast growing developing countries can emerge as a solution to the “ave wave crisis”
Roadmap

- Model Setup
- Special case: Composition effect in isolation
- General case: Competing Forces
- An application: Lucas Puzzle
- Suggestive Empirics
- Conclusion and future research
Outline

1. A Stochastic Two-Country Multi-Sector Model
2. Case I: The Composition Effect
3. General Case: Numerical Solutions
4. An Application: Lucas Puzzle Revisited
5. Conclusion
Model Ingredients

- **Symmetric Two-country OLG model** with capital accumulation (Abel (Econometrica 2003))
- **Free and costless trade** in goods and financial assets
- **Multiple sectors** that differ in factor intensity
- **Adjustment costs** to pin down capital stock and analyze the price of capital
Production Technologies

- Intermediate Goods Production:

\[
Y_{jt}^j = \left(K_{i,t}^j\right)^{\alpha_i} \left(A_t^j N_{it}^j\right)^{1-\alpha_i}
\]  

\[
\ln A_t^j = \ln A_{t-1}^j + \epsilon_A^j
\]

\[
\ln N_t^j = \ln N_{t-1}^j + \epsilon_N^j
\]

- Investment Good

\[
I_{it}^j = \left[\sum_{k=1}^m \gamma_i^{\frac{1}{\theta}} \left(i_{ki,t}^j\right)^{\frac{\theta-1}{\theta}}\right]^\frac{\theta}{\theta-1}
\]

where \(i_{ki,t}^j\): amount of good \(k\) used for investment in the \(i\)'th sector of country \(j\).
• **Capital accumulation equation** [Abel (2003)]:

\[ K_{i,t+1}^j = a \left( I_{it}^j \right)^\phi \left( K_{it}^j \right)^{1-\phi} \]

- \( a = 1, \phi = 1 \): neoclassical growth model with complete depreciation.
- \( \phi = 0 \): Lucas fruit-tree model.

▶ Compare with:

\[ K_{i,t+1}^j = (1 - \delta) K_{it}^j + I_{it}^j - \frac{b}{2} \left( \frac{I_{it}^j}{K_{it}^j} - \delta \right)^2 K_{it}^j \]

- Equivalent up to second-order if \( \phi = \delta \), \( b = \frac{1-\phi}{\phi} \)
• Price of Capital:

\[ q_{it}^j = \left( \frac{dK_{it}^j}{dl_{it}^j} \right)^{-1} = \frac{1}{a\phi} \left( \frac{l_{it}^j}{K_{it}^j} \right)^{1-\phi} \]

– Alternatively,

\[ q_{it}^j K_{i,t+1}^j = l_{it}^j / \phi \]

• Rate of Return:

\[ R_{it} = \frac{\alpha_i p_{it} Y_{it}^1}{K_{it}^1} + \frac{1-\phi}{\phi} \frac{l_{it}}{K_{it}} \frac{Y_{i,t-1}}{q_{i,t-1}} \]

• Wages:

\[ w_t = (1 - \alpha_1)p_{1t} \frac{Y_{1t}}{N_{1t}} = (1 - \alpha_2)p_{2t} \frac{Y_{2t}}{N_{2t}} \]

– Determines specialization patterns
Consumers

- **Demographics:**
  - Overlapping generations: $N_t$ young, $N_{t-1}$ old.

  \[ \ln N_t^j = \ln N_{t-1}^j + e_{N,t}^j \]

- **Preferences:**

  \[ u(c_t^j) = \frac{(c_t^j)^{1-\rho}}{1-\rho} \]

- **Consumption index:**

  \[ C_t^j = \left[ \sum_{i=1}^{2} \gamma_i \frac{1}{\theta} \left( c_{it}^j \right)^{\theta-1} \right]^\frac{\theta}{\theta-1} \]
• Objective:

\[ \max u(c_t^y) + \mathbb{E}_t u(c_{t+1}^o) \]

• Constraints:
  Young:

\[ c_{t,i}^{y,h} = w_t^h - \sum_{j=h,f}^{2} \sum_{k=1}^{2} q_{it}^j k_{i,t+1}^{h,j} \]

Old:

\[ c_{t+1,i}^{o,h} = \sum_{j=h,f}^{2} \sum_{i=1}^{2} R_{i,t+1}^j q_{it}^j k_{i,t+1}^{h,j} \]
• Price Index

\[ P = \left[ \gamma p_1^{1-\theta} + (1 - \gamma) p_2^{1-\theta} \right]^{\frac{1}{1-\theta}} = 1 \]

• Price of Intermediate goods:

  - Law of one price: international prices \( p_1 \) and \( p_2 \)

\[ \frac{p_1}{p_2} = \left( \frac{\gamma_1 Y_2^g}{\gamma_2 Y_1^g} \right)^{\frac{1}{\theta}} \]
Semi-closed form and closed-form solutions rely on:

**Assumptions**

(i) Unitary elasticity of substitution of intermediate goods 
\[ \theta = 1 \]

(ii) The capital-adjustment technology is log-linear

(iii) \[ u(c) = \log(c) \]
Home’s Investment: $I^h_t \propto \eta_t Y^g_t$

one sector: $\eta_t = \lambda \sum_{k=0}^{\infty} (1 - \lambda)^k \mathbb{E}_t \left[ \frac{Y^h_{t+k+1}}{Y^g_{t+k+1}} \right]$

two sectors: $\eta_t = \left[ \frac{\alpha_1 \gamma}{\alpha_1 \gamma + \alpha_2 (1 - \gamma)} \eta_1 t + \frac{\alpha_2 (1 - \gamma)}{\alpha_1 \gamma + \alpha_2 (1 - \gamma)} \eta_2 t \right]$

$\Rightarrow$ Investment depends on the composition of production
Outline

1 A Stochastic Two-Country Multi-Sector Model

2 Case I: The Composition Effect

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5 Conclusion
Special Case: the Composition Effect

Assumption (iv): $\alpha_1 = 0$

- Commodity trade $\Rightarrow$

\[
    w_t = w_t^* = p_{1t} \\
    \Rightarrow k_{2t} = k_{2t}^* \quad \forall t
\]

- achieved through labor reallocation across sectors
Special Case: the Composition Effect

Assumption (iv): $\alpha_1 = 0$

- Commodity trade $\Rightarrow$

$$w_t = w_t^* = p_{1t}$$
$$\Rightarrow k_{2t} = k_{2t}^* \quad \forall t$$

- achieved through **labor reallocation** across sectors
- The “**convergence effect**” is effectively **shut down**
How is a marginal unit of savings allocated?

- Rental earned from production, \( \alpha_2 p_{2t} k_{2t}^{\alpha_2 - 1} \), is equalized across countries

\[ \Rightarrow \text{Allocate savings such that marginal } \textbf{adjustment costs}, \ (\propto \frac{l_i}{K_i}), \text{ are equalized across countries} \]

**Proposition**

*Home’s investment share of world GDP in any period \( t \) is determined by its initial capital intensity.*

\[ \eta_t = \frac{K_{\text{init}}}{K^g_{\text{init}}} \]
Results (1)

- **Investment comovement:**

\[ I_t \propto \eta_{i\text{init}} Y_t^g \]

- **Current account falls:**

\[ NFA_t \equiv q^f_t k_{t+1}^{h,f} \cdot N_t^h - q^h_t k_{t+1}^{f,h} \cdot N_f^t \]

\[ CA_t \equiv \Delta NFA_t = S_t^\gamma - q^h_t K_{t+1}^h - (S_{t-1}^\gamma - q_{t-1}^h K_t^h) \]

- **Evolution of Capital Stock:** (labor share: \( s_l = 1 - \alpha \gamma \))

\[ \ln(\tilde{k}^j_{t+1}) = \ln \Theta + (1 - \phi s_l) \ln(\tilde{k}^j_t) + \phi s_l \ln \left( \sum_i \mu_i \eta_{i0}^j \right) \]

\[ + \phi s_l \left( \ln \tilde{N}^g_t - \ln \tilde{N}^l_t \right) - (\epsilon^j_{N,t+1} + \epsilon^j_{A,t+1}) \]
A Graphical Exposition

Figure: Impact effect of a change in $\frac{k^j}{kw}$
Long-Run Behavior

Sector-level effective-capital-labor ratio:

\[ \tilde{k}_i^j \propto \left[ \left( \frac{1}{\beta} + 1 \right) \left( \frac{1}{s_l} - 1 \right) \right]^{-1/s_l} \]

Country level:

\[ \tilde{k} \propto \eta_{init} \left[ 1 + \left( \frac{\tilde{N}^*}{\tilde{N}} \right) \right] \]

- FPE attained after one period
- Speed of mean reversion depends on \( \phi \) and labor share, \( s_l \)
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The General Case

- **Special Case** \((\alpha_1 = 0)\):
  - FPE occurs after one period (through labor reallocation)
  - Investment and Asset Prices always comove

- **General Case**:
  - \( k_{it} \neq k_{it}^* \)
  - Composition effect and “convergence” effect are **competing**
  - Quantitative exercise: composition effect dominates
  - Show conditions under which one dominates the other
Quantitative Analysis

<table>
<thead>
<tr>
<th>Benchmark Parameter Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferences</td>
</tr>
<tr>
<td>( \beta = 0.45 )</td>
</tr>
<tr>
<td>( \gamma = 0.61 )</td>
</tr>
<tr>
<td>( \rho = 1 )</td>
</tr>
<tr>
<td>( \theta = 1 )</td>
</tr>
<tr>
<td>Technology</td>
</tr>
<tr>
<td>( \alpha_1 = 0.52 )</td>
</tr>
<tr>
<td>( \alpha_2 = 0.11 )</td>
</tr>
<tr>
<td>( b = 0.2 )</td>
</tr>
</tbody>
</table>

Table: Parameters for Simulation

- \( \alpha_i \) from OECD Annual National Accounts (Cunat and Maffezzoli (2004))
- \( \gamma_i \): the share of each sector in total OECD value added
- From Data, \( s_k = 0.36 \), weighted variance=0.04
- \( b \) to match output adjustment costs paid over a 20 year period
- Assume initially that capital-labor ratio in North is six times that of South
- Initial technology level chosen to normalize North’s income per capital to 1, South’s to one-seventh of that of North: \( A^n = 2.48 \), \( A^s = 1.2 \).
Comparison: One sector and Two Sector model

Figure: A Foreign Labor Force Boom in the one and two sector case.
When is the Composition Effect Strong Enough?

Relevant Statistic:

\[
\text{weighted variance} = \sum_{i=1}^{m} (\alpha_i - s_k)^2 \gamma_i
\]

- From the data

\[
s_k = \sum_{i=1}^{m} \alpha_i \gamma_i = 0.36
\]

weighted variance = 0.04

- Experiment: hold constant \( s_k \), vary the weighted variance.
5 Sectors

Home Investment on Impact

mean = 0.36

From Data

Weighted Variance Percentage Change in Investment Home Investment on Impact
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Application: The Lucas Puzzle Revisited

- A main explanation to the “Lucas Puzzle”: complementary factors are low in poor countries
- In a multi-sector framework, equalization of returns does not imply little capital flows once countries integrate
- Trade induces capital flows
A Globalization Experiment

- Suppose countries North and South are initially in autarky:

\[
\frac{p_{s}^{\text{aut},n}}{p_{c}^{\text{aut},n}} < \frac{p_{s}^{\text{aut},s}}{p_{c}^{\text{aut},s}}
\]

- Trade and financial liberalization:
  - \(p_{\text{steel}} \uparrow\) for North, \(p_{\text{cotton}} \uparrow\) for South \(\Rightarrow\) specialization
  - Composition effect causes investment demand \(\uparrow\) in North
Figure: A Globalization Shock
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Concluding Remarks

• Trade + Capital Flows should be jointly analyzed
• Is the canonical international-macro workhorse model missing an important dimension?
• Potential link between global imbalances and specialization

Back to original Question:
• Younger and fast-growing developing countries may help sustain asset prices in an aging North
• All of this depends on how integrated the world is
An Empirical Exercise

- Is there a link between specialization and the current account?
- Do changes in demographics affect specialization patterns?

A Measure of Specialization, \( \alpha_c \), for each country \( c \):

\[
x_{cz} = \beta_c + \alpha_c \cdot k_z + \alpha_{c,2} \cdot s_z + \epsilon_{cz}
\]

where \( x_{cz} \) is the country \( c \)'s market share of U.S. imports of good \( z \), \( k \) and \( s \) are the capital and skill intensity of industry \( z \).

- \( \alpha_c \) is a measure of country \( c \)'s “revealed comparative advantage” in capital-intensive sectors.

Data:
- Factor intensity data: NBER manufacturing productivity database.
- U.S. imports: Feenstra (4-digit SIC).
Table: South’s “RCA” in Capital Intensity over Time

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_c$</td>
<td>$-0.38^{***}$</td>
<td>$-0.65^{***}$</td>
<td>$-0.60^{***}$</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>2002</td>
<td>$-0.66^{***}$</td>
<td>$-0.77^{***}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.32</td>
<td>0.32</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>0.25</td>
<td>0.27</td>
<td></td>
</tr>
</tbody>
</table>

Aggregate South is defined to be countries with per capita GDP less than 50% of that of U.S. at PPP.
<table>
<thead>
<tr>
<th></th>
<th>$\alpha_c$</th>
<th>CA</th>
<th>Predicted $\Delta$CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>-0.7</td>
<td>1.38</td>
<td>0.72</td>
</tr>
<tr>
<td>U.K.</td>
<td>2.9</td>
<td>-1.56</td>
<td>0.72</td>
</tr>
<tr>
<td>China</td>
<td>-2.19</td>
<td>2.4</td>
<td>1.22</td>
</tr>
<tr>
<td>Australia</td>
<td>1.1</td>
<td>-3.7</td>
<td></td>
</tr>
</tbody>
</table>

- In 2002, if India had U.K.’s degree of specialization, the predicted difference in CA amounts to $\frac{0.72}{2.94} = 25\%$ of the difference in actual CA.
- If China had Australia’s degree of specialization, the predicted difference in CA amounts to $\frac{1.22}{6.1} = 20\%$ of the difference in actual CA.
\[ \alpha_{ct} = \alpha + \beta_1 \cdot \alpha_{ct} + \gamma' Z_{ct} + u_{ct} \]

- **Additional Controls**: GDP, population growth, GDP per capita
- **Pooled (2) uses the average current account over a period as a dependent variable, \( CA_t \).**

### Table

<table>
<thead>
<tr>
<th></th>
<th>Pooled</th>
<th>Pooled</th>
<th>Between</th>
<th>Within</th>
<th>F-E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>( \alpha_{ct} )</td>
<td>-0.193***</td>
<td>-0.19***</td>
<td>-0.30**</td>
<td>-0.17*</td>
<td>-0.23***</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.074)</td>
<td>(0.127)</td>
<td>(0.09)</td>
<td>(0.07)</td>
</tr>
<tr>
<td>Openness</td>
<td>1.98***</td>
<td>1.54</td>
<td>-0.42</td>
<td>-0.15</td>
<td></td>
</tr>
<tr>
<td>Annual GDP growth</td>
<td>-0.03</td>
<td>2.8</td>
<td>-0.1***</td>
<td>-0.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.074)</td>
<td>(12.7)</td>
<td>(0.01)</td>
<td>(0.07)</td>
<td></td>
</tr>
<tr>
<td>Population growth</td>
<td>-0.67**</td>
<td>-1.3</td>
<td>-0.22</td>
<td>-0.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.27)</td>
<td>(13.5)</td>
<td>(0.35)</td>
<td>(0.38)</td>
<td></td>
</tr>
<tr>
<td>Country Fixed Effect</td>
<td>No</td>
<td>No</td>
<td>-</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year Fixed Effect</td>
<td>No</td>
<td>No</td>
<td>-</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.01</td>
<td>0.05</td>
<td>0.07</td>
<td>0.55</td>
<td>0.20</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>450</td>
<td>450</td>
<td>86</td>
<td>450</td>
<td>450</td>
</tr>
</tbody>
</table>
Figure: An anticipated Foreign labor force boom that occurs at $t = 4$. 
\[ \alpha_{ct} = \beta_c + \text{Share}_{ct} + \gamma' \text{Z}_{ct} + \epsilon_{ct} \]

- Share of working age population in total population
### Sensitivity to the Adjustment Cost Parameter and Factor Intensities

<table>
<thead>
<tr>
<th>Two-Sector</th>
<th>CA:</th>
<th>q:</th>
<th>T=1</th>
<th>T=5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(1) Varying Adjustment Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b=0.05</td>
<td></td>
<td></td>
<td>−8.37%</td>
<td>2.96%</td>
</tr>
<tr>
<td>b= 0.1</td>
<td></td>
<td></td>
<td>−8%</td>
<td>5.04%</td>
</tr>
<tr>
<td>b= 0.3</td>
<td></td>
<td></td>
<td>−7.04%</td>
<td>9.41%</td>
</tr>
<tr>
<td>b= 0.5</td>
<td></td>
<td></td>
<td>−6.43%</td>
<td>11.27%</td>
</tr>
<tr>
<td><strong>(2) Varying Factor Intensity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>α₂/α₁ = 1</td>
<td></td>
<td></td>
<td>0.1%</td>
<td>−0.1%</td>
</tr>
<tr>
<td>α₂/α₁ = 3</td>
<td></td>
<td></td>
<td>−4.84%</td>
<td>5.88%</td>
</tr>
<tr>
<td>α₂/α₁ = 9</td>
<td></td>
<td></td>
<td>−5.06%</td>
<td>6.08%</td>
</tr>
<tr>
<td><strong>(3) Interaction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High b and high α₂/α₁</td>
<td></td>
<td></td>
<td>−7.57%</td>
<td>16.75%</td>
</tr>
<tr>
<td>low b and high α₂/α₁</td>
<td></td>
<td></td>
<td>−9.10%</td>
<td>5.45%</td>
</tr>
<tr>
<td>high b and low α₂/α₁</td>
<td></td>
<td></td>
<td>−2.95%</td>
<td>5.97%</td>
</tr>
<tr>
<td><strong>(4) Elasticity of Substitution</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>θ = 0.8</td>
<td></td>
<td></td>
<td>−5.77%</td>
<td>6.29%</td>
</tr>
<tr>
<td>θ = 4</td>
<td></td>
<td></td>
<td>−6.31%</td>
<td>6.41%</td>
</tr>
<tr>
<td><strong>(5) Risk Aversion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ρ = 0.8</td>
<td></td>
<td></td>
<td>−6.33%</td>
<td>6.71%</td>
</tr>
<tr>
<td>ρ = 2</td>
<td></td>
<td></td>
<td>−4.56%</td>
<td>4.4%</td>
</tr>
</tbody>
</table>

| One-Sector |     |    |     |     |
| b=0.1     |     |    | 0.01% | −0.3% | 0 |
| b= 0.3     |     |    | 0.02% | −1% | 0 |
| b= 0.5     |     |    | 1.22% | −4% | 0 |
An Illustration of Composition Effects

\[ \hat{I}_t = \hat{\eta}_t + \hat{Y}_t \]

<table>
<thead>
<tr>
<th>Investment in Home</th>
<th>( \alpha = 0.3 )</th>
<th>( \alpha_1 = 0.1, \alpha_2 = 0.5 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \hat{\eta}_i )</td>
<td>–11.13%</td>
<td>–12.46%, –1.4%</td>
</tr>
<tr>
<td>w.a.( \hat{\eta} )</td>
<td></td>
<td>–3.24%</td>
</tr>
<tr>
<td>( \hat{Y}_g )</td>
<td>+10%</td>
<td>+6.86%</td>
</tr>
<tr>
<td>( \hat{I} )</td>
<td>–1.13%</td>
<td>+3.62%</td>
</tr>
</tbody>
</table>

Table: Impact Effect of an unexpected 20% labor force boom in Foreign, \( \gamma_i = 0.5 \).
The Future: Demographic heterogeneity