Structural Change in an Interdependent World: 
A Global View of Manufacturing Decline

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1. Introduction

• We live in the global economy, where countries are interdependent with one another.
• The only closed economy we know of is our planet, the world economy.

Yet,
• Most studies on structural change develop a closed economy model, apply it to each country, and use the cross-country data to test it,
• as if countries were still independent fiefdoms in the Middle Ages or were located on different planets.

• We show how misleading this common practice can be in the context of productivity-based theory of manufacturing employment decline.
What is “Productivity-Based Theory of Manufacturing Decline”?

Productivity growth in $M$ causes the broad trend of its employment decline observed in many countries.

**Logic:** High productivity growth in $M$ sectors
→ Less workers are needed to produce the same amount of $M$ goods
→ Unless demand for $M$ goods keeps up with productivity growth, some $M$ workers has to move to other sectors, such as Services.

**Cross-country evidence:** higher productivity growth in $M$ is not associated with a faster decline in $M$. Some (very good) economists have interpreted this as a rejection of the theory.

The following example shows that this interpretation is *false*.  

2. *A Ricardian Model of the World Economy*

**Two Countries**: Home and Foreign (*)

- Each is endowed with one unit of the nontradeable factor (Labor).
- They differ only in Labor Productivity.

**Three Goods:**

- **Numeraire** ($O$); tradeable at zero cost;
  No production. Endowment of $y$ units
- **Manufacturing** ($M$); tradeable at zero cost;
  A unit of Home (Foreign) Labor produces $A_M (A_M^*)$ units of $M$.
- **Services** ($S$): nontradeable;
  A unit of Home (Foreign) Labor produces $A_S (A_S^*)$ units of $S$. 
Prices and Wages:

\[ P_M: \text{ World Price of } M, \]
\[ W (W^*): \text{ Home (Foreign) Wage Rate} \]
\[ P_S (P_S^*): \text{ Home (Foreign) Price of } S. \]

Perfect Competition implies that, when both economies produce \( M \) and \( S \),

\[ P_M = \frac{W}{A_M} = \frac{W^*}{A_M^*}, \]

\[ P_S = \frac{W}{A_S} \quad \& \quad P_S^* = \frac{W^*}{A_S^*}. \]
Home Preferences:

\[
U = \begin{cases} 
(C_O)^{\alpha} \left[ \beta_M (C_M - \gamma)^{\theta} + \beta_S (C_S)^{\theta} \right]^{1-\alpha} & \text{for } \theta < 1, \theta \neq 0, \\
(C_O)^{\alpha} (C_M - \gamma)^{\beta_M (1-\alpha)} (C_S)^{\beta_S (1-\alpha)} & \text{for } \theta = 0.
\end{cases}
\]

If \( \gamma > 0 \), the income elasticity of demand for \( M \) is less than one. If \( \theta < 0 \), the price elasticity of relative demand of \( M \& S \) is less than one.

Home Budget Constraint:

\[ C_O + P_M C_M + P_S C_S \leq y + W \]
Home Demand Schedules for $O$ and $S$:

$$C_O = \alpha(y + W - \gamma P_M), \quad C_S = \frac{(\beta_S)^\sigma (P_S)^{-\sigma} (1-\alpha)(y + W - \gamma P_M)}{(\beta_M)^\sigma (P_M)^{1-\sigma} + (\beta_S)^\sigma (P_S)^{1-\sigma}}$$

$\sigma = 1/(1-\theta)$: the price elasticity of relative demand of $M$ & $S$.

Likewise,

Foreign Demand Schedules for $O$ and $S$:

$$C_O^* = \alpha(y + W^* - \gamma P_M^*), \quad C_S^* = \frac{(\beta_S)^\sigma (P_S^*)^{-\sigma} (1-\alpha)(y + W^* - \gamma P_M^*)}{(\beta_M)^\sigma (P_M^*)^{1-\sigma} + (\beta_S)^\sigma (P_S^*)^{1-\sigma}}$$
Market Clearing Conditions:

\[ C_O + C_O^* = 2y, \]

\[ C_S = A_S (1 - L_M^*), \]

\[ C_S^* = A_S^* (1 - L_M^*) \]

where

\[ L_M (L_M^*): \text{ Home (Foreign) Manufacturing Employment Share}. \]
Equilibrium Employment Shares:

\[ L_M = \frac{2}{\alpha} \left( 1 - \frac{A_M^*}{A_M} \right) + \frac{\gamma}{A_M} + \left( \frac{\beta_M}{\beta_S} \right)^{\sigma} \left( \frac{A_S}{A_M} \right)^{1-\sigma} \]

\[ 1 + \left( \frac{\beta_M}{\beta_S} \right)^{\sigma} \left( \frac{A_S}{A_M} \right)^{1-\sigma} \]

\[ L_M^* = \frac{2}{\alpha} \left( 1 - \frac{A_M}{A_M^*} \right) + \frac{\gamma}{A_M^*} + \left( \frac{\beta_M}{\beta_S} \right)^{\sigma} \left( \frac{A_S^*}{A_M^*} \right)^{1-\sigma} \]

\[ 1 + \left( \frac{\beta_M}{\beta_S} \right)^{\sigma} \left( \frac{A_S^*}{A_M^*} \right)^{1-\sigma} \]
3. Comparative Statics: Structural Change in an Interdependent World

3.1. Income-elasticity Differentials across sectors: \( \gamma > 0 \) \& \( \sigma = 1 \) \((\theta = 0)\). (Non-homothetic preferences)

\[
L_M = (1 - \beta) \left[ \frac{\alpha}{2} \left( 1 - \frac{A_M^*}{A_M} \right) + \frac{\gamma}{A_M} \right] + \beta,
\]

\[
L_M^* = (1 - \beta) \left[ \frac{\alpha}{2} \left( 1 - \frac{A_M^*}{A_M^*} \right) + \frac{\gamma}{A_M^*} \right] + \beta
\]

where \( \beta \equiv \frac{\beta_M}{\beta_S + \beta_M} \),
Global Productivity Gains in Manufacturing: Income Effect

\[ \frac{\Delta A_M}{A_M} = \frac{\Delta A^*_M}{A^*_M} > 0 \Rightarrow \Delta L_M < 0 \quad \& \quad \Delta L^*_M < 0. \]

National Productivity Gains in Manufacturing:

\[ \frac{\Delta A_M}{A_M} > 0 = \frac{\Delta A^*_M}{A^*_M} \Rightarrow \text{sgn}[\Delta L_M] = \text{sgn}\left[\frac{\alpha}{2} - \frac{\gamma}{A^*_M}\right] \quad \& \quad \Delta L^*_M < 0. \]

- Ambiguity due to the two forces: Income & Trade Effects
- Trade Effect can cause, in cross-section, a positive correlation between productivity gains and the employment share in M.
3.2. Productivity growth differentials across sectors: $\gamma = 0$ & $\sigma < 1 (\theta < 0)$. ($M$ and $S$ are not very substitutable)

Global Productivity Gains in Manufacturing: **Relative Supply Effect**

$$\frac{\Delta A_M}{A_M} = \frac{\Delta A^*_M}{A^*_M} > \frac{\Delta A_S}{A_S} = \frac{\Delta A^*_S}{A^*_S} = 0 \quad \Rightarrow \quad \Delta L_M < 0 \quad \& \quad \Delta L^*_M < 0.$$

National Productivity Gains in Manufacturing:

$$\frac{\Delta A_M}{A_M} > \frac{\Delta A^*_M}{A^*_M} = \frac{\Delta A_S}{A_S} = \frac{\Delta A^*_S}{A^*_S} = 0 \quad \Rightarrow \quad \Delta L_M \neq 0 \quad \& \quad \Delta L^*_M < 0.$$

- Ambiguity due to the two forces: **Relative Supply & Trade Effects**
- **Trade Effect** can cause, in cross-sections, a *positive* correlation between productivity gains and the employment share in $M$. 
The model suggests both:

• A *broad, global* trend of manufacturing decline occurs due to productivity gains in manufacturing.

• In *cross-section of countries*, manufacturing productivity can be *positively* correlated with the manufacturing employment share, due to *comparative advantage*.

Hence, **you cannot use cross-country evidence to reject the first implication.**

e.g. Higher productivity gains in the South Korean manufacturing sector means that the manufacturing sectors must decline *somewhere* in the world, but not necessarily in South Korea.
Messages:

• A Caution when using the Cross-Country Data to test a Closed Economy Model

• Need for A Global Perspective on Structural Change
Some earlier related work:

**Role of Agriculture in Industrialization:** As many historians believe,
- Agricultural Revolution was a necessary precondition for Industrial Revolution.
- Countries and regions with less productive agricultural sectors (Britain, Belgium, Switzerland, New England) were the first to industrialize.

Matsuyama (1992) showed that these two observations are not contradictory.

**Growth Convergence in an Endogenous Growth Model:**
Many (very good) economists interpreted that growth convergence in cross-section of countries as the evidence against endogenous growth.

See Acemoglu and Ventura (2002) for a counter-example.