The Decline in Manufacturing Production: China Shock or Structural Change?

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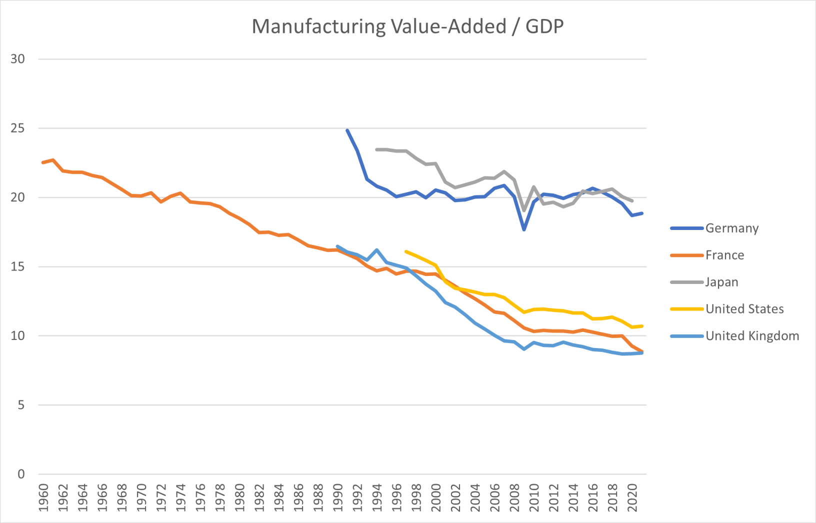
Manufacturing Value-Added / GDP
30
25
20
15
10
5
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Germany
France
Japan
United States
United Kingdom

Outline

- The manufacturing value-added (per GDP) declined in advanced economies.
- Possible reasons are
  1. structural change in advanced economies themselves,
  2. the rise in manufacturing in China and other developing countries.
- Using a structural model, we quantify the contributions of these economic forces.
- We develop a dynamic many-country trade model with capital accumulation and non-homothetic preferences.

Contribution to the Literature

1. Dynamic Eaton-Kortum Models
   - Eaton, Kortum, Neiman, and Romalis (2016), Ravikumar, Santacreu, and Sposi (2019)
2. Structural Change (the Baumol effect and the income effect)
   - Boppart (2014), Matsuyama (2019), Comin, Lashkari, and Mestieri (2021, henceforth CLM)

We introduce the CLM-style non-homothetic utility function into a dynamic EK model with capital accumulation.

Model

Environment

- Time is discrete $t = 0, 1, 2, \cdots$.
- There are N countries indexed by n or i.
- There are three industries $j = a, m, s$.
  - Agriculture,
  - Manufacturing,
  - Services.

Preferences

- A representative agent in country n has the lifetime utility

$$\sum_{t=0}^{\infty} \frac{C_{n,t}^{1-\theta}}{1-\theta}, \tag{1}$$

where consumption in period t is *implicitly* defined by

$$\sum_{j=a,m,s} (\Omega^j)^{\frac{1}{\sigma}} \left(\frac{C_{n,t}^j}{C_{n,t}^{\epsilon_j}} \right)^{\frac{\sigma-1}{\sigma}} = 1. \tag{2}$$

- This follows CLM (and Hanoch (1975)).
- The sectoral good $C_{n,t}^j$ is a CES aggregate

$$C_{n,t}^j = \left[\int_0^1 C_{n,t}^j(z)^{\frac{\eta-1}{\eta}} dz \right]^{\frac{\eta}{\eta-1}}. \tag{3}$$

Properties of CLM Preferences

- The expenditure is

$$E_{n,t} = \left[\sum_{j=a,m,s} \Omega^j (C_{n,t}^{\epsilon_j} p_{n,t}^j)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}. \tag{4}$$

- The expenditure share on sector j, $\omega_{n,t}^j = E_{n,t}^j / E_{n,t}$, satisfies

$$\frac{\omega_{n,t}^{j'}}{\omega_{n,t}^j} = \left(\frac{p_{n,t}^{j'}}{p_{n,t}^j} \right)^{1-\sigma} C_{n,t}^{(1-\sigma)(\epsilon_{j'} - \epsilon_j)} \left(\frac{\Omega^{j'}}{\Omega^j} \right), \tag{5}$$

with $\sum_{j=a,m,s} \omega_{n,t}^j = 1$.

Dynamic Optimization

$$\max \sum_{t=0}^{\infty} \beta^t \frac{C_{n,t}^{1-\theta}}{1-\theta}$$

subject to

$$E_{n,t} = \left[\sum_{j=a,m,s} \Omega^j (C_{n,t}^{\epsilon_j} p_{n,t}^j)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \tag{6}$$

$$E_{n,t} + p_{n,t}^m I_{n,t} \leq w_{n,t} L_{n,t} + r_{n,t} K_{n,t}, \tag{7}$$

$$K_{n,t+1} = (1-\delta) K_{n,t} + I_{n,t}. \tag{8}$$

Euler Equation

- The Euler equation is

$$\frac{C_{n,t+1}^{1-\theta}}{C_{n,t}^{1-\theta}} = \frac{p_{n,t}^{m}}{\beta(p_{n,t+1}^{m}(1-\delta)+r_{n,t+1})}\frac{\bar{\epsilon}_{n,t+1}}{\bar{\epsilon}_{n,t}}\frac{E_{n,t+1}}{E_{n,t}}, \tag{9}$$

where

$$\bar{\epsilon}_{n,t} = \sum_{j=a,m,s} \omega_{n,t}^{j}\epsilon_{j}. \tag{10}$$

Production

- The production function for variety z in sector j is

$$y^j_{n,t}(z) = a^j_{n,t}(z) \left(\frac{K^j_{n,t}(z)}{\gamma\alpha} \right)^{\gamma\alpha} \left(\frac{L^j_{n,t}(z)}{\gamma(1-\alpha)} \right)^{\gamma(1-\alpha)} \cdot \prod_{j'=a,m,s} \left(\frac{M^{jj'}_{n,t}(z)}{(1-\gamma)\beta^{M,jj'}} \right)^{(1-\gamma)\beta^{M,jj'}} . \tag{11}$$

- Following Eaton and Kortum (2002), we assume that productivity $a^j_{n,t}(z)$ is drawn from

$$F^j_{n,t}(a) = Pr[a^j_{n,t} \leq a] = \exp \left[- \left(\frac{a}{\gamma A^j_{n,t}} \right)^{-\theta} \right] \tag{12}$$

independently and identically across $z \in [0, 1]$.

Costs and Prices

- Costs for the input bundle is

$$\tilde{c}^{j}_{n,t} = (r_{n,t})^{\gamma\alpha}(w_{n,t})^{\gamma(1-\alpha)} \prod_{j'=a,m,s} (p^{j'}_{n,t})^{(1-\alpha)\beta^{M,jj'}}. \qquad (13)$$

- Price index is

$$P^{j}_{n,t} = \left[\sum_{i=1}^{N} \left(\frac{\tilde{c}^{j}_{i,t} d^{j}_{ni,t}}{A^{j}_{i,t}} \right)^{-\theta} \right]^{-1/\theta}. \qquad (14)$$

Trade Shares

- Let $X^j_{ni,t}$ be country n's spending on sector j goods from country i in period t.
- Let $X^j_{n,t}$ be country n's spending on sector j goods in period t.
- Then trade shares $\pi^j_{ni,t} = X^j_{ni,t}/X^j_{n,t}$ are

$$\pi^j_{ni,t} = \frac{(\tilde{c}^j_{i,t} d^j_{ni,t}/A^j_{i,t})^{-\theta}}{\sum_{i'=1}^{N}(\tilde{c}^j_{i',t} d^j_{ni',t}/A^j_{i',t})^{-\theta}} = \left(\frac{\tilde{c}^j_{i,t} d^j_{ni,t}}{A^j_{i,t} p^j_{n,t}}\right)^{-\theta}. \quad (15)$$

Market Clearing (1)

and Accounting Indentities

- Let $Y^j_{n,t}$ be the gross production of sector j goods/services in country n in period t. Then

$$Y^j_{n,t} = \sum_{i=1}^{N} \pi^j_{in,t} X^j_{i,t}. \quad (16)$$

- For $j = a, s$,

$$X^j_{n,t} = p^j_{n,t} C^j_{n,t} + \sum_{j'=a,m,s} (1-\gamma)\beta^{M,j'j} Y^{j'}_{n,t}. \quad (17)$$

- For $j = m$,

$$X^m_{n,t} = p^m_{n,t} C^m_{n,t} + p^m_{n,t} I_{n,t} + \sum_{j'=a,m,s} (1-\gamma)\beta^{M,j'j} Y^{j'}_{n,t}. \quad (18)$$

Market Clering (2)

- Labor markets clear

$$w_{n,t} L_{n,t} = \gamma(1-\alpha) \sum_{j=a,m,s} Y_{n,t}^{j}. \tag{19}$$

- Capital markets clear

$$r_{n,t} K_{n,t} = \gamma\alpha \sum_{j=a,m,s} Y_{n,t}^{j}. \tag{20}$$

Equilibrium

Given $\{K_{n,0}\}$, an equilibrium is a tuple of

- $\{w_{n,t}\}$ s.t. (19),
- $\{r_{n,t}\}$ s.t. (20),
- $\{E_{n,t}\}$ s.t. (4),
- $\{\tilde{c}^j_{n,t}\}$ s.t. (13),
- $\{p^j_{n,t}\}$ s.t. (14),
- $\{\pi^j_{ni,t}\}$ s.t. (15),
- $\{Y_{n,t}\}$ s.t. (16),
- $\{X^j_{n,t}\}$ s.t. (17) and (18),
- $\{\bar{\epsilon}_{n,t}\}$ s.t. (10),
- $\{\omega^j_{n,t}\}$ s.t. (5),
- $\{C_{n,t}\}$ s.t. (9),
- $\{K_{n,t}\}$ s.t. (8),
- $\{I_{n,t}\}$ s.t. (7).

Quantification

- We use novel expenditure data from Japanese households to estimate the parameters σ, ϵ_j, Ω^j in nonhomothetic utility.

- The calibration of other parameters follows Caliendo and Parro (2015) using WIOD.

Estimating the Nonhomothetic Utility (1)

- A property of the utility function (2) is, for $j = a, s$,

$$\log\left(\frac{\omega^j_{n,t}}{\omega^m_{n,t}}\right) = (1-\sigma)\log\left(\frac{p^j_{n,t}}{p^j_{n,t}}\right) + (1-\sigma)(\epsilon_j - \epsilon_m)\left[\log\left(\frac{E_{n,t}}{p^m_{n,t}}\right) + \frac{1}{1-\sigma}\log\omega^m_{n,t}\right] + \log\left(\frac{\Omega^j}{\Omega^m}\right). \tag{21}$$

Estimating the Nonhomothetic Utility (2)

- Since we have repeated cross-sectional data of households, let n and t be household and period.
- Then the econometric specification is, for $j = a, s$,

$$\log\left(\frac{\omega^j_{n,t}}{\omega^m_{n,t}}\right) = (1-\sigma)\log\left(\frac{p^j_{n,t}}{p^m_{n,t}}\right) + (1-\sigma)(\epsilon_j - 1)\log\left(\frac{E_{n,t}}{p^m_{n,t}}\right) + (\epsilon_j - 1)\log\omega^j_{n,t} + \zeta^j + \nu^j_{n,t}. \tag{22}$$

- But what's $p^j_{n,t}$?

Household-level Prices?

- We follow CLM.
- Let $q = 1, \cdots, Q_j$ be subcategories in sector j.
- Let $\omega^q_{n,t}$ be the expenditure share on q within j

$$\omega^q_{n,t} = \frac{E^q_{n,t}}{E^j_{n,t}} \tag{23}$$

- The price index of sector j for household n in period t is

$$\log p^j_{n,t} = \sum_{q=1}^{Q_j} \omega^q_{n,t} \log p^q_{r(n),t}, \tag{24}$$

  where $r(n)$ denotes the region where household n lives.
- We instrument $\log(p^j_{n,t}/p^m_{n,t})$ by the Hausman instrument$\log(p^j_{-r(n),t}/p^m_{-r(n),t})$, where

$$\log p^j_{-r(n),t} = \sum_{q=1}^{Q_j} \omega^q_{r(n),t} \log p^q_{-r(n),t}. \tag{25}$$

・日本語概要

経済活動のサービス化というのは、女性の就労行動を考える上でも非常に重要であることが従来の研究でも指摘されてきた。別添３においては、我が国における経済のサービス化、すなわち製造業の衰退の背景にあるメカニズムを解明するための数量的一般均衡モデルについて解説している。ここで筆者らが注目したのは、製造業の衰退を説明しうる二つの経済学的メカニズムである。一つ目は、所得が上昇することにより、消費者の消費性向が製造業からサービス業へとシフトしていくという、選好にもとづく構造変化である。もう一つは、中国を代表とする新興国の台頭による国際的な生産の分業の深化であり、すなわち、日本はサービス業に特化し、中国等の新興国が製造業に特化していくというものである。我々が構築した一般均衡モデルでは、ノンホモセティックな効用関数を持つ家計を包含する動学的な枠組みの中に、国際貿易を組み込むことにより、上記の二つのメカニズムが経済の構造変化を説明できるようにした。ノンホモセティックな効用関数の推定のためには、詳細な財レベルの支出データが必要となるため、総務省・家計調査から作られたモーメントにより、パラメータを推定するための手順についても資料内で詳述している。なお、現在、パラメータの推定を進めているところであり、数量的分析の結果については今後公開予定である。