China, Structural Change, and Multinational Production[1]

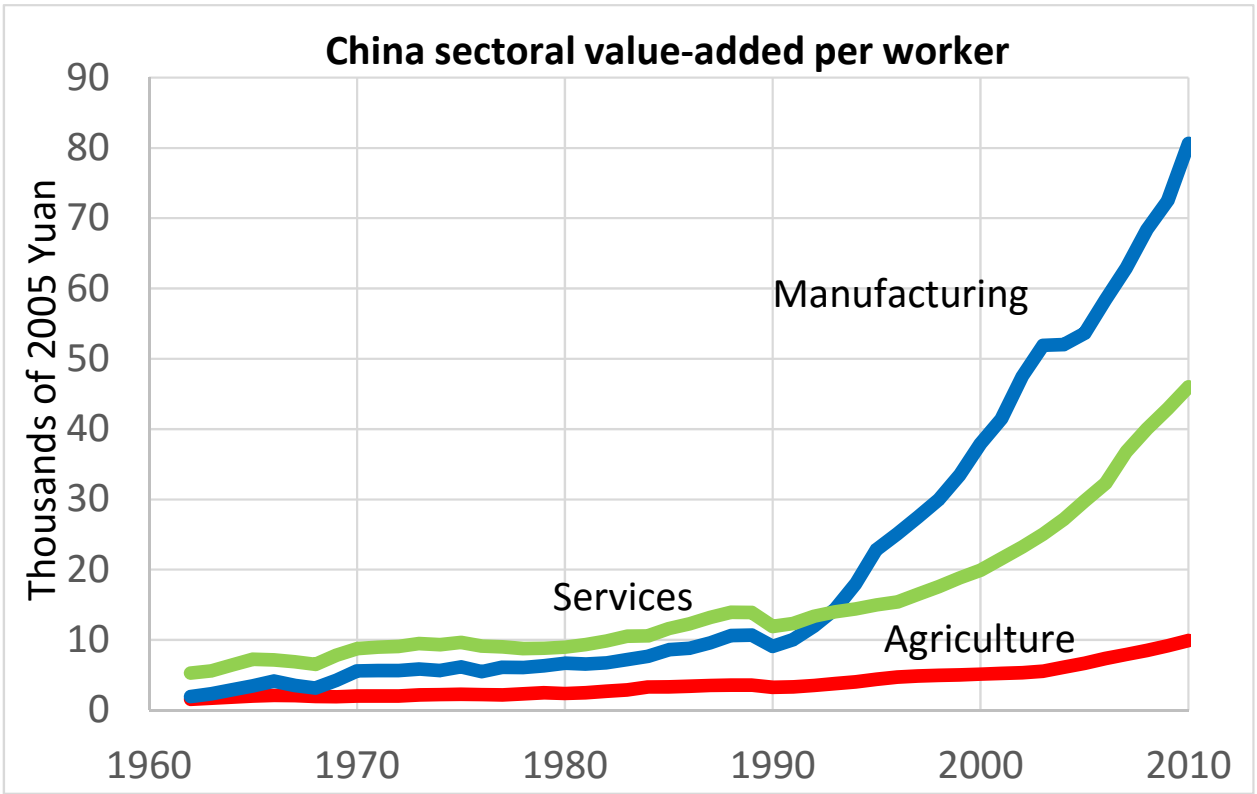
Kei-Mu Yi
University of Houston and NBER

May 23, 2016
ABFER 4th Annual Conference
Economic Transformation of Asia Session

[1] Preliminary and incomplete. The views expressed here are those of the author and are not necessarily reflective of views of the Federal Reserve Banks of Dallas, Minneapolis or the Federal Reserve System.

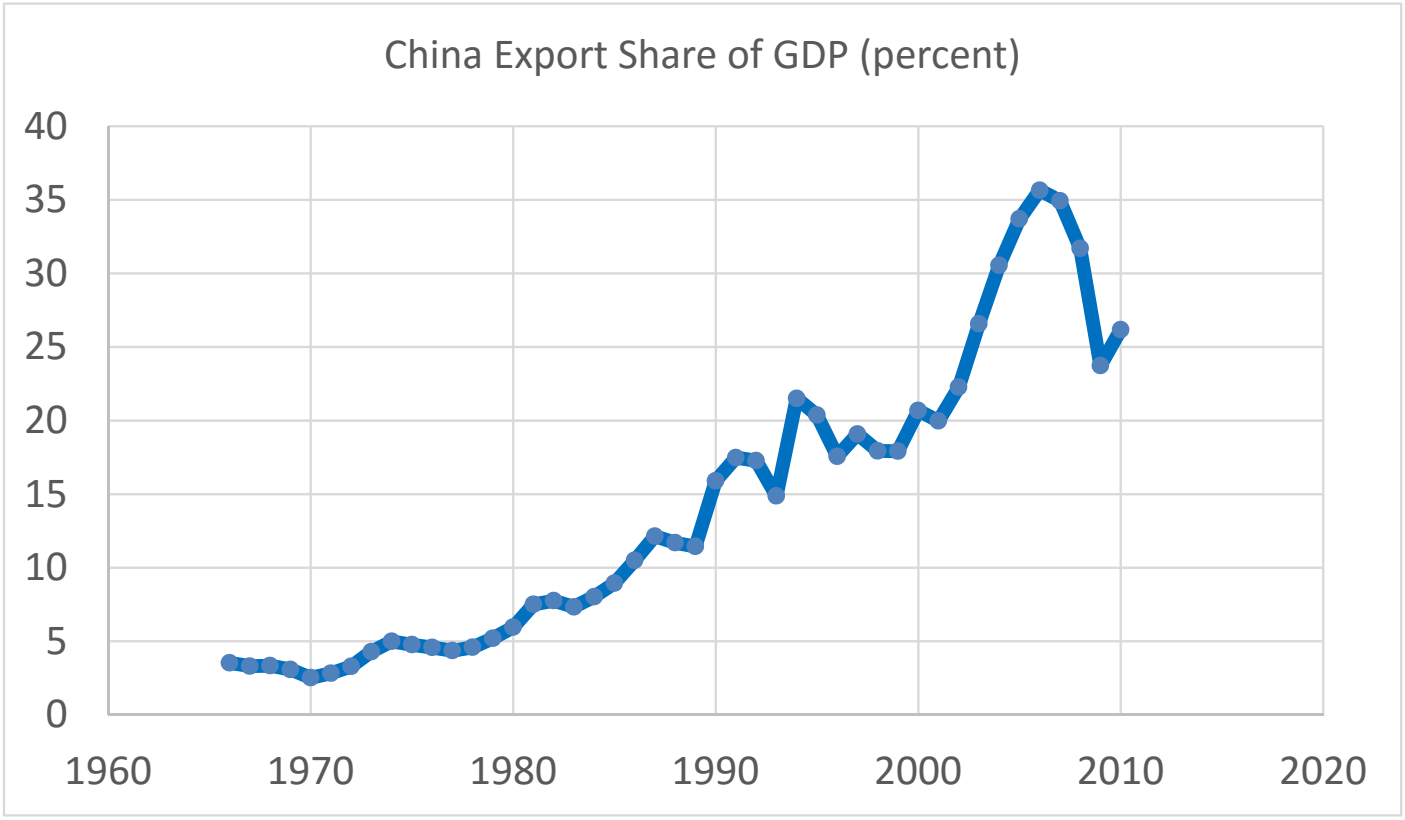
China's Sectoral Productivity Growth

China's manufacturing (and mining); services (including non-manufacturing industry); and agriculture sectors averaged 8.4, 5.3, and 4.6 percent growth, respectively, in value-added per worker between 1978 and 2010.



Data source: GGDC 10-sector database

China's Trade



Data source: World Bank, WDI

China's FDI

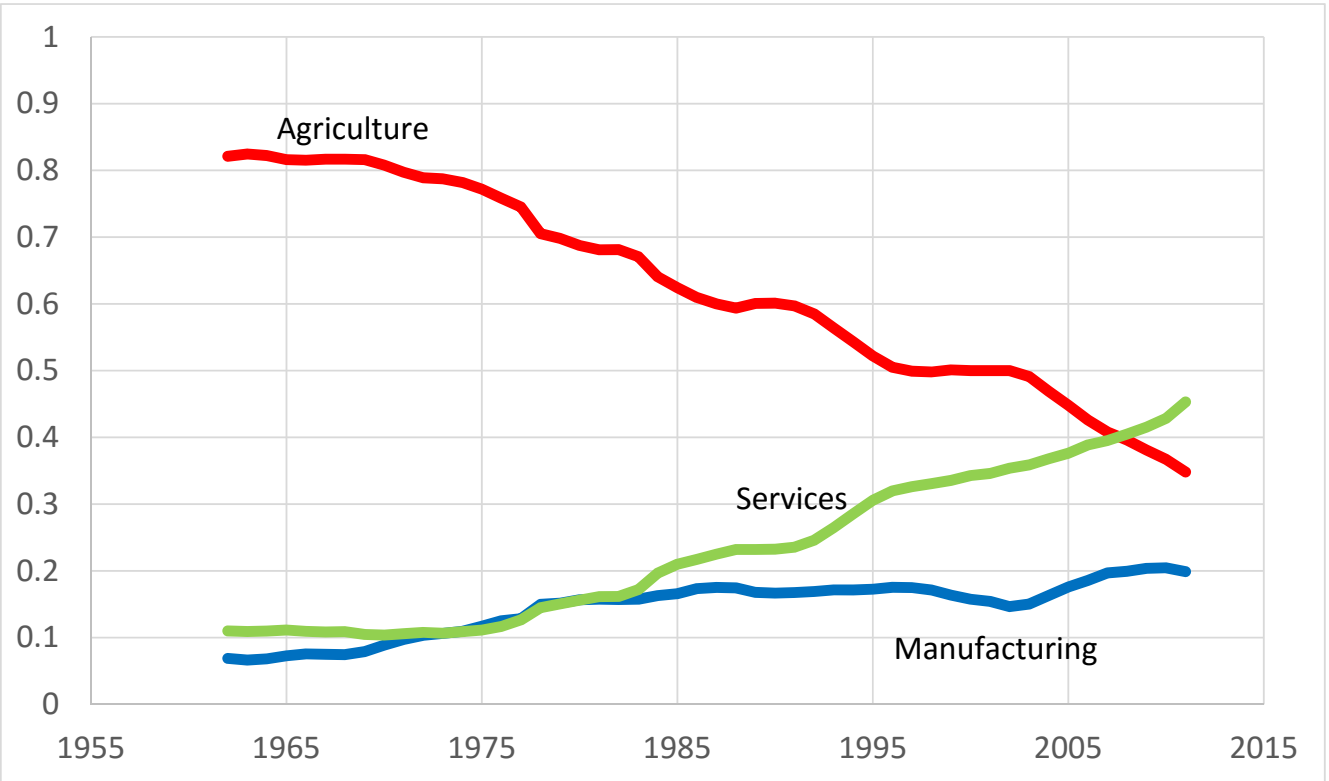
Inward FDI Stock in Billions of $ U.S.

1995	2011	2012	2013	2014
101.1	711.8	832.9	956.8	1085.3

Source: UNCTAD, World Investment Report 2015

Structural Change in China

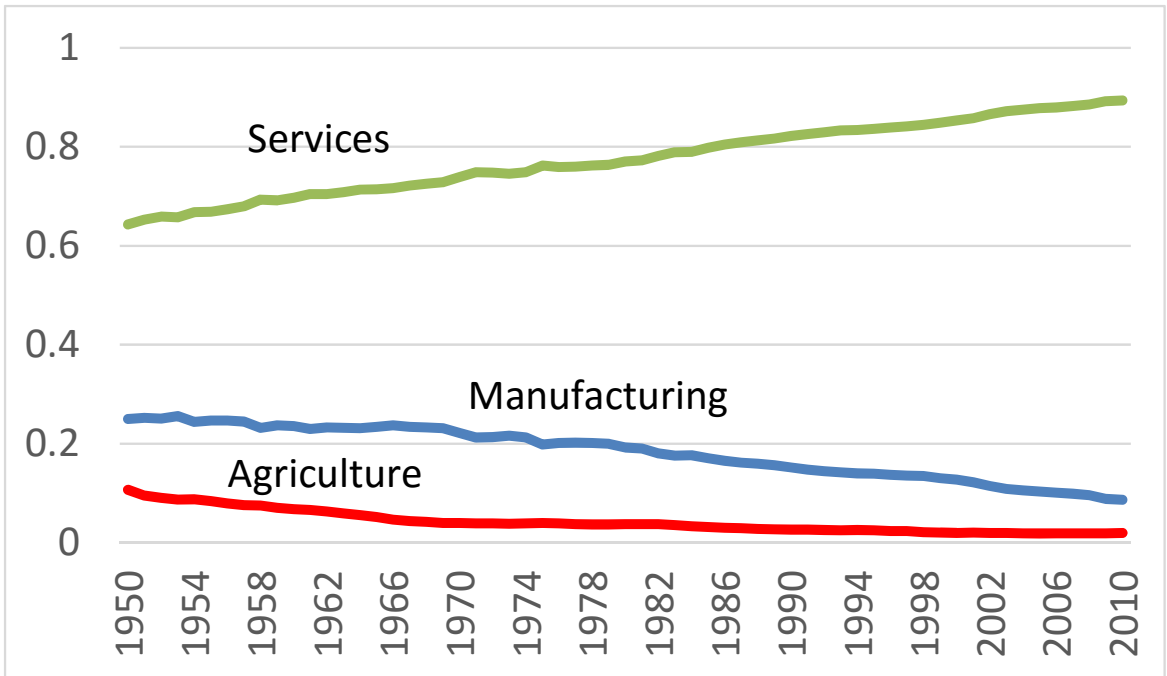
- China Sectoral Employment Shares:



Data source: GGDC 10-sector database

Structural Change in United States

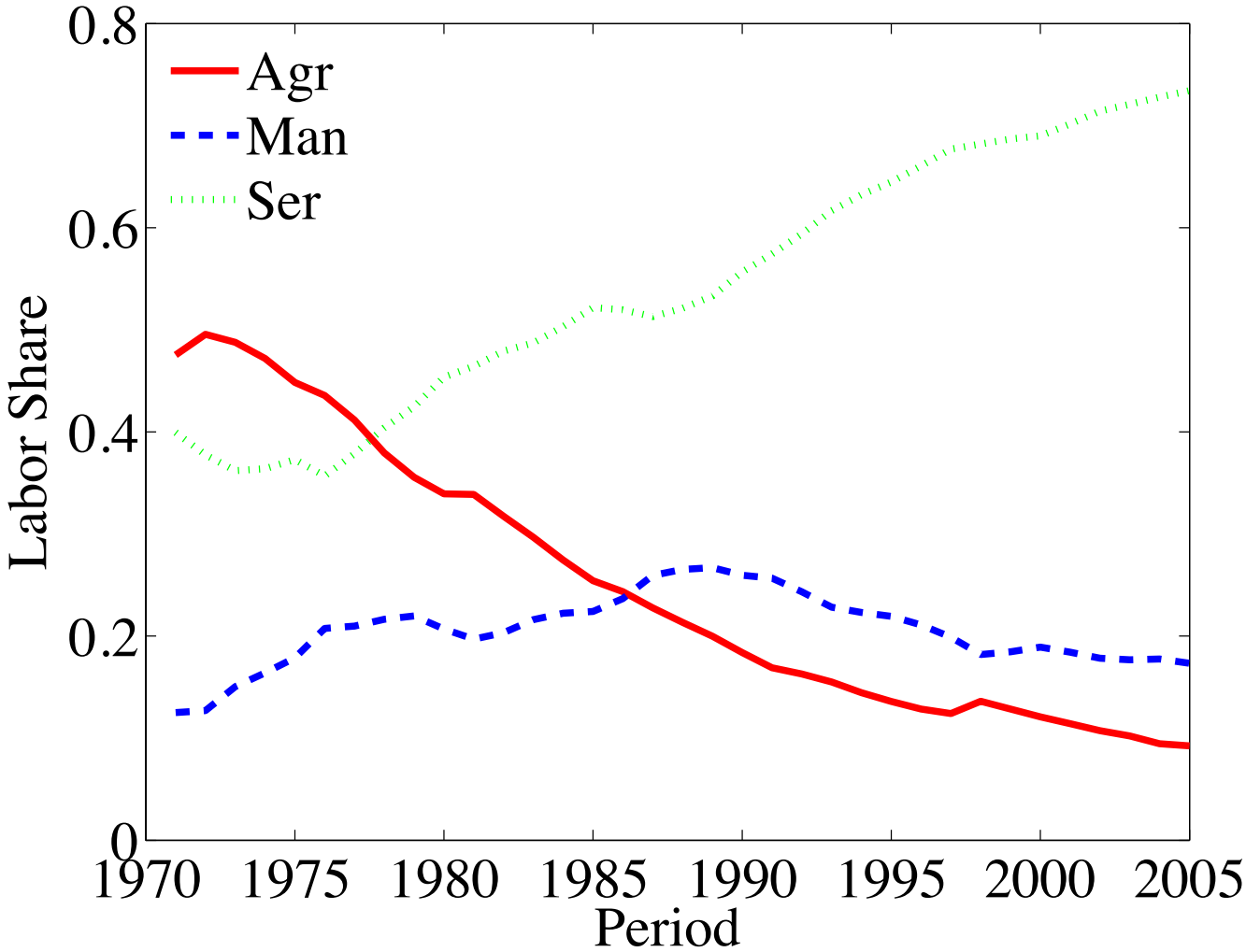
- U.S. Employment Shares:



Data source: GGDC 10-sector database

- "Hump" pattern in manufacturing employment shares common in OECD and many EM economies

Structural Change in South Korea



Data source: EU KLEMS database

Summary of Preceding Facts

China has experienced:

- High and asymmetric (across sectors) productivity growth
- Large increase in trade and inward FDI
- Rapid structural change

How do these facts fit together? Before turning to modeling frameworks, a little more data ...

Premature De-Industrialization?

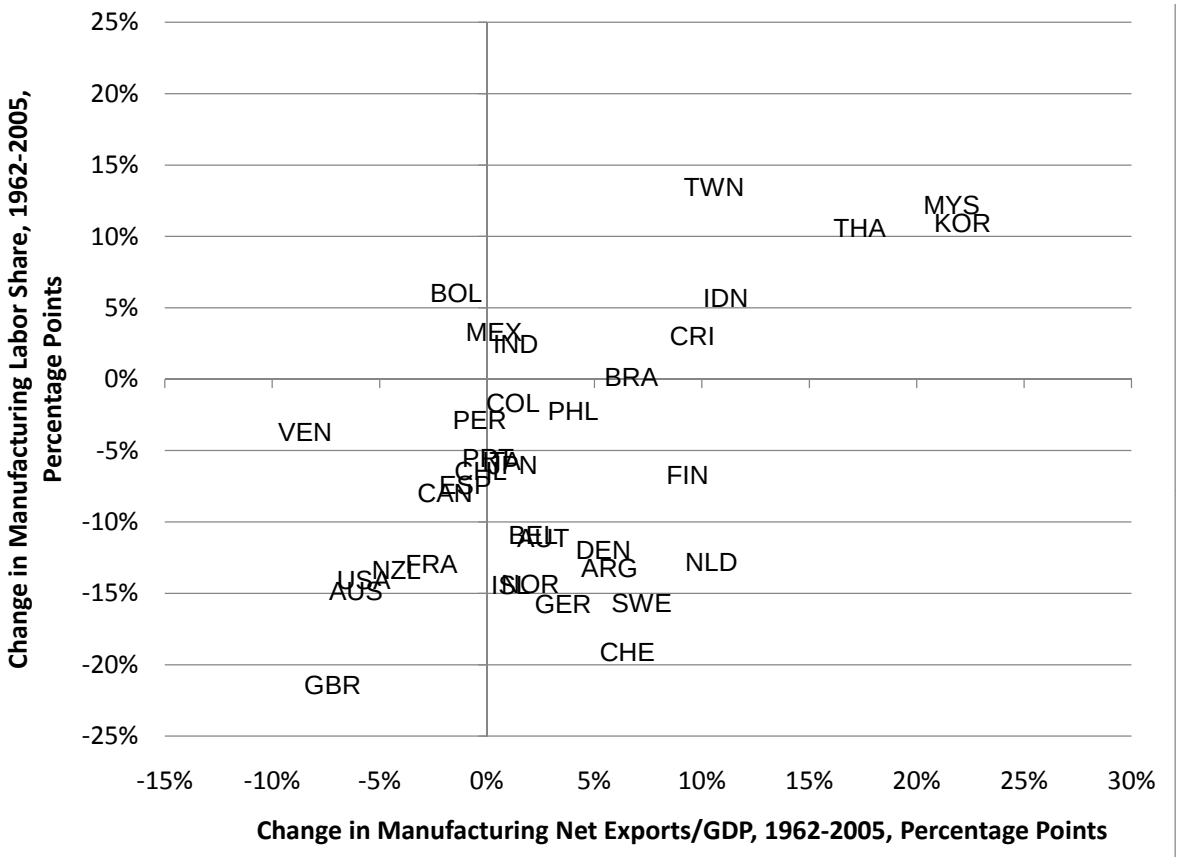
Rodrik (2016, JEG) documents: "A significant deindustrialization trend in recent decades that goes considerably beyond the advanced, post-industrial economies. The hump-shaped relationship between industrialization (measured by employment or output shares) and incomes has shifted downwards and moved closer to the origin. This means countries are running out of industrialization opportunities sooner and at much lower levels of income compared to the experience of early industrializers."

Trade Openness and Structural Change

- Structural change is ongoing and evolving in developed and emerging market countries
- Increased global trade has increased links between developed and emerging market countries
- Link between globalization and structural change?
  - Autor, Dorn, and Hanson (2012) attribute about 1/4 of decline in U.S. manufacturing employment to trade with China

Manufacturing Trade and Employment

Figure: Manufacturing Net Exports and Manufacturing Employment



Dominant Frameworks for Modeling Structural Change

- Non-unitary income elasticity of demand

  Engel (1895), Kongsamut, Rebelo and Xie (2001)

- Non-unitary substitution elasticity and sector-biased technical change

  Baumol (1967), Ngai and Pissarides (2007)

- Common feature: closed economy frameworks

Recent Research has Highlighted Role of Open Economy in Structural Change

- Main mechanism involves comparative advantage and international trade
  - Relatively high sectoral productivity growth and/or declines in barriers to trade (trade costs) in a country changes comparative advantage and specialization patterns, which affects sectoral composition of employment (and output)
  - See, for example, Uy, Yi, Zhang (2013); Teignier-Bacque (2014); Sposi (2015); Swiecki (2015); Betts, Giri, Verma (2015)
  - Related research includes Levchenko and Zhang (2016); Caliendo and Parro (2015);

Multinationals and Structural Change

- Multinationals have played large role in globalization – responsible for significant fraction of increase in international trade, and, most (all?) of increase in FDI
- Multinationals have played significant role in China's economic development
- Boehm, Flaaen, and Pandalai-Nayar (2015) find U.S. multinationals responsible for large share of decline in U.S. manufacturing employment since 1990
- What role do multinationals play in hump pattern, and in speeding up of de-industrialization in recent decades?

Goal and What I Do

Study role of multinationals in structural change in open economy

- Develop simple two-country, three-sector model with:
  - Ricardian trade (Eaton and Kortum (2002), Uy, Yi, and Zhang (2013))
  - Multinational production (Ramondo and Rodriguez-Clare (2013), Alviarez (2014))
- Develop intuition for how multinationals can lead to and propagate structural change in an open economy

Set up

- Two countries
- Three sectors: agriculture, manufacturing, services
  - Continuum of goods in each sector
  - Services are nontradable
- One factor of production: labor
  - Mobile across sectors, but immobile across countries
- Productivity levels (and growth rates) differ across sectors and countries
- Trade: based on Ricardian comparative advantage
  - Iceberg trade costs
- Multinational Production: Manufacturing sector only
- Perfect competition in all markets

Preferences and Budget Constraint

- Cobb-Douglas utility across sectoral goods:

$$U(C_n^a, C_n^m, C_n^s) = (C_n^a)^{\mu^a}(C_n^m)^{\mu^m}(C_n^s)^{\mu^s}$$

  - Sectoral elasticities of substitution and income: 1
  - Any change in sectoral labor shares will be because of open economy (trade or MP)

- CES utility over individual goods:

$$C_n^j = \left[\int_0^1 c_n^j(u)^{\frac{\sigma-1}{\sigma}} du\right]^{\frac{\sigma}{\sigma-1}}$$

- Budget constraint (period-by-period):

$$\sum_{j=a,m,s} P_n^j C_n^j = w_n L_n$$

  - Static model over time

Technologies

- Continuum of goods in each sector j:

$$q_n^j(u) = z_n^j(u) L_n^j(u) \qquad u \in [0,1]$$

  - For $j = a, s$: $z_n^j(u)$ is distributed as $F_n^j(z) = \exp(-T_n z^{-\theta})$

- In manufacturing, there is possibility of multinational production (MP); each country can produce a particular good at home or abroad. Technology is drawn for each production possibility:

$$F(\mathbf{z}_i^m; T_i) = exp\left\{ -T_i \left[\sum_l (z_{li}^m)^{-\theta} \right] \right\}$$

  - Draws are independent of each other
  - Hallmark of MP in model is that home country technology is combined with host country inputs

Input, trade, and MP costs

- Unit cost of input bundle is: $c_n^j = w_n$
- For each sector, iceberg trade costs: $d_{nl}^j \geq 1$ of sector j goods must be shipped from country l in order for country n to receive one unit
- For manufacturing, iceberg MP costs, which raise the cost of using technology from country i to produce in country l:

$$c_{li}^m = c_l^m h_{li}^m$$

where $h_{li}^m \geq 1$.

Sectoral Prices (Agriculture and Services)

$$P_n^j = \left[\int_0^1 p^j(u)^{1-\sigma} du \right]^{\frac{1}{1-\sigma}}$$

- For agriculture (and services), sectoral prices have usual EK formulation:

$$P_n^a = \gamma \left[\sum_i T_i^a \left(c_i^a d_{ni}^a \right)^{-\theta} \right]^{-1/\theta}$$

Sectoral Prices (Manufacturing; 1)

Price that importer country n pays for a manufactured good u is outcome of double minimization:

1. Minimize over host countries for a given technology, e.g., country i technology:

$$p_{ni}^{m}(u) = min_{l}\left(\frac{c_{li}^{m} d_{nl}^{m}}{z_{li}^{m}(v)}\right)$$

   - Note that there are potentially both MP costs and trade costs

2. Minimize over home country technologies:

$$p_{n}^{m}(u) = min_{i}\left(p_{ni}^{m}(u)\right)$$

Sectoral Prices (Manufacturing; 2)

Manufacturing sectoral price index is given by:

$$P_n^m = \gamma \left[\sum_i T_i^m \left(\tilde{c}_{ni}^m \right)^{-\theta} \right]^{-1/\theta}$$

where

$$\tilde{c}_{ni}^m = \left[\sum_k \left(c_{ki}^m d_{nk}^m \right)^{-\theta} \right]^{\frac{-1}{\theta}}$$

- The cost bundle reflects all the possible locations where the good can be produced.

Expenditure Shares (Agriculture and Services)

For agriculture (and services), expenditure by country n on goods from country i is given by familiar expression:

$$\pi_{ni}^{a} = \frac{T_i^a \left[c_i^a d_{ni}^a\right]^{-\theta}}{\sum_{k=1}^{I} T_k^a \left[c_k^a d_{ki}^a\right]^{-\theta}}$$

Expenditure Shares (Manufacturing;1)

For manufacturing, it is more complicated:

$$\pi_{nli}^{m} = \frac{T_i^m \left(\tilde{c}_{ni}^m\right)^{-\theta}}{\sum_j T_j^m \left(\tilde{c}_{nj}^m\right)^{-\theta}} \frac{\left(c_{li}^m d_{nl}^m\right)^{-\theta}}{\sum_k \left(c_{ki}^m d_{nk}^m\right)^{-\theta}}$$

where $\tilde{c}_{ni}^m = \left[\sum_k \left(c_{ki}^m d_{nk}^m\right)^{-\theta}\right]^{\frac{-1}{\theta}}$

- This captures share of country n's manufactured good spending on goods produced in country l with country i's technology.
- There are two terms on RHS. First term is share of country n's spending on goods produced with country i's technology, regardless of location of production. Second term is, conditional on being produced with i's technology, share of spending on goods produced in country l.

Expenditure Shares (Manufacturing;2)

Manufacturing expenditure share simplifies to:

$$\pi_{nli}^{m} = \frac{T_i^m \left(c_{li}^m d_{nl}^m\right)^{-\theta}}{\sum_j T_j^m \left(\tilde{c}_{nj}^m\right)^{-\theta}}$$

MP

Total MP in country l using i's technology is given by:

$$Y_{li}^{m} = \mu^{m} \sum_{n} \pi_{nli}^{m} w_n L_n$$

- This is total spending on manufactured goods multipled by fraction of that spending that is on goods produced in l with i's technology, summed over all spending countries.

This yields:

$$Y_{li}^{m} = \frac{\mu^{m} T_i^{m} c_{li}^{m-\theta}}{p_l^{m-\theta}} \sum_{n} \left(\frac{\gamma d_{nl}^{m} p_l^{m}}{p_n^{m}} \right)^{-\theta} w_n L_n$$

Trade Shares

- If we sum π^m_{nli} across countries i, we get the spending share by n on goods produced in l, i.e., the import share:

$$\pi^m_{nl} = \frac{\tilde{T}^m_l (c^m_l d^m_{nl})^{-\theta}}{\sum_{j=1}^{N} \tilde{T}^m_j (c^m_j d^m_{nj})^{-\theta}}$$

where

$$\tilde{T}^m_l = \sum_{i=1}^{I} T^m_i g^{m-\theta}_{li}$$

  - Import share is based on effective technology of a country, which is based on all the possible technologies from home and abroad that can be used to produce in that country, mitigated by the MP cost g

Labor Shares

- Labor share in country 2 sector j is given by:

$$\lambda_2^j = \mu^j \left(\pi_{22}^j + \frac{\pi_{12}^j w_1 L_1}{w_2 L_2} \right)$$

  - Sectoral labor share is given by the Cobb-Douglas weight times the share of 2's spending on its own sectoral goods plus 1's spending on 2's sectoral goods normalized by 2's GDP
  - In manufacturing, spending share by country 1 or 2 on country 2's goods is summed over all possible technology source countries for country 2's goods
  - In absence of trade, $\lambda_2^j = \mu^j$
  - What multinationals do is affect π_{nl}^m directly, and π_{nl}^a and π_{nl}^s indirectly, through GE effects.

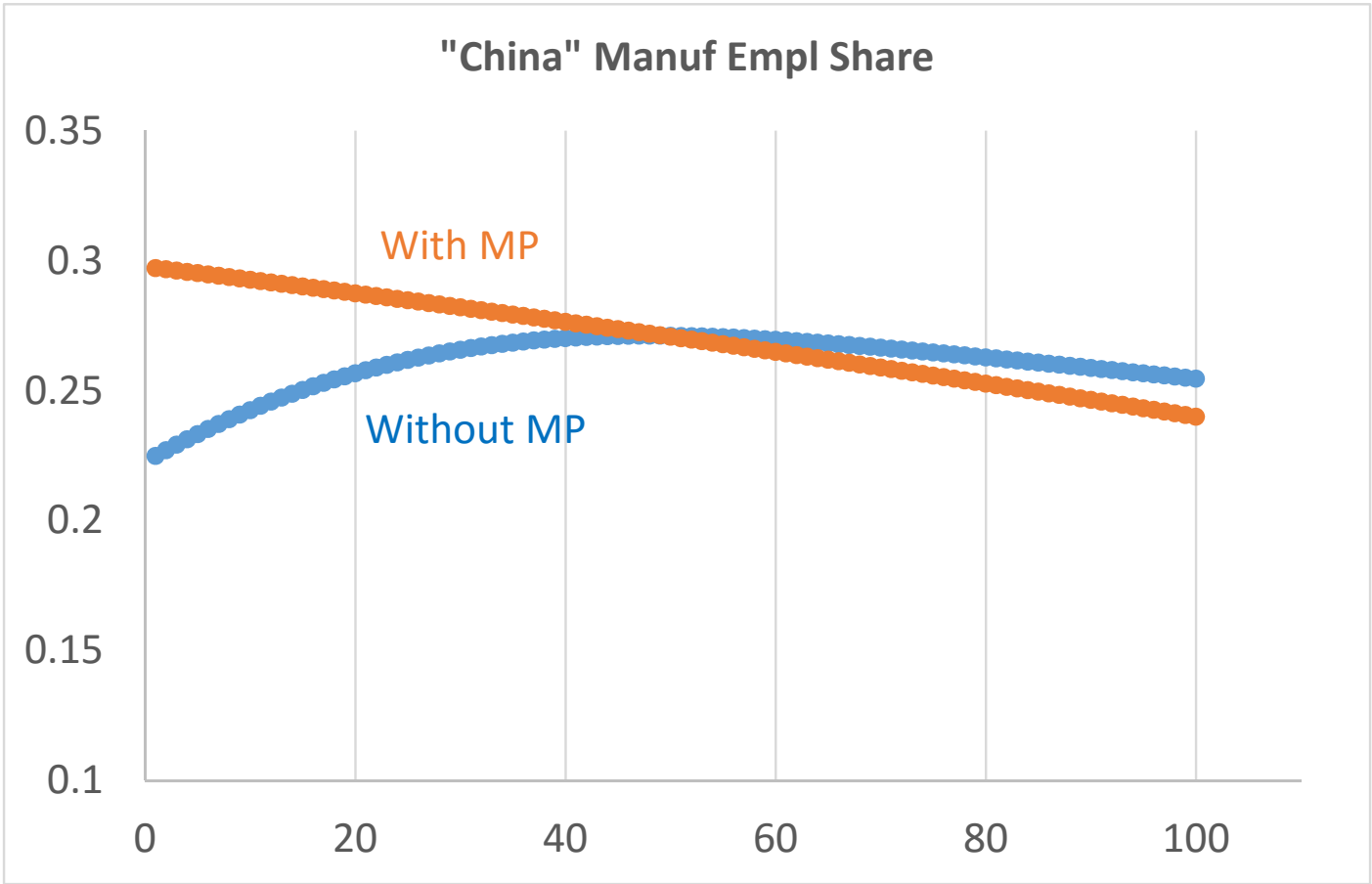
Two Sets of Exercises

1. Compare sectoral employment effects of asymmetric sectoral TFP growth in model with trade only vs. model with trade and MP
2. Compare sectoral employment effects of asymmetric sectoral TFP growth, asymmetric sectoral trade cost declines, (and in model with MP, MP cost declines) in model with trade only vs. model with trade and MP

First Exercise: Asymmetric TFP growth under frictionless trade with and without MP

- Two countries: labor endowment, sector weights, and initial sectoral TFP, set to loosely correspond to U.S. and China
  - China has comparative advantage in manufacturing
- Agriculture and manufacturing have frictionless trade; services effectively non-traded
  - In MP case, frictionless MP, too
- Starting in period 1, high TFP growth in manufacturing, and low TFP growth in agriculture, in China
  - U.S. has zero TFP growth in each sector
  - Next graph shows manufacturing labor share in China for the with MP and without MP cases

First Exercise: Manuf labor share, with and without MP



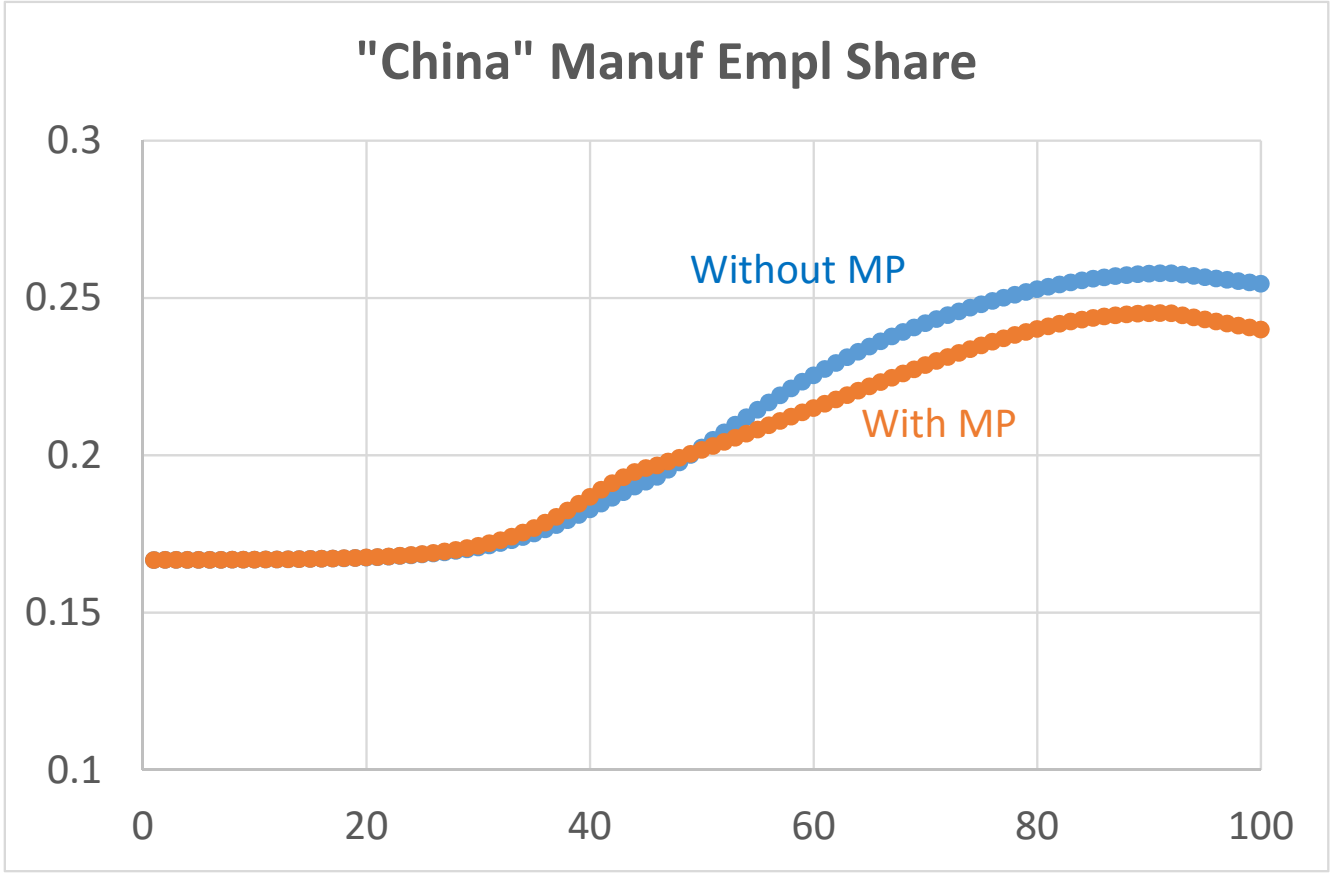
Intuition for First Exercise

- Without MP: "hump" pattern in manuf L share (as shown in UYZ, 2013)
  - Increasing comparative advantage over time leads to increased net exports in manufacturing and in manuf L share
  - However, owing to higher Chinese income and wages, relative size of U.S. market declines – fewer Chinese workers needed to serve U.S. market, and, owing to ever increasing productivity, fewer workers needed to serve China's market
- With MP: initial manuf L share high; then, over time, declines
  - Initially, low wages in China leads to U.S. sourcing MP in China
  - Over time, as China's productivity (and wages) increase, forces in non-MP case above are complemented by China sourcing MP in U.S.
  - Eventually, China manuf L share lower than in non-MP case

Second Exercise: Asymmetric TFP growth and trade cost declines (as well as MP cost declines in MP model) with and without MP

- Labor endowments, initial sectoral TFP, and sector weights same as in first exercise
  - Initially, trade and MP costs sufficiently high that all three sectors effectively non-traded; no MP
- Starting in period 1:
  - High TFP growth in manufacturing and low TFP growth in agriculture in China; 0 TFP growth in U.S.
  - Rapid decline in manufacturing trade costs, slow decline in agriculture trade costs, in both countries
  - In model with MP, decline in MP costs over time in both countries

Manuf labor share, with and without MP



Intuition for Second Exercise: Without MP

- Initially, economy effectively closed
- As trade costs decline and China's productivity in manufacturing increases, China's comparative advantage in manufacturing emerges and strengthens: manuf L share increases
- Eventually, forces underlying declining portion of hump (decreasing size of export market; high manufacturing productivity) become important, and manufacturing L share flattens and begins to decline

Intuition for Second Exercise: With MP

- Overall pattern is same as above, with some nuances
  - As costs of trade and MP decline, and as China's manufacturing productivity increases, trade and MP increase
  - Early on, owing to U.S. absolute advantage in manufacturing and low Chinese wages, U.S. sources MP in China; also, China's comparative advantage in manufacturing increases; hence, China's manuf L share increases for both reasons
  - Over time, as China's productivity in manufacturing, and wages, increase, China starts sourcing MP in U.S.
  - Eventually, China's manuf L share is lower than in non-MP case

Conclusion

- Presence of MP can potentially help us understand patterns of structural change, especially in manufacturing, in China and other countries
  - Can potentially help explain decline, and recent rapid rate of decline, in manufacturing employment in U.S. and other countries
  - China's manufacturing employment share will likely decline going forward; the question is how fast

Future Research

- Study simple model further
  - Allow services to have MP
  - Develop propositions
- Develop richer model for quantitative research
  - Modify preferences to allow non-homothetic preferences, and non-unitary substituton elasticities
  - Modify production structure to allow for intermediate goods and vertical specialization, and inter-sectoral linkages
  - Calibrate model to sectoral trade, output, employment, and multinat data across countries and over time