# Does Openness Matter for Structural Change?

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# Motivation

- Structural change is defined as long-run shifts in relative sizes of major sectors of economy
- It has typically been studied in a context of a closed economy
- Yet much of the political debate these days revolves around trade-induced de-industrialisation
- How important is trade in explaining de-industrialization against the backdrop of secular decline in manufacturing?

# Research questions and method

Focus on manufacturing value added (MVA) shares

1. What are the channels that lead to structural change in an open economy? Their quantitative importance?
   - Use a changes decomposition of MVA shares in the WIOD data
2. What fundamental shocks stand behind the operation of these channels?
   - Use a quantitative model to study effects of shocks on the size of the manufacturing sector

# Summary of results

Channels:

- It is true that the demand for manufacturing has declined around the world
- But over and above it, the manufacturing shares responded to
  - Shifts in competitiveness in international trade
  - Increasing trade imbalances between countries

Shocks:

- Shifts in competitiveness are mainly driven by evolution of comparative advantage

**Abstracting from openness limits severely our capacity to understand and model structural change**

# Literature

Structural change:

- Closed economy: Ngai and Pissarides (2007), Acemoglu and Guerrieri (2008), Kongsamut et al. (2001), Herrendorf et al. (2013), etc
- I-O: Sposi (2015)
- Trade: Matsuyama (2009), Uy et al. (2013), Cravino and Sotelo (2017)
- Deficits: Kehoe et al. (2018)

Trade:

- Ricardian models: Eaton and Kortum (2002), Dekle et al. (2007)

# Roadmap

Channels:

1. Closed economy: small example
2. Open economy: MVA share changes decomposition
3. Application

Shocks:

1. Structural model
2. Shifts in competitiveness: comparative advantage or trade costs?

# Channels: Decomposition Analysis

# Closed economy: shocks and channels

- Two forces produce structural change in a closed economy:
  1. Differential sectoral productivity growth + non-unitary EoS
  2. Income growth + non-homothetic preferences
- In both cases, shocks are to sectoral productivity
- But the channel is adjustment of agents' expenditures portfolio
- Everything that happens to MVA share in a closed economy can be traced back to changes in expenditure allocation decisions
- An easy way to quantify contribution of channels
- NB: not causal, more of a "proximate causes" type of thing

# Structural change in a closed economy: small example

- Suppose there are two sectors: $\{m, s\}$
- Only $m$ is used as intermediate input
- The market clearing condition for $m$ is

$$Y_m = X_m + M_m + M_s,$$

where

- $Y_m$ is manufacturing sales
- $X_m$ is manufacturing final expenditure
- $M_k$ manufacturing intermediate inputs purchased by sector $k$

# Structural change in a closed economy: small example

- Rewrite demand terms as shares of expenditure:

$$X_m = S_m Y, \quad M_m = \beta_m Y_m, \quad M_s = \beta_s Y_s,$$

where

  - $S_m$ is the manufacturing final expenditure share
  - $Y$ is total final expenditure (= income)
  - $\beta_k$ be the share of $k$'s sales spent on manufacturing inputs

- Easy to show that

$$va_m = S_m + \beta_s S_s \quad \text{and} \quad \Delta va_m \approx \Delta S_m + S_s \Delta\beta_s + \beta_s \Delta S_s$$

- In a closed economy structural change occurs via the final expenditure share and intermediate input use channels

# From closed to open

- In an open economy domestic production and consumption are decoupled:
  - No need to produce everything at home, trade instead
  - Total final expenditure not bound by income from selling output: borrow to spend more today
- What a country ends up producing now depends on demand at home and abroad, import decisions and total trade deficit
- Structure of an economy is determined globally

# Structural change in an open economy: general case

- Obtain a similar $va_m$ changes decomposition
- Take market clearing condition of manufacturing in country $i$:

$$Y_{im} = \sum_j X_{jim},$$

where $X_{jim}$ is expenditure of country $j$ on manufacturing from $i$

- Break down into shares:
  - Import share $\Pi_{jim}$: $X_{jim} = \Pi_{jim}(X_{jm} + \sum_k M_{jkm})$
  - Expenditure and intermediate inputs use shares
  - Allow for total trade deficits

$$Y_{im} = \sum_j \Pi_{jim}(S_{jm} D_j Y_j + \sum_k \beta_{jkm} Y_{jk})$$

# Changes decomposition in an open economy

It can be shown that to a first order approximation

$$\Delta va_{im} \approx \underset{(II)}{\sum_{j,k,n} \phi^{\beta}_{jnk} \Delta\beta_{jnk}} + \underset{(ES)}{\sum_{j,k} \phi^{S}_{jk} \Delta S_{jk}} + \underset{(IS)}{\sum_{j,i,k} \phi^{\Pi}_{jik} \Delta\Pi_{jik}} + \underset{(TD)}{\sum_{i} \phi^{D}_{i} \Delta D_{i}}$$

MVA share changes can be traced back to changes in:

- Intermediate inputs use (II)
- Final expenditure shares (ES)
- Import shares (IS)
- Total trade deficits (TD)

NB: (IS) and (TD) are new! those are open economy channels

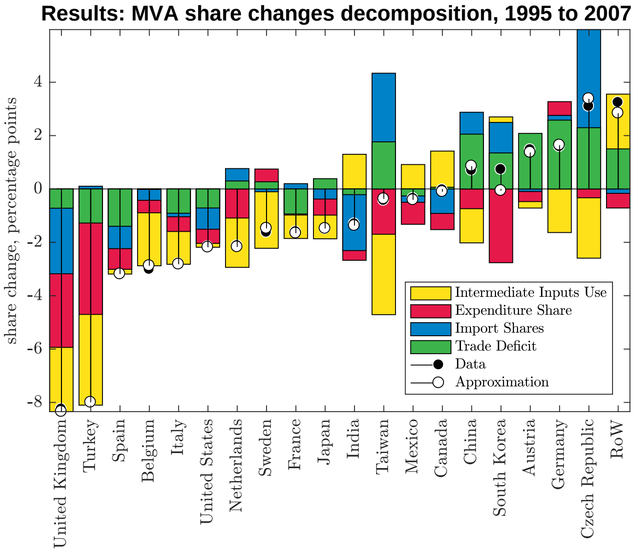
# Open economy channels: interpretation

$$\Delta va_{im} = \underbrace{\sum_{j,k,n} \phi^{\beta}_{jnk} \Delta\beta_{jnk}}_{(II)} + \underbrace{\sum_{j,k} \phi^{S}_{jk} \Delta S_{jk}}_{(ES)} + \underbrace{\sum_{j,i,k} \phi^{\Pi}_{jik} \Delta\Pi_{jik}}_{(IS)} + \underbrace{\sum_{i} \phi^{D}_{i} \Delta D_{i}}_{(TD)}$$

- (IS) captures the importing decisions of the trading partners
- (IS) will increase if trading partners switch towards $i$'s manufacturing and away from other exporters
- (TD) captures the composition effects arising from transferring purchasing power across countries
- (TD) will increase if $i$ runs total trade surplus and manufacturing is more tradeable than services

# Data

- Apply the decomposition to the WIOD data
- Period: 1995 to 2007
- Countries: 20 largest exporters in the sample
- 35 industries aggregated into 3 sectors: agriculture, manufacturing and services
  - Agriculture includes agriculture and food production
  - Manufacturing corresponds to B, C in ISIC rev. 4
- Apply year-by-year, then add up


Results: MVA share changes decomposition, 1995 to 2007
share change, percentage points
4
2
0
-2
-4
-6
-8
United Kingdom
Turkey
Spain
Belgium
Italy
United States
Netherlands
Sweden
France
Japan
India
Taiwan
Mexico
Canada
China
South Korea
Austria
Germany
Czech Republic
RoW
Intermediate Inputs Use
Expenditure Share
Import Shares
Trade Deficit
Data
Approximation

# Decomposition analysis: variance decomposition

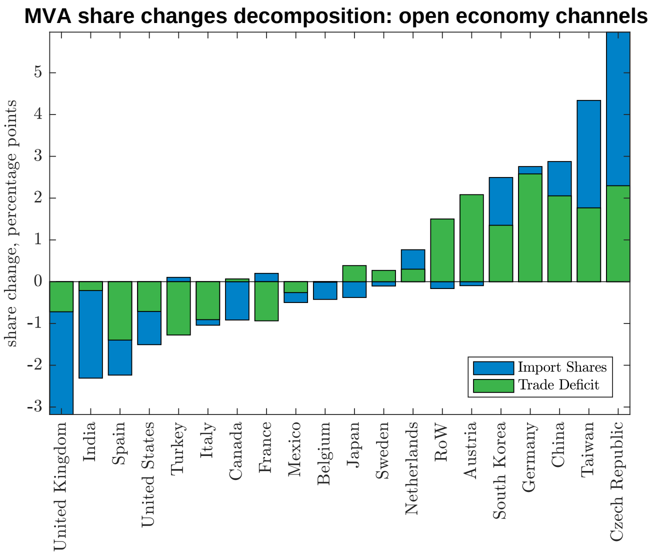
$$Var(\Delta va_{im}) = Var(II) + Var(ES) + Var(IS) + Var(TD) + \sum 2Cov(...)$$

Decomposition of $Var(\Delta va_{im})$

| $Var(II)$ | $Var(ES)$ | $Var(IS)$ | $Var(TD)$ | $\sum 2Cov(...)$ |
|---|---|---|---|---|
| 26% | 12% | 21% | 18% | 23% |

38% vs 39%: openness is half of the story!

# Decomposition analysis: heterogeneous effects



# Decomposition takeaways

- Secular decline of manufacturing continues but
- Offset completely by rising competitiveness and favourable trade balance in some countries
- And compounded by loss of competitiveness and trade deficits in others
- Can we say anything about the fundamental shocks driving these channels?
- Still work in progress, for the time being focus on competitiveness and leave deficits as exogenous

# Shocks: Structural Model

# Multi-sector Eaton and Kortum (2002) with I-O

Consumption and production

- Household utility is C-D
- Sectoral varieties are produced with labour and sectoral intermediate inputs using C-D technology
- Productivity of a variety is drawn from Frechet distribution

Markets

- Countries trade sectoral varieties
- Trade costs are iceberg
- Deficits are modelled as exogenous transfers between countries

Details of the model here

# Tying back in

- Same manufacturing market clearing condition holds:

$$Y_{im} = \sum_j \Pi_{jim}(\alpha_{jm} D_j Y_j + \sum_k \beta_{jkm} Y_{jk}),$$

- But now import shares are endogenous:

$$\Pi_{ijm} = \frac{(c_{jm} d_{ijm} / A_{jm})^{-\theta_m}}{\sum_l (c_{lm} d_{ilm} / A_{lm})^{-\theta_m}}$$

- Importing decisions depend on costs of production $c_{jk}$ (endog), trade costs $d_{jik}$ and sectoral productivities $A_{jk}$
- What is the relative contribution of $d_{jik}$ and $A_{jk}$ to the operation of the import shares channel?

# To proceed

- Rewrite the model in changes (ala Dekle et al. (2007))
- Calibrate the model
  - Estimate parameters $\alpha_{ik,t}, \beta^{n}_{ik,t}, \beta^{L}_{ik,t}$
  - $\theta_k$ taken from the literature
  - Back out shocks $(\hat{L}_{i,t}, \hat{A}_{ik,t}, \hat{d}_{ijk,t}, \hat{D}_{i,t})$
- Simulate the model with different sets of shocks on and off
- Compare the MVA share decomposition of counterfactuals to infer effects of shocks

# Calibration

- $\alpha_{ik,t}, \beta^{n}_{ik,t}, \beta^{L}_{ik,t}$ parameters are time-varying, (=expenditure shares)
- $\theta_k = 5$ for all sectors
- $\hat{L}_{i,t}, \hat{D}_{i,t}$ taken directly from the data
- $\hat{A}_{ik,t}, \hat{d}_{ijk,t}$ are backed out using equations from the model and
  - Data on trade flows
  - Model-based wages ($GDP/emp$)
  - Head and Ries (2001) trade costs for a reference country
  - Details on the method available here

# Counterfactual simulations

- Run 4 simulations
  - $\hat{A}_{ik,t} = \hat{d}_{ijk,t} = 1$ (both off)
  - $\hat{A}_{ik,t} = 1$ (changes in trade costs only)
  - $\hat{d}_{ik,t} = 1$ (changes in productivity only)
  - Both on (matches the data by construction)
- $\hat{L}_{i,t}, \hat{D}_{i,t}$ are always on as controls

# Compare channel decompositions of different simulations

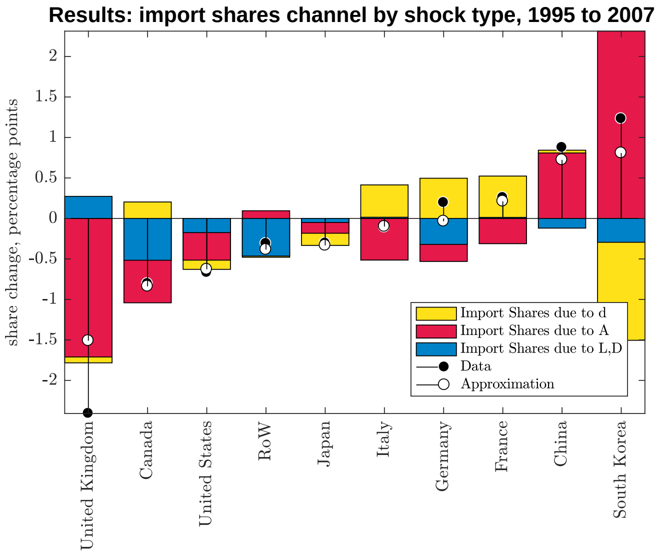
$$\Delta va_{im} = \underbrace{\sum_{j,k,n} \phi^{\beta}_{jnk} \Delta\beta_{jnk}}_{(II)} + \underbrace{\sum_{j,k} \phi^{\alpha}_{jk} \Delta\alpha_{jk}}_{(ES)} + \underbrace{\sum_{j,i,k} \phi^{\Pi}_{jik} \Delta\Pi_{jik}}_{(IS)} + \underbrace{\sum_{i} \phi^{D}_{i} \Delta D_{i}}_{(TD)}$$

- Decompose MVA share changes in each counterfacutal
- It turns out that simulated series are approximately additive:

$$IS_{LdAD} \approx \underbrace{(IS_{LdD} - IS_{LD})}_{\text{due to trade costs}} + \underbrace{(IS_{LAD} - IS_{LD})}_{\text{due to productivity}} + \underbrace{IS_{LD}}_{\text{everything else}},$$

i.e. changes in the data can be closely matched by a sum of changes from different simulations

# Trade costs vs sectoral productivity



# Trade costs vs sectoral productivity: variance decomposition

$$Var(IS_{LdAD}) \approx Var\left[(IS_{LdD} - IS_{LD}) + (IS_{LAD} - IS_{LD}) + IS_{LD}\right] =$$

$$Var(IS_{LdD} - IS_{LD}) + Var(IS_{LAD} - IS_{LD}) + Var(IS_{LD}) + \sum 2Cov(...)$$

| Decomposition of $Var\left[(IS_{LdD} - IS_{LD}) + (IS_{LAD} - IS_{LD}) + IS_{LD}\right]$ | | | |
|---|---|---|---|
| $Var(IS_{LdD} - IS_{LD})$ | $Var(IS_{LAD} - IS_{LD})$ | $Var(IS_{LD})$ | $\sum 2Cov(...)$ |
| 50% | 219% | 12% | −181% |

**Sectoral productivity shocks explain 4 times more variation in the operation of the import shares channel**

# Conclusion

# Conclusion

- Where the economy stands in terms of it's manufacturing today is as much about competitiveness in trade and international borrowing as it is about sectoral demand
- Open economy framework key for thinking about sectoral dynamics
- This project suggests one such framework

# Model

# Consumption

- Population $L_i$ is exogenous
- Total trade deficit is modelled as transfers, $\sum_i D_i = 0$
- Utility gives rise to sectoral final expenditure:

$$U_i = \prod_k C_{ik}^{\alpha_{ik}}, \quad \sum_k \alpha_{ik} = 1, \quad X_{ik}^F = \alpha_{ik} E_i$$

- Each household supplies a unit of labour, deficit is shared:

$$E_i = w_i + \frac{D_i}{L_i}$$

# Production

- Production function of a variety $z$ in country $i$'s sector $k$:

$$y_{ik}(z) = a_{ik}(z) L_{ik,t}(z)^{\beta^L_{ik}} \prod_n M^n_{ik}(z)^{\beta^n_{ik,t}}$$

- Productivity of varieties in $i, k$ is drawn from Frechet distribution:

$$F_{ik}(a) = \exp\left[-\left(\frac{a}{\gamma A_{ik}}\right)^{\theta_k}\right],$$

  $A_{ik}$ governs average productivity of sector $k$ in $i$

- Varieties can be shipped abroad with an iceberg cost $d_{ijk,t}$

# Markets

- Import shares $\Pi_{ijk}$ are as in EK:

$$\Pi_{ijk} = \frac{(c_{jk} d_{ijk}/A_{jk})^{-\theta_k}}{\sum_l (c_{lk} d_{ilk}/A_{lk})^{-\theta_k}}$$

($c_{ik}$ is the cost of sector $k$ variety in $i$ with unit productivity)

- Sectoral sales in $i$ satisfy home and foreign demand:

$$Y_{ik} = \sum_j \Pi_{jik} X_{jk}, \quad \text{where} \quad X_{jk} = X_{jk}^F + \sum_n M_{jnk}$$

- Solve model in changes as in Dekle et al. (2007)
- Exogenous shocks: $\hat{L}_{i,t}, \hat{A}_{ik,t}, \hat{d}_{ijk,t}, \hat{D}_{i,t}$, where $\hat{x} = \frac{x_{t+1}}{x_t}$

Back to main

# Shocks calibration

# Calibration of trade cost and sectoral productivity shocks

- Take the following equations from the equilibrium in changes:

$$\hat{\Pi}_{ijk,t} = \frac{\hat{c}_{jk,t}\hat{d}_{ijk,t}}{\hat{A}_{jk,t}\hat{P}_{ik,t}}$$

$$\hat{c}_{ik,t} \approx \hat{w}_{i,t}^{\beta^L_{ik,t}} \prod_n \hat{P}_{in,t}^{\beta^n_{ik,t}}$$

$$\hat{P}_{ik,t} = \sum_j \Pi_{ijk,t-1} \frac{\hat{c}_{jk,t}\hat{d}_{ijk,t}}{\hat{A}_{jk,t}}$$

- Plug in $\hat{\Pi}_{ijk,t}$, $\Pi_{ijk,t-1}$ from the data
- Compute model consistent $\hat{w}_{i,t}$ and plug in

# Calibration of trade cost and sectoral productivity shocks

- That's $c \times (c+1) \times K \times (T-1)$ equations in $c \times (c+2) \times K \times (T-1)$ unknowns
- Need another $c \times K \times (T-1)$ restrictions
- Literature has worked with $\hat{P}_{ik,t}$ from the data
- Problem: series inconsistent with model, resulting shock series implausible

# Calibration of trade cost and sectoral productivity shocks

- Instead, use Head and Ries (2001) trade cost shock estimates for a reference country
- Still not strictly consistent with the model (assumes symmetrical trade costs)
- But delivers $c$ sets of shock estimates, one per each reference country
- Check if shock series sets are similar
- Treat differences as arising due to measurement error
- Average out across reference countries to minimize its effect

Back to main