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Contributions of the Paper

• Extends the analysis of GVCs to developing countries

• Uses an input-output framework while circumventing actual input-output tables

• Generates a data set of 93 countries and 19 industrial sectors for 1970 – 2008

• Preliminary look at the effects of specializing in production stages on the growth of domestic value-added in exports
Role of Industrialization in Development

• Without Global Fragmentation
  – Industrialization yields competencies that give a country a comparative advantage in manufacturing
  – Export competitiveness results from a comparative advantage in the complete production of final manufactured products

• With Global Fragmentation
  – Industrial competencies can be gained by unbundling stages of production as a result of lower information and communication costs
  – Export competitiveness results from specialization in production stages in which a country has a comparative advantage

• Does specialization necessarily increase domestic value-added in exports?
## Input-Output Framework

<table>
<thead>
<tr>
<th></th>
<th>$D_{Agr}$</th>
<th>$D_{Mfg}$</th>
<th>$D_{Serv}$</th>
<th>Final Demand</th>
<th>Exports</th>
<th>Gross Output</th>
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</thead>
<tbody>
<tr>
<td>$D_{Agr}$</td>
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<td>$Z_{\text{domestic}}$</td>
<td>$F_{D_{\text{domestic}}}$</td>
<td>$E_{\text{domestic}}$</td>
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<td>$D_{Mfg}$</td>
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<td>$M_{Serv}$</td>
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<td>Value-Added</td>
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<tr>
<td>Gross Output</td>
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</tbody>
</table>

- $Z_{\text{domestic}}$: Domestic intermediate inputs
- $F_{D_{\text{domestic}}}$: Domestic final demand
- $E_{\text{domestic}}$: Domestic exports
- $M$: Total imports
- $X'$: Gross output
- $X$: Total output
- $FD_{\text{domestic}}$: Domestic final demand
- $FD_{\text{imports}}$: Imports final demand
Input-Output Framework

• Technical Coefficients
  - $A_{domestic} = Z_{domestic}(\hat{X})^{-1}$
  - $A_{imports} = Z_{imports}(\hat{M})^{-1}$
  - $A_{total} = A_{domestic} + A_{imports}$

• System of Equations
  - Uses of domestic output: $X = A_{domestic}X + FD_{domestic} + E_{domestic}$
  - Uses of imports: $M = A_{imports}M + FD_{imports} + E_{imports}$
  - Gross Output: $X' = X'A_{total} + VA$

• Expressed with Leontief Inverse
  - $X = (I - A_{domestic})^{-1}(FD_{domestic} + E_{domestic})$
  - $M = (I - A_{imports})^{-1}(FD_{imports} + E_{imports})$
Domestic Value-Added in Exports

• Value-Added Per Unit of Gross Output
  – \( V = \bar{V} \hat{A}(\bar{X})^{-1} \)

• Domestic Value-Added in Exports
  – \( DVAX = V(I - A_{domestic})^{-1} E_{domestic} \)
  – Yields the domestic input requirements embodied in exports weighted by the value-added share of gross output

• DVAX Ratio
  – \( DVAXr = \frac{DVAX}{E_{domestic} + E_{imports}} \)
  – Alternative interpretations reflect the channel through which value-added in trade affects the domestic economy
Approximating DVAX

\[ \text{DVAX} = \mathbf{V} \left( \mathbf{I} - \mathbf{Z}_{\text{domestic}} (\hat{\mathbf{X}})^{-1} \right)^{-1} \mathbf{E}_{\text{domestic}} \]

\[ \mathbf{Z}^{\text{est}}_{\text{domestic}} = \mathbf{Z}^{\text{est}}_{\text{total}} - \mathbf{Z}^{\text{est}}_{\text{imports}} \]

**Step 1**: Estimate \( \mathbf{Z}_{\text{total}} \)

- \( ii_{\text{total}}^{u} = X' - VA \)
  - Available in actual data
- How to distribute \( ii_{\text{total}}^{u} \) across supplying industries?
  - Proxy coefficient table \( \mathbf{C}_{\text{total}}^{\text{proxy}} \)
  - \( \mathbf{Z}^{\text{est}}_{\text{total}} = \mathbf{C}_{\text{total}}^{\text{proxy}} ii_{\text{total}}^{u} \)
- \( \mathbf{C}_{\text{total}}^{\text{proxy}} \) is based on an average across countries from WIOD
Approximating DVAX

- **Step 2**: Estimate $Z_{imports}$
  - $ii^s_{imports}$ is available from trade data
  - How to distribute $ii^s_{imports}$ across using industries?
    - Proxy coefficient table $R_{proxy\ total}$
    - $Z_{est\ imports} = R_{proxy\ total} \times ii^s_{imports}$
  - $R_{proxy\ total}$ is based on an average across countries from WIOD
  - However...
    - $Z_{est\ imports}$ is not balanced and needs row constraints (i.e., $ii^s_{imports}$) and column constraints (i.e., $ii^u_{imports}$)
    - GRAS is used to balance (Lenzen et al. 2007)
Approximating DVAX

**Step 3:** Estimate $\hat{i}_u^u$ imports

- Proxy vector $F_{proxy}$ depicts shares of foreign-sourced intermediates in total-sourced intermediates by industry
  - $F_{proxy}$ is based on an average across countries from WIOD
  - There is variation in penetration of imported intermediates across industries but less variation across countries
- Estimate a distribution of imported intermediates by using industry
  - $\hat{D} = \hat{F}_{proxy} \hat{i}_u^{total}$ (latter is known from $X'$ and $VA$)
- Estimate a distribution of imported intermediates relative to the sum of total intermediates by using industry
  - $\hat{H} = \hat{D} (\hat{i}_u^{sum})^{-1}$ (latter is known from $\hat{i}_u^{total}$)
- Estimate imported intermediates by using industry
  - $\hat{i}_u^{import} = \hat{H} \hat{i}_u^{sum}$ (latter is known from $\hat{i}_u^{import}$)
Source Data

• Gross Output and Value-Added
  – UN Official Country Data
  – UN National Accounts Main Aggregates
  – UNIDO INDSTAT

• Trade Flows
  – UN Comtrade
  – Feenstra et al. (2005)

• Caveats
  – No trade flows in services (may bias DVAXr)
  – Gross output and value-added in basic prices but intermediates in purchase prices (may bias technical coefficients)
  – $C_{proxy \ total}$, $R_{proxy \ total}$, and $F_{proxy}$ are based on a “one-size fits all” approach
  – Results hinge on $C_{proxy \ total}$, $R_{proxy \ total}$, and $F_{proxy}$
Validation

• WIOD with and without Complete Information
  – One size fits all: average across all WIOD countries in 1995
  – Grouping countries into regions for different years
  – Overall fit reasonably good
  – Grouping countries improves the fit especially at the aggregate level

• Constructed Data Set and WIOD
  – Correlations between 0.88 and 0.93 in agreement with correlations for WIOD, OECD-WTO TiVA, and Johnson and Noguera (2014)
  – Differences explained by sectoral detail and lack of trade in services

• Constructed Data Set and Johnson and Noguera (2014)
  – Reflects long-term trends
  – Differences arise because of conceptual differences between DVAX and VAX and because of end year differences (2008 v. 2009)
Does DVAXr Explain Growth in DVAX?

\[ \Delta \ln(DVAX)_{j,t} = \alpha_0 + \beta \ln(DVAXr)_{j,t-k} + \gamma X + \eta_j + v_t + \varepsilon_{j,t} \]

- Lagged values reduce endogeneity
- Fixed effects control for unobserved heterogeneity

**Preliminary Results**
- \( \beta \) is negative and statistically significant in all but one specification
- DVAX grows faster when the initial domestic contribution to exports is lower

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<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
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<tr>
<td>( \Delta \ln(DVAX) )</td>
<td>-0.0342</td>
<td>-0.0693***</td>
<td>-0.0443**</td>
<td>-0.0931**</td>
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Conclusions

• Methodology widely applicable to study production fragmentation across time and countries
  – Good fit and systematic improvements possible

• Data set contains 93 countries and 19 industrial sectors from 1970 to 2008
  – To be extended by at least 10 countries from 1963 to 2015

• First results indicate a negative correlation between the initial DVAXr levels and subsequent growth of DVAX
  – To be extended to explore time periods and groups of countries
Discussion

• How accurate are the proxies (i.e., C, R, and F)?
  – Two Assumptions
    • Share of intermediates sourced by an industry can be approximated by a given set of countries
    • Foreign penetration of industries holds across a given set of countries
  – C and R yield the same technology assumptions across countries
  – F yields equal shares of foreign-sourced intermediates across countries
  – Bullón et al. (2014) warn against overarching assumptions for developing countries

• How effective is WIOD for validation given its use for proxies?
  – Why would we expect anything other than high correlations in tables 1 and 2?
  – Tables 3 and 4 demonstrate differences
  – Countries in WIOD not in Pahl (2016) data set?
Discussion

• Are UN Comtrade data designed for international comparison?
  – Conversion to a single currency?
  – Variation in price levels (i.e., purchasing power)?
  – May be relevant for DVAX but not DVAXr?

• Plans for an IV approach?
  – DVAXr is composed of DVAX
  – Are lags consistent with the related literature?
    • Common substitute in other applications
    • Kummritz (2016) and Boffa et al. (2016) do not use lags?

• Comprehensive interpretation of the sign on DVAXr in the context of the conceptual framework?
  – Estimation strategy discusses possibility of a positive sign
  – Results discuss the actual negative sign