

# **Economic Development under Global Production Fragmentation: Value-Added in Exports of 93 Countries between 1970 and 2008**

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- 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

- 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

	$D_{Agr}$	$D_{Mfg}$	$D_{Serv}$	Final Demand	Exports	Gross Output
$D_{Agr}$	<b>Z</b> domestic			<b>FD</b> domestic	<b>E</b> domestic	<b>X</b>
$D_{Mfg}$						
$D_{Serv}$						
$M_{Agr}$	<b>Z</b> imports			<b>FD</b> imports	<b>E</b> imports	<b>M</b>
$M_{Mfg}$						
$M_{Serv}$						
Value-Added	<b>VA</b>					
Gross Output	<b>X'</b>					

- 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

- $X = (I - A_{domestic})^{-1}(FD_{domestic} + E_{domestic})$
- $M = (I - A_{imports})^{-1}(FD_{imports} + E_{imports})$

- Value-Added Per Unit of Gross Output
  - $V = \widehat{VA}(\widehat{X})^{-1}$
- 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

- $DVAX = V(I - Z_{domestic}(\hat{X})^{-1})^{-1} E_{domestic}$
- $Z_{domestic}^{est} = Z_{total}^{est} - Z_{imports}^{est}$
- **Step 1: Estimate  $Z_{total}$** 
  - $\hat{ii}_{total}^u = X' - VA$ 
    - Available in actual data
  - How to distribute  $\hat{ii}_{total}^u$  across supplying industries?
    - Proxy coefficient table  $C_{total}^{proxy}$
    - $Z_{total}^{est} = C_{total}^{proxy} \hat{ii}_{total}^u$
  - $C_{total}^{proxy}$  is based on an average across countries from WIOD

- **Step 2:** Estimate  $Z_{imports}$

- $\mathbf{ii}_{imports}^S$  is available from trade data
- How to distribute  $\mathbf{ii}_{imports}^S$  across using industries?
  - Proxy coefficient table  $\mathbf{R}_{total}^{proxy}$
  - $\mathbf{Z}_{imports}^{est} = \mathbf{R}_{total}^{proxy} \hat{\mathbf{ii}}_{imports}^S$
- $\mathbf{R}_{total}^{proxy}$  is based on an average across countries from WIOD
- However...
  - $\mathbf{Z}_{imports}^{est}$  is not balanced and needs row constraints (i.e.,  $\mathbf{ii}_{imports}^S$ ) and column constraints (i.e.,  $\mathbf{ii}_{imports}^u$ )
  - GRAS is used to balance (Lenzen et al. 2007)



- **Step 3:** Estimate  $\hat{\mathbf{u}}_{imports}^u$ 
  - Proxy vector  $\mathbf{F}^{proxy}$  depicts shares of foreign-sourced intermediates in total-sourced intermediates by industry
    - $\mathbf{F}^{proxy}$  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
    - $\hat{\mathbf{D}} = \hat{\mathbf{F}}^{proxy} \hat{\mathbf{u}}_{total}^u$  (latter is known from  $\mathbf{X}'$  and  $\mathbf{VA}$ )
  - Estimate a distribution of imported intermediates relative to the sum of total intermediates by using industry
    - $\hat{\mathbf{H}} = \hat{\mathbf{D}} (\hat{\mathbf{u}}_{total}^{sum})^{-1}$  (latter is known from  $\hat{\mathbf{u}}_{total}^u$ )
  - Estimate imported intermediates by using industry
    - $\hat{\mathbf{u}}_{imports}^u = \hat{\mathbf{H}} \hat{\mathbf{u}}_{imports}^{sum}$  (latter is known from  $\hat{\mathbf{u}}_{imports}^s$ )

- 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)
  - $C_{total}^{proxy}$ ,  $R_{total}^{proxy}$ , and  $F^{proxy}$  are based on a “one-size fits all” approach
  - Results hinge on  $C_{total}^{proxy}$ ,  $R_{total}^{proxy}$ , and  $F^{proxy}$

- 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

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \ln(DVAX)$	$\Delta \ln(DVAX)$	$\Delta \ln(DVAX)$	$\Delta \ln(DVAX)$	$\Delta \ln(DVAX)$	$\Delta \ln(DVAX)$
DVAXr	-0.0342	-0.0693***	-0.0443**	-0.0931**	-0.148***	-0.0961**
N	2,902	2,902	2,902	2,902	2,902	2,902
R <sup>2</sup>	0.001	0.010	0.065	0.035	0.100	0.132
Controls	No	Yes	No	No	No	Yes
Year FE	No	No	Yes	No	Yes	Yes
Country FE	No	No	No	Yes	Yes	Yes

- 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

- 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?

- 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