

# International Macroeconomics with Global Supply Chains

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# Global Supply Chains in International Macro

Most int'l macro analysis is done without global supply chains.

More ought to be done with global supply chains.

Supply chain thinking improves *empirical* answers to core questions:

- ▶ How does trade transmit shocks across countries?
- ▶ How do international relative prices influence 'competitiveness'?
- ▶ What is the size/distribution of the burden of external rebalancing?
- ▶ How do monetary shocks spill over across countries?

Plan for this talk:

1. The Macro-Mechanics of Input Linkages
2. The Research Frontier

# Value-Added Models and Beyond

Canonical models ignore traded inputs – they are “value-added models.”

Example: International RBC Model [Backus, Kehoe, and Kydland (1994)]

## Problem 1: Mis-calibration of value-added models.

- ▶ Researchers mix gross and value-added data/parameters.
  - ▶ Openness:  $\text{exports/GDP} \neq \text{value-added exports/GDP}$ .
  - ▶ Elasticities:  $\text{gross trade elasticities} \neq \text{value-added elasticities}$ .
  - ▶ Bilateral linkages:  $\text{CHN-US gross exports} > \text{value-added exports}$ .
- ▶ This is correctable. [Bems (2014), Johnson (2014a), Bems and Johnson (2015)]  
Structural transformation analog [Herrendorf, Rogerson, and Valentinyi (2013)].

## Problem 2: Inputs introduce new channels for shock transmission.

- ▶ Value-added models focus exclusively on demand-side linkages, but GSCs link countries together on the supply side too.
- ▶ Needed: models with explicit cross-border input linkages ...

## Bare Bones Model (IRBC + IO)

Static (no capital) model with  $N$  countries indexed by  $i, j \in \{1, \dots, N\}$ .

Consumers:  $U_i = \log(F_i) - \frac{\chi\epsilon}{1+\epsilon} L_i^{(1+\epsilon)/\epsilon}$

with  $F_i = \left[ \sum_{j=1}^N F_{ji}^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}$  and  $w_i L_i = \sum_{j=1}^N p_j F_{ji}$ .

Production:  $Q_i = \left[ \omega V_i^{(\gamma-1)/\gamma} + (1-\omega) X_i^{(\gamma-1)/\gamma} \right]^{\gamma/(\gamma-1)}$ ,

with  $V_i = Z_i L_i$  and  $X_i = \left[ \sum_{j=1}^N X_{ji}^{(\rho-1)/\rho} \right]^{\rho/(\rho-1)}$

Output allocation:  $Q_i = \sum_{j=1}^N [F_{ij} + X_{ij}]$ .

Full IRBC + IO models: Ambler et al. (2002), Johnson (2014b).

# Domestic and IO International Linkages

Large literature on domestic cross-sector linkages:

1. Sectoral comovement and aggregate fluctuations:

Long and Plosser (1983), Horvath (2000), Conley and Dupor (2003),  
Foerster, Sarte, and Watson (2011), Acemoglu et al. (2012)

2. Weak links and misallocation:

Jones (2011), Bartelme and Gorodnichenko (2015)

Parallel issues in international macro:

1. Explaining cross-country comovement and regional cycles.
2. Quantifying aggregate costs of border frictions.

Shock transmission is broadly similar in domestic and int'l context.

Key exception: labor is mobile across sectors, immobile across borders.

# Application: Int'l Relative Prices and Competitiveness

Example: suppose Japanese Yen depreciates.

Does demand for value added (DfVA) from Asian trade partners rise/fall?

- ▶ Since Japan is upstream in 'factory Asia', then devaluation boosts competitiveness of downstream Asian partners (DfVA rises).
- ▶ But, there is expenditure switching toward Japanese inputs, reducing demand for inputs from downstream countries (DfVA falls).

Point 1: IO links + elasticities determine how DfVA changes.

Point 2: low input elasticity  $\Rightarrow$  maximizes pro-competitive effect  
 $\Rightarrow$  yen depreciation raises DfVA from Asia.

Point 3: Broadly, input linkages reallocate beggar-thy-neighbor spillovers away from supply chain partners.

# Formalizing the Role of IO linkages & Elasticities

Bems and Johnson (2015)

Focus on “demand side” of the IRBC + IO framework (demand for  $V_i$ ).  
Linearize FOC's, production function, and market clearing conditions.

Three steps:

1. Demand for Gross Output:  $\hat{\mathbf{Q}} = f(\hat{\mathbf{F}}, \hat{\mathbf{p}}; [\sigma, \gamma, \rho])$
2. Demand for Value Added:  $\hat{\mathbf{V}} = g(\hat{\mathbf{Q}}, \hat{\mathbf{p}}; \gamma)$
3. Gross Output Prices:  $\hat{\mathbf{p}} = h(\hat{\mathbf{p}}^v)$

Demand for Value Added

$$\begin{aligned}\hat{\mathbf{V}} &= v(\hat{\mathbf{p}}^v, \hat{\mathbf{F}}; [\sigma, \gamma, \rho]) \\ &= -(\sigma \mathbf{T}_\sigma + \rho \mathbf{T}_\rho + \gamma \mathbf{T}_\gamma) \hat{\mathbf{p}}^v + w(\hat{\mathbf{F}})\end{aligned}$$

The  $\mathbf{T}$ 's depend on input and final goods linkages across countries.

# Demand for Value Added and Value-Added REERs

$$\hat{V}_i = -\tilde{\epsilon}_i(\sigma, \rho, \gamma) T_{VA}^{ii} \widehat{REER}_i + w(\hat{\mathbf{F}})$$

$$\widehat{REER}_i \equiv \sum_{j \neq i} \underbrace{\left[ \frac{-(\sigma T_{\sigma}^{ij} + \rho T_{\rho}^{ij} + \gamma T_{\gamma}^{ij})}{\sigma T_{\sigma}^{ii} + \rho T_{\rho}^{ii} + \gamma T_{\gamma}^{ii}} \right]}_{\text{Typically +, not always. Sum to 1.}} (\hat{p}_i^v - \hat{p}_j^v)$$

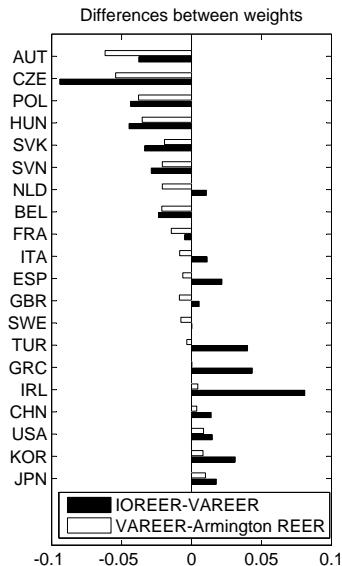
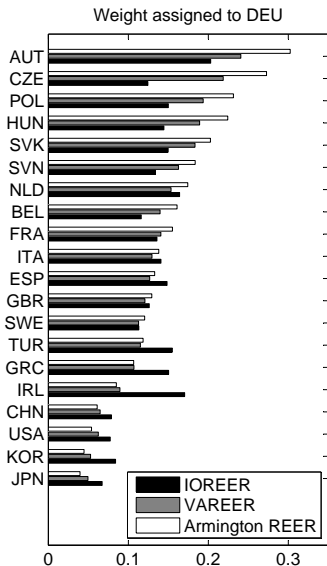
$$\tilde{\epsilon}_i(\sigma, \rho, \gamma) \equiv \sigma \frac{T_{\sigma}^{ii}}{T_{VA}^{ii}} + \rho \frac{T_{\rho}^{ii}}{T_{VA}^{ii}} + \gamma \frac{T_{\gamma}^{ii}}{T_{VA}^{ii}}$$

$$T_{VA}^{ii} \equiv T_{\sigma}^{ii} + T_{\rho}^{ii} + T_{\gamma}^{ii}$$



# Value-Added REERs

## REER Weights Assigned to Germany, 2007



# Frontiers I: Input Linkages in Int'l Macro Models

## Contours of the literature

- ▶ IRBC & Trade-Comovement: Ambler et al. (2002), Johnson (2014b).
- ▶ External Rebalancing: Bems (2014).
- ▶ Import Demand & Trade Collapse: Bems, Johnson, and Yi (2010), Eaton et al. (2011), Bussière et al. (2013).
- ▶ REERs & Competitiveness: Bems and Johnson (2015), Patel et al. (2014).

## GSCs, Exchange Rates, and Monetary Policy

- ▶ Obs. 1: Imported inputs can be natural exchange rate hedge.  
Recent micro pass-through evidence by Amiti, Itskhoki, and Konings (2014).
- ▶ Obs. 2: IO linkages  $\Rightarrow$  pricing complementarities (real rigidity)  
– “act as multiplier for price stickiness” [Basu (1995)].

How do GSCs alter monetary shock transmission in NOEM models?

## Frontiers II: Elasticities Matter... What are They?

Most credible elasticity estimates are at micro level (firms or sectors).

**Challenge**: aggregating micro-estimates to macro-relevant parameters.

### Firm-level $\mapsto$ sector-level elasticities

- ▶ Example: Boehm et al. (2015) use 2011 Japan shock to estimate firm-level elasticities b/n F & H inputs, and inputs & factors.
- ▶ Agg. elasticity = within-firm substitution + cross-firm reallocation + exit-entry dynamics [Ramanarayanan (2013), Oberfield and Raval (2014)].

### Sector-level $\mapsto$ aggregate elasticities

- ▶ Imbs and Mejean (2014) study elasticity heterogeneity and aggregation in multi-sector model without IO linkages.
- ▶ How does aggregation work with IO linkages?

# Frontiers III: Cascades via Input Chains

## Issue 1: Measuring exposure to GSC shocks

- ▶ Both first-order (direct) and higher order (indirect) linkages matter.
  - ▶ Across countries: e.g., Japanese inputs embodied in Korean semiconductors, which are exported to the US.
  - ▶ Across firms: e.g., firm that directly imports from Japan may supply inputs to downstream firms in the US.
- ▶ Holy grail: credible information on firm-to-firm links, both across countries and behind the border.

## Issue 2: macro-amplification of GSC shocks

- ▶ Domestic IO linkages may amplify GSC shocks.
- ▶ Large agg. weight on shocks to upstream sectors (IO multiplier).
- ▶ Example: Blaum, Lelarge, and Peters (2015) aggregate firm-level gains from imported inputs via IO structure.

# Conclusion

We know a lot more about IO-in-macro now than even 5 years ago.  
But, a lot of work still to be done, particularly in international macro.

Important micro-to-macro dimensions:

- ▶ Aggregating micro-elasticities into macro-elasticities.
- ▶ Translating micro-shocks into macro-outcomes.

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