BANK FOR INTERNATIONAL SETTLEMENTS

# International Price System, Intermediate Inputs and Regional Trade

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**Disclaimer: The views expressed here are those of the authors and not necessarily of the Bank for International Settlements**

# A modern day look at a classical question

- **Classical question in international macroeconomics**
  - What is the impact of monetary policy and exchange rate shocks on international trade?
- **A modern take**
  - Pricing: Dominant currency paradigm
  - Trade patterns: Intermediate inputs, global value chains, multiple border crossings



# International Price System

- Sticky prices imply exchange rate policy can play a role in allocation of trade.
  - But which prices? And which exchange rates?
- **The traditional views**
  1. Producer Currency pricing (PCP)
     - ★ Friedman (1953), Fleming (1962), and Mundell (1963)
  2. Local currency pricing (LCP)/ Pricing to market (PTM)
     - ★ Betts and Devereux (1996), many more..
- **The New view: Dominant currency paradigm (Gopinath et al, 2016, Goldberg and Tille, 2008)**
  - Even bilateral trade between non US countries is invoiced in dollars
  - All trade prices are sticky in dollars and passthrough is far from complete.

# Intraregional Trade and Global Value Chains (GVCs)

- Share of global value chains and complex trade activities has increased with time (Wang et al 2017)
  - Within GVCs, share of more complex trade activities (involving multiple border crossings) has increased.
  - Most models and data sources (UNCAD, COMTRADE etc) typically ignore or consider only a bivariate decomposition of trade flows(intermediate and final goods)
- Share of Intra-regional trade has increased markedly in EMEs (south -south trade), particularly in Asia



# This paper

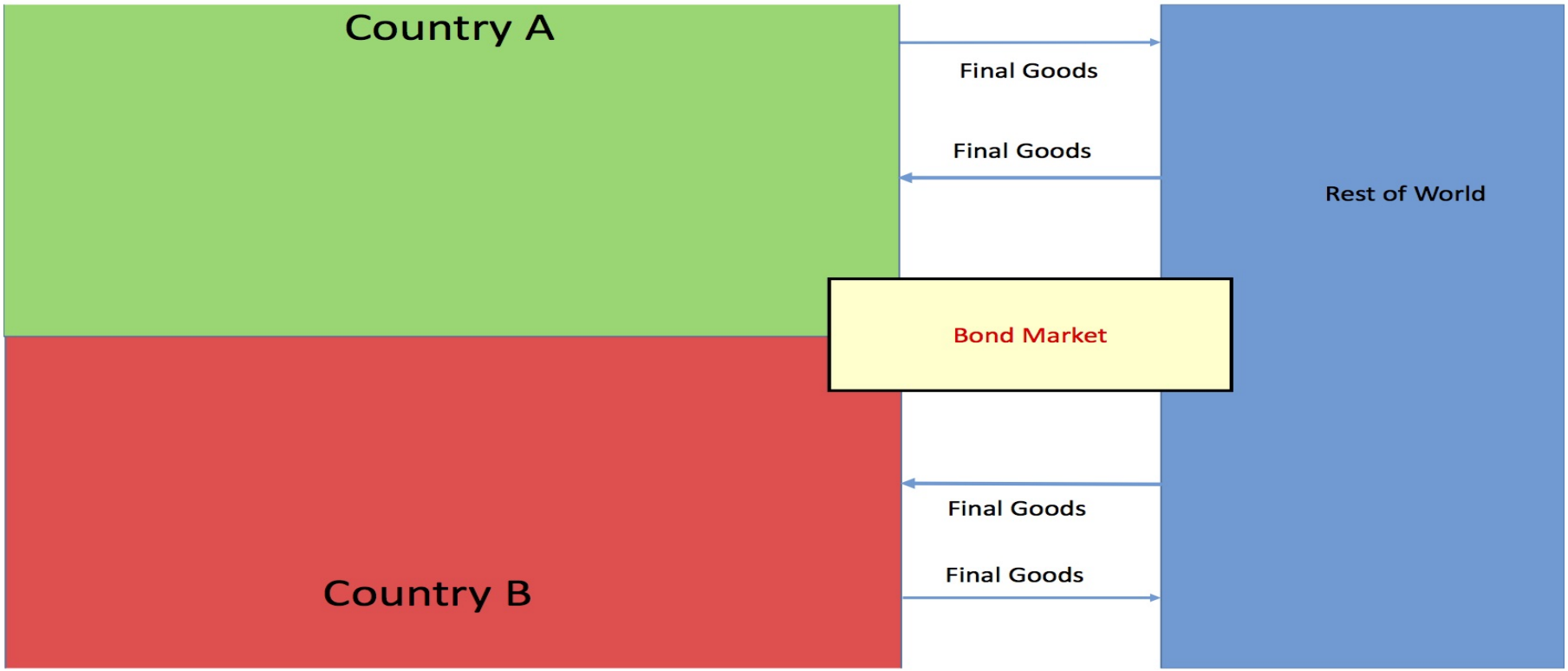
- **Theory**: Construct DSGE model of trade in a world with two emerging market economies and a global economy (US)
  - Illustrate effects of interest rate shocks on trade
- **Empirics**: Examine the impact of external interest rate shocks on trade using sectoral level trade data.
- **Preview of main results**
  - US monetary policy tightening: response of bilateral final goods trade between EMEs $>$ GVC trade
  - EME monetary policy tightening: response of GVC trade$>$bilateral final goods trade between EMEs



# Model Description

Open Economy New Keynesian Model:

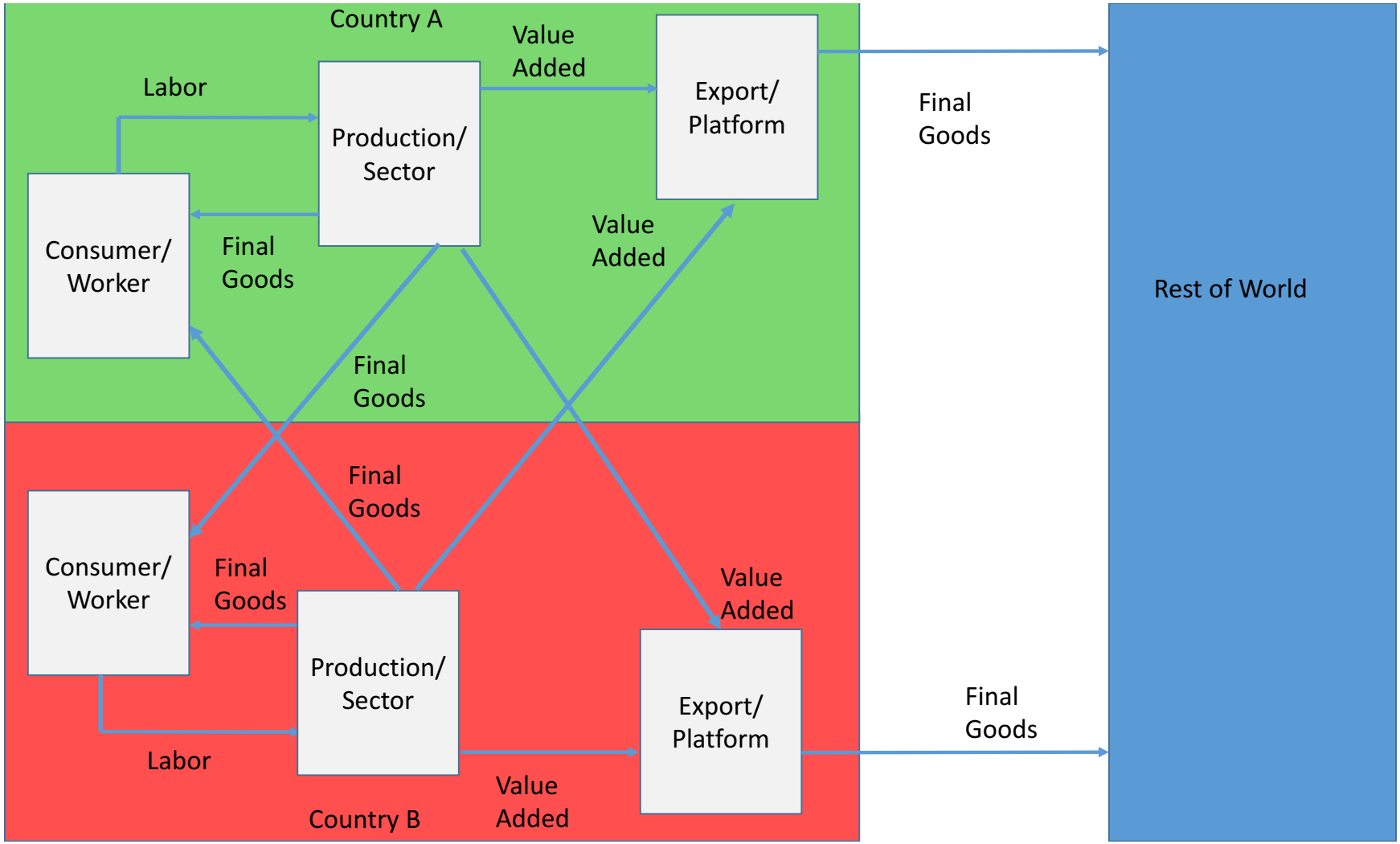
- Two (fully modeled) small open regional economies
  - Regional economies have their own currencies which are only used in the domestic economy.
- *plus* Global economy
  - Global currency used for all international trade and finance
  - Global bond market with exogenous external interest rate
  - Exports final goods to regional economies at fixed global dollar price
  - Imports goods from regional economies with downward sloping demand.


Country A
Final Goods
Final Goods
Rest of World
Bond Market
Final Goods
Final Goods
Country B

# Regional Economy

- Infinitely lived Consumer/Worker
  - Provides labor to Production Sector
  - Consumes final goods from domestic production sector, regional trading partner, and global economy
  - Saves through international bond market
- Production Sector
  - Constant returns to scale.
  - Sells final goods to domestic and regional consumers
  - Delivers value added to export platform for global value chain.
- Export Platform
  - Constant returns to scale.
  - Produces Goods for Export to Global economy.




Country A
Labor
Value Added
Production/ Sector
Export/ Platform
Final Goods
Consumer/ Worker
Final Goods
Value Added
Rest of World
Final Goods
Final Goods
Consumer/ Worker
Final Goods
Value Added
Production/ Sector
Export/ Platform
Final Goods
Labor
Value Added
Country B

# Model Details: Households

## Preferences

$$\sum_{t=0}^{\infty} \beta^t u(C_t^j, L_t^j) = \sum_{t=0}^{\infty} \beta^t \left\{ \frac{\zeta}{\zeta - 1} {C_t^j}^{\frac{\zeta-1}{\zeta}} - \frac{\theta \cdot \Gamma}{1+\theta} {L_t^j}^{\frac{\theta+1}{\theta}} \right\}$$

$$C_t^j = \left( a^{\frac{1}{\varsigma}} \cdot \left\{ CR_t^j \right\}^{\frac{\varsigma-1}{\varsigma}} + (1-a)^{\frac{1}{\varsigma}} \cdot \left\{ CW_t^j \right\}^{\frac{\varsigma-1}{\varsigma}} \right)^{\frac{\varsigma}{\varsigma-1}}$$

$$CR_t^j = \left( b^{\frac{1}{\psi}} \cdot \left\{ CH_t^j \right\}^{\frac{\psi-1}{\psi}} + (1-b)^{\frac{1}{\psi}} \cdot \left\{ CM_t^j \right\}^{\frac{\psi-1}{\psi}} \right)^{\frac{\psi}{\psi-1}}$$

## Budget Constraint

$$S_t^j B_{t+1}^j = (1 + r_t^j) S_t^j B_t^j + W_t^j H_t^j - CPI_t^j C_t^j + \Pi_t^j \qquad (1)$$

# Model Details: Production firms

## Domestic value added

$$Y_t^j = Z_t^j L_t^j \rightarrow MCY_t^j = \frac{W_t^j}{Z_t^j}$$

## Export Platforms

$$V_t^j = \left( d^{\frac{1}{\nu}} \cdot \left\{ VH_t^j \right\}^{\frac{\nu-1}{\nu}} + (1-d)^{\frac{1}{\nu}} \cdot \left\{ VM_t^j \right\}^{\frac{\nu-1}{\nu}} \right)^{\frac{\nu}{\nu-1}}$$

# Three sets of distribution Firms: Sticky prices

- Domestic

$$CH_t^j + VH_t^j = H_t^j = \left[ \int h_{l,t}^{\frac{\phi-1}{\phi}} dl \right]^{\frac{1}{1-\phi}}$$

- Regional Exports

$$CM_t^{\neq j} + VM_t^{\neq j} = EX_t^j = \left[ \int ex_{l,t}^{\frac{\phi-1}{\phi}} dl \right]^{\frac{1}{1-\phi}}$$

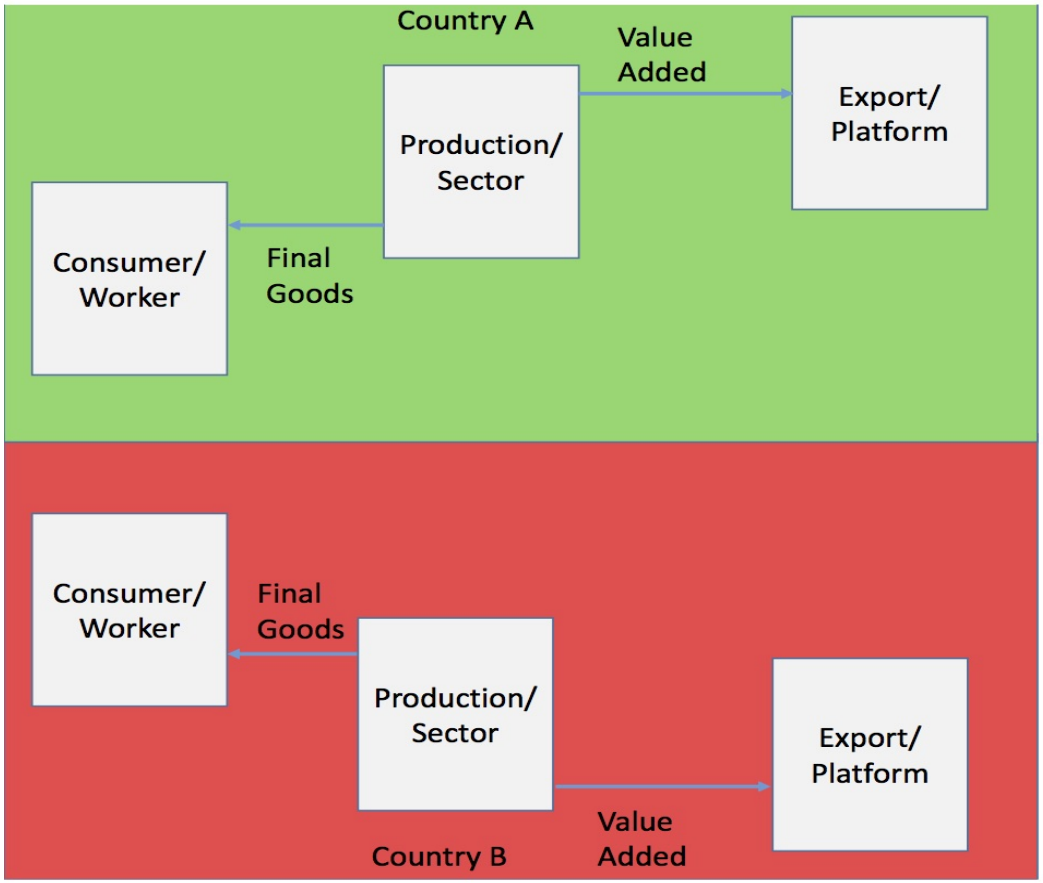
- Exports to the world economy (US)

$$WM_t^j = \left[ \int wim_{l,t}^{\frac{\phi-1}{\phi}} dl \right]^{\frac{1}{1-\phi}}$$

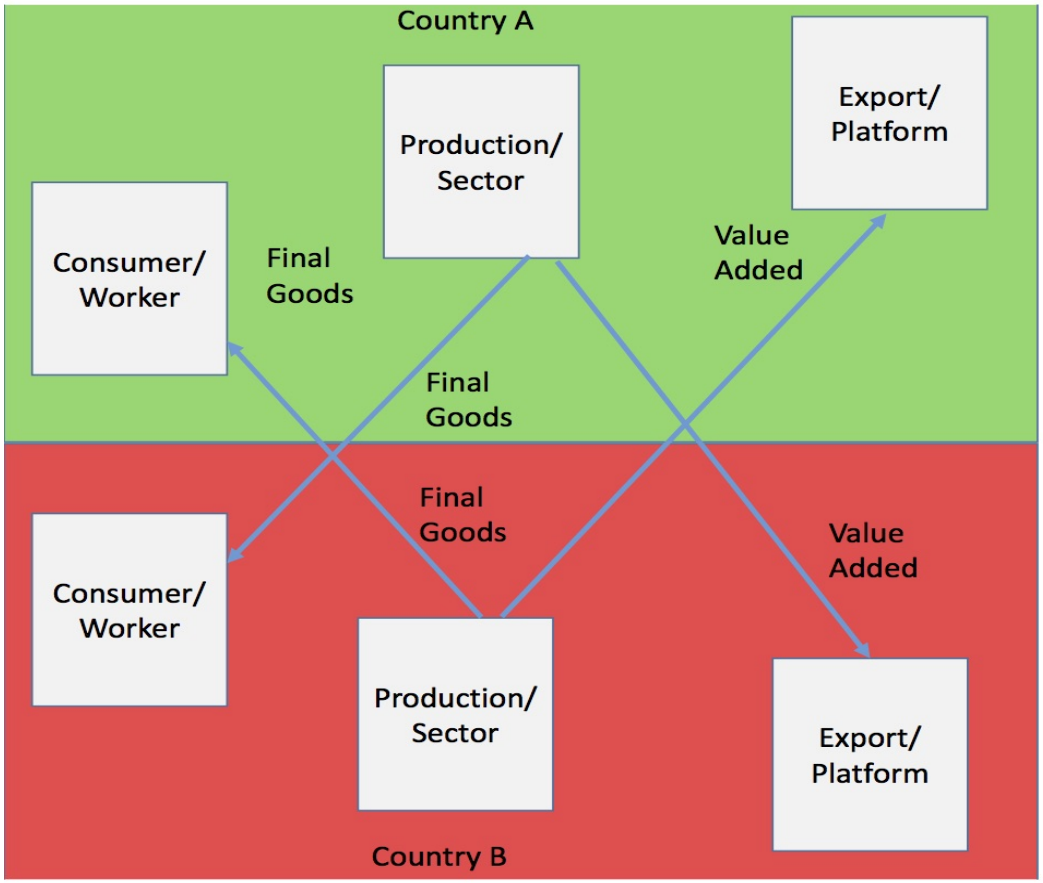
# Regional Trade

- Regional economies ship final goods to each other for final consumption.
- Regional trade in intermediate materials.
  - Imported regional materials only used in exports to global economy
  - Exports to global economy is CES combination of domestic value added and imported regional materials.
- Regional trade invoiced in global dollars





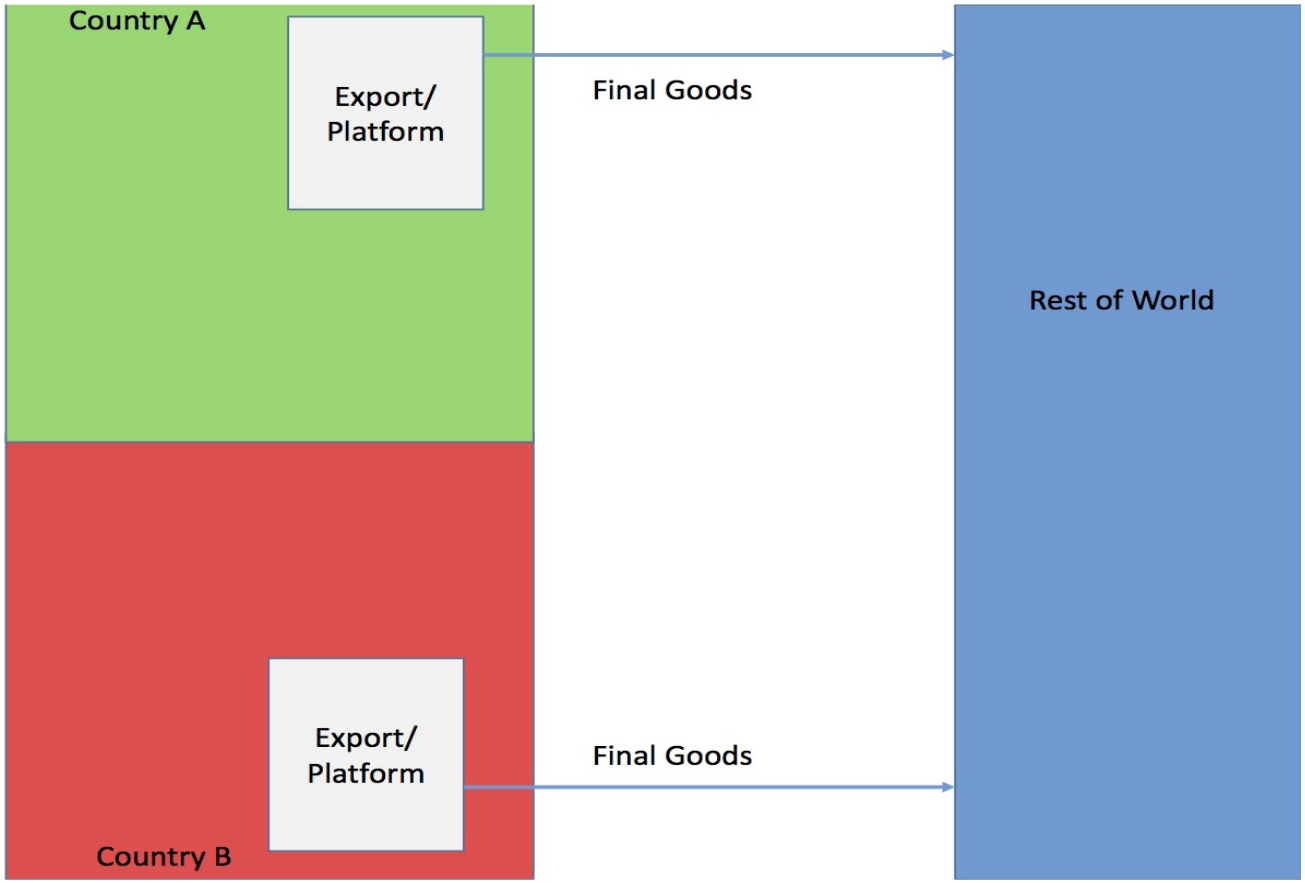

# Calvo Prices in Domestic Currency




# Calvo Prices in Global Dollars

Final Goods

# Calvo Prices in Global Dollars



# Closing the model

## Global demand

$$WM_t^j = f \cdot \left( \frac{XPI_t^j}{P_t^W} \right)^{-\varsigma} \cdot Y_t^W$$

## External Interet rate

$$1 + r_t^j = \Lambda_t^R \cdot \{1 + (r \cdot e^{-\eta B_t^j})\}$$

## Domestic interest rate

$$1 + i_t^j = (1+i)^{1-\chi_i} \left(1 + i_{t-1}^j\right)^{\chi_i} \left( \frac{P_t^j}{P_{t-1}^j} \right)^{\chi_\pi (1-\chi_i)} \left\{ \frac{S_t^j}{S_t^{\neq j}} \right\}^{\chi_S (1-\chi_i)} \lambda_t^j$$

# Calibration

- Unit inter-temporal elasticity of consumption
- Unit Frisch elasticity of labor supply
- Elasticity of substitution between goods from all countries for all uses: 1.5
- All prices change annually on average
- Exports are 50% of GDP; Regional exports are 50% of exports; Intermediate materials are 50% of regional exports.
- Markups are 10%;



# Numerical Experiments

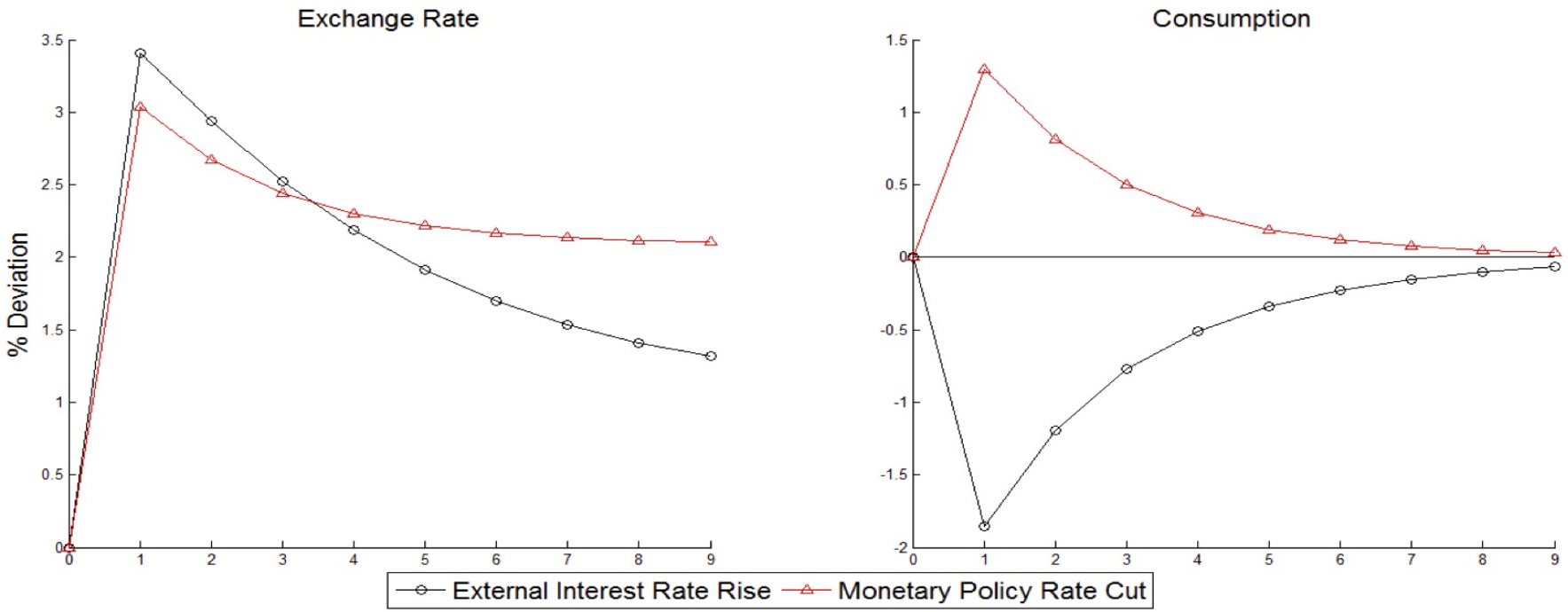
- Examine impulse responses to persistent interest rate shocks
  - 100 basis point rise in external interest rate for both economies
  - 100 basis point cut to domestic interest rate rule in one regional economy
- Auto-correlation of shocks: .75
- Benchmark monetary policy: CPI targeting with interest rate smoothing.
  - Long term Taylor response 1.5
  - Autocorrelation of interest rates .75



# Interest Rate Shocks: Exchange Rates and Demand

- Both shocks lead to exchange rate depreciation vs. global currency
  - Uncovered interest parity channel
- External interest rate shocks lead to a decline in regional final demand
- Domestic monetary policy shocks lead to an increase in regional final demand.
  - Real interest rate channel

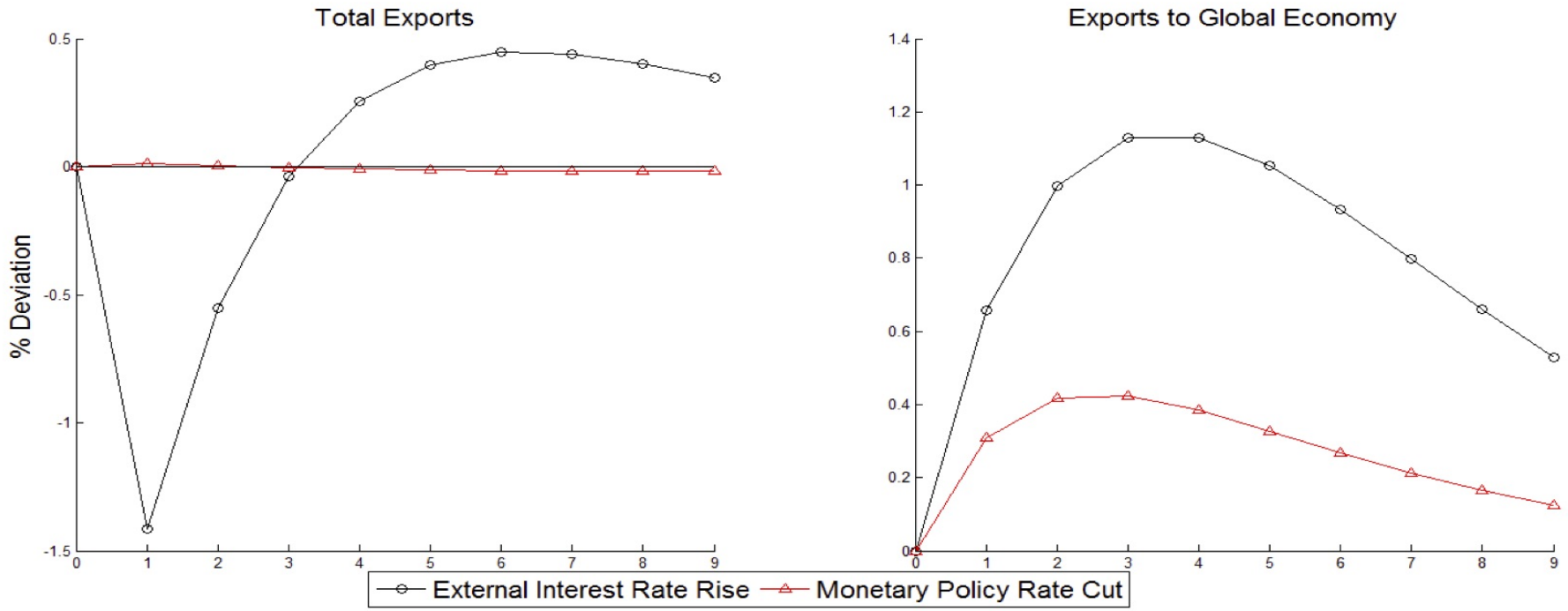



Exchange Rate
% Deviation
3.5
3
2.5
2
1.5
1
0.5
0
0 1 2 3 4 5 6 7 8 9
Consumption
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0 1 2 3 4 5 6 7 8 9
External Interest Rate Rise
Monetary Policy Rate Cut

# Interest Rate Shocks: Exports

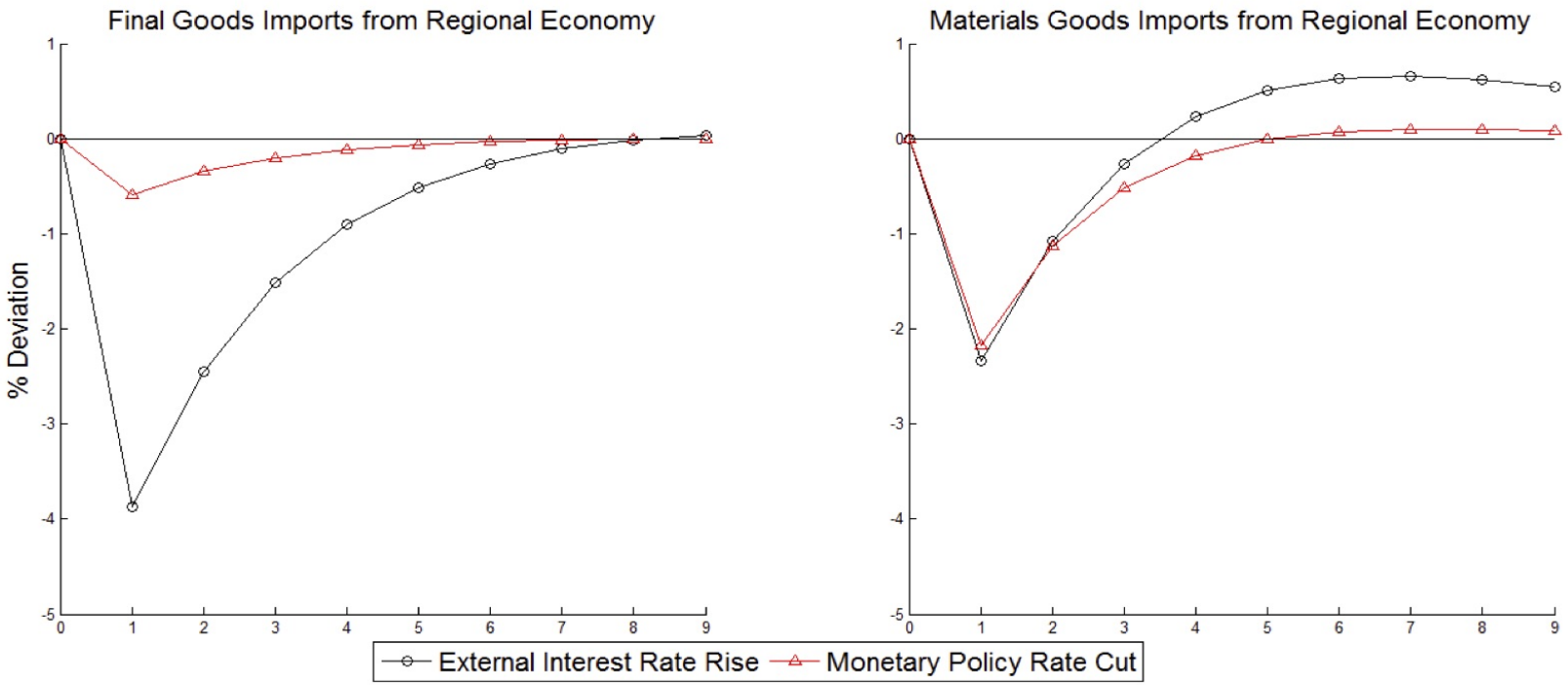
- Despite devaluations against global currency, neither shock leads to an increase in exports
- Both shocks lead to an increase in exports to the global economy due to ultimate competitiveness effects.




Total Exports
Exports to Global Economy
% Deviation
External Interest Rate Rise
Monetary Policy Rate Cut

# Impact of interest rate shock on trade

| Impact of an interest rate shock leading to an exchange rate depreciation | | |
|---|---|---|
| | External rise | Domestic cut |
| Domestic exchange rate | Depreciation | Depreciation |
| Total exports | ↓ | ↓/↑ |
| Exports to regional economy | ↓ | ↓ |
| Final goods exports to regional | ↓ | ↓ |
| Final exports to global economy | ↑ | ↑ |
| Intermediate exports to regional economy | ↓/↑ | ↓ |
| **Ratio of intermediate to final goods exports within region** | ↑ | ↓ |


Final Goods Imports from Regional Economy
Materials Goods Imports from Regional Economy
% Deviation
1
0
-1
-2
-3
-4
-5
0
1
2
3
4
5
6
7
8
9
External Interest Rate Rise
Monetary Policy Rate Cut

# Empirics

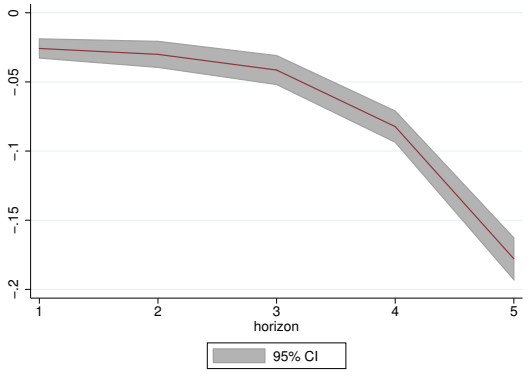
- Focus on response of regional trade to US interest rate shocks
- Main goal: Uncover differences between different trade flows:
  - Intermediate vs final
  - Regional vs global value chain
- Main Data source: World input output database and gross export decomposition of Wang, Wei and Zhu (2013, 2017)
  - 40 Countries, 35 sectors
  - 1995-2011, annual

# Specification

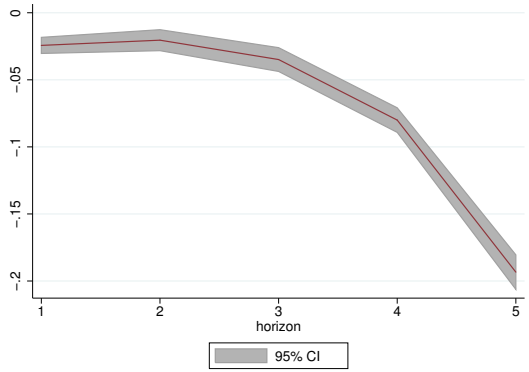
$$Y^{i,j}_{t+h}(s) = \alpha^{i,j}(s) + \eta Y^{i,j}_{t-1}(s) + \beta i_{us,t} + \delta X_t + \epsilon^{i,j}_t(s)$$

- $X_t$ : Vector of controls and includes contemporaneous and lagged values of
  - US growth and inflation
  - bilateral exchange rate between the importer and the exporter
  - real GDP and inflation of the importer and exporter
  - total imports by the importer, and total imports and exports by the importing country with the US,
  - unit labor cost in the exporting country
  - quadratic time trend
- Sample:
  - 1995-20011, annual
  - 39 countries, 35 sectors
  - Upto 51870 (=39*35*38) observations per year

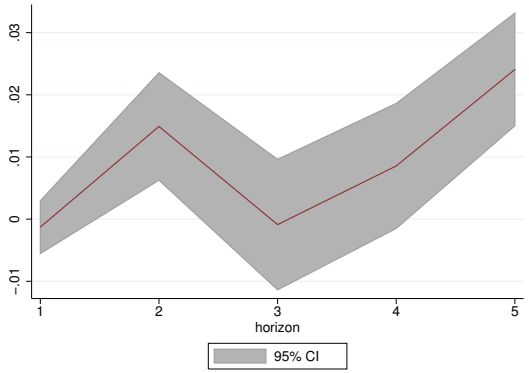
# Response of real intermediate and final goods exports to US monetary contraction




Total bilateral exports (real)




Intermediate bilateral exports (real)

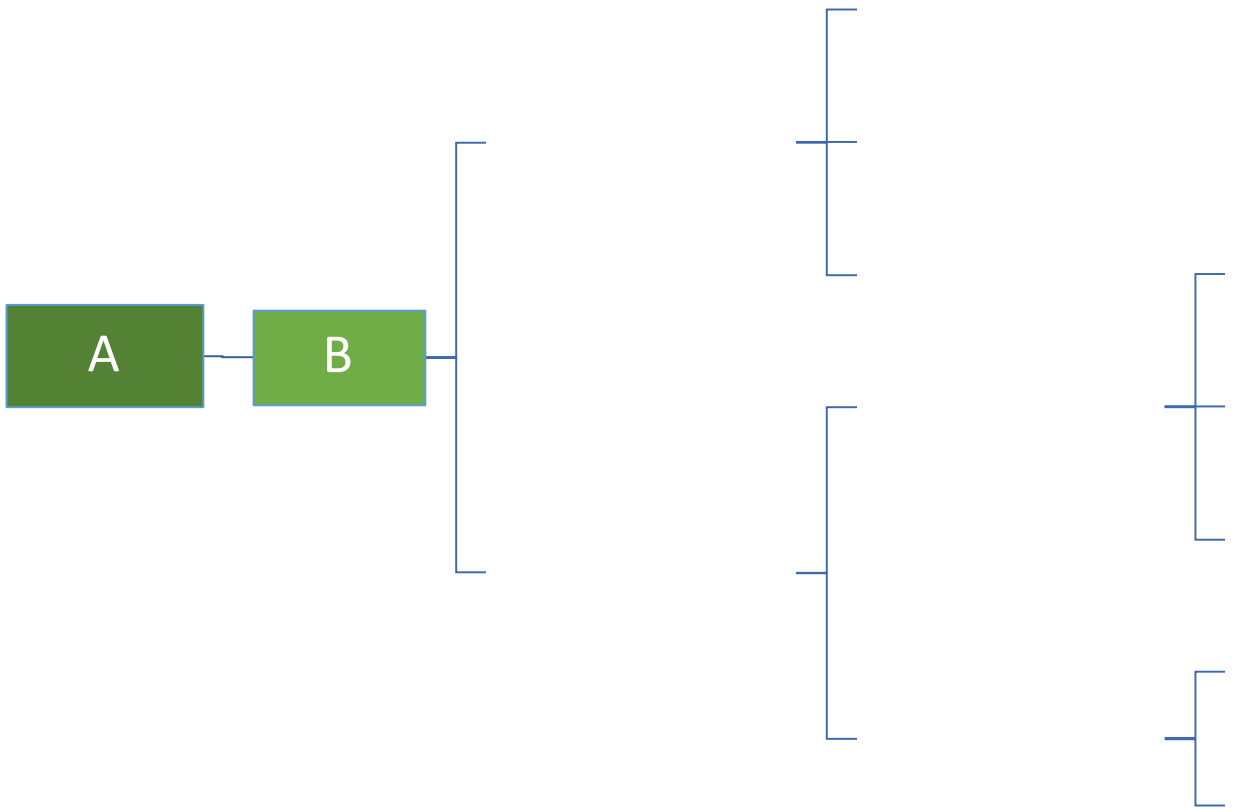



Ratio of intermediate to final goods exports



▸ Corresponding results with aggregate country level data

# Tracing the journey of intermediate exports



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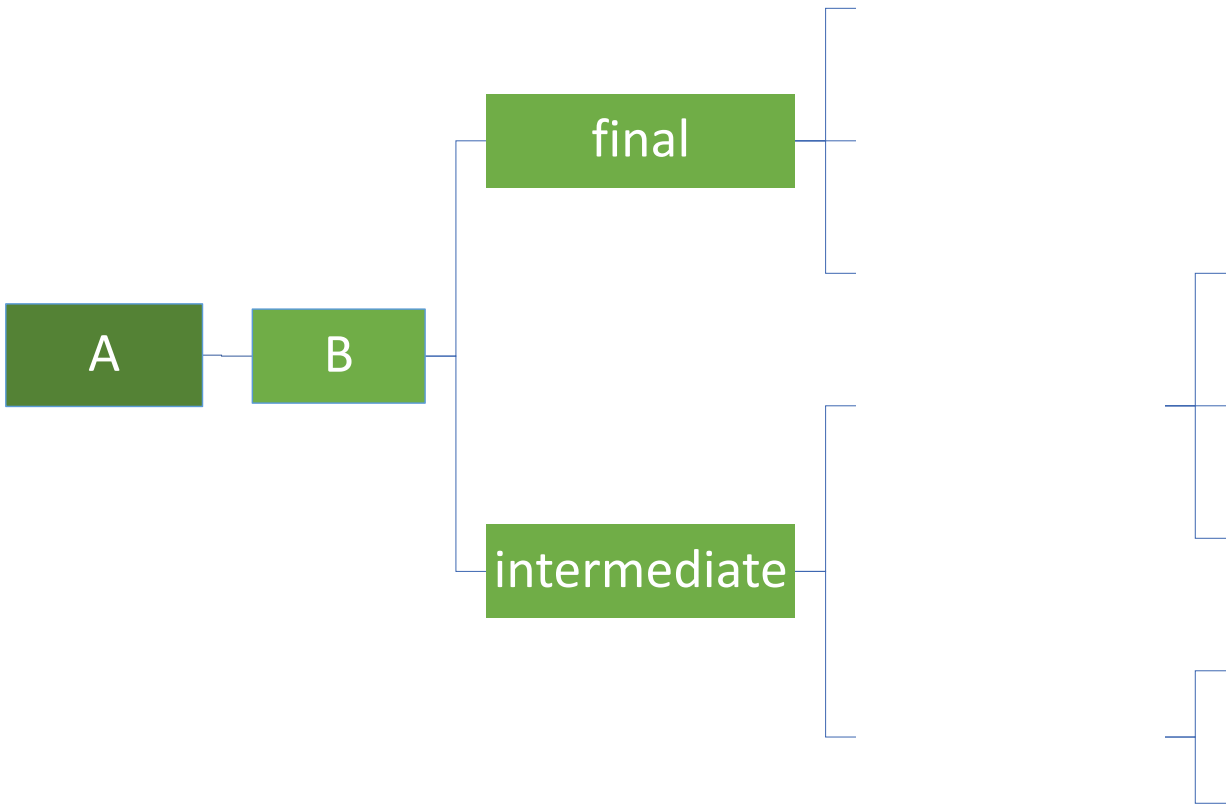

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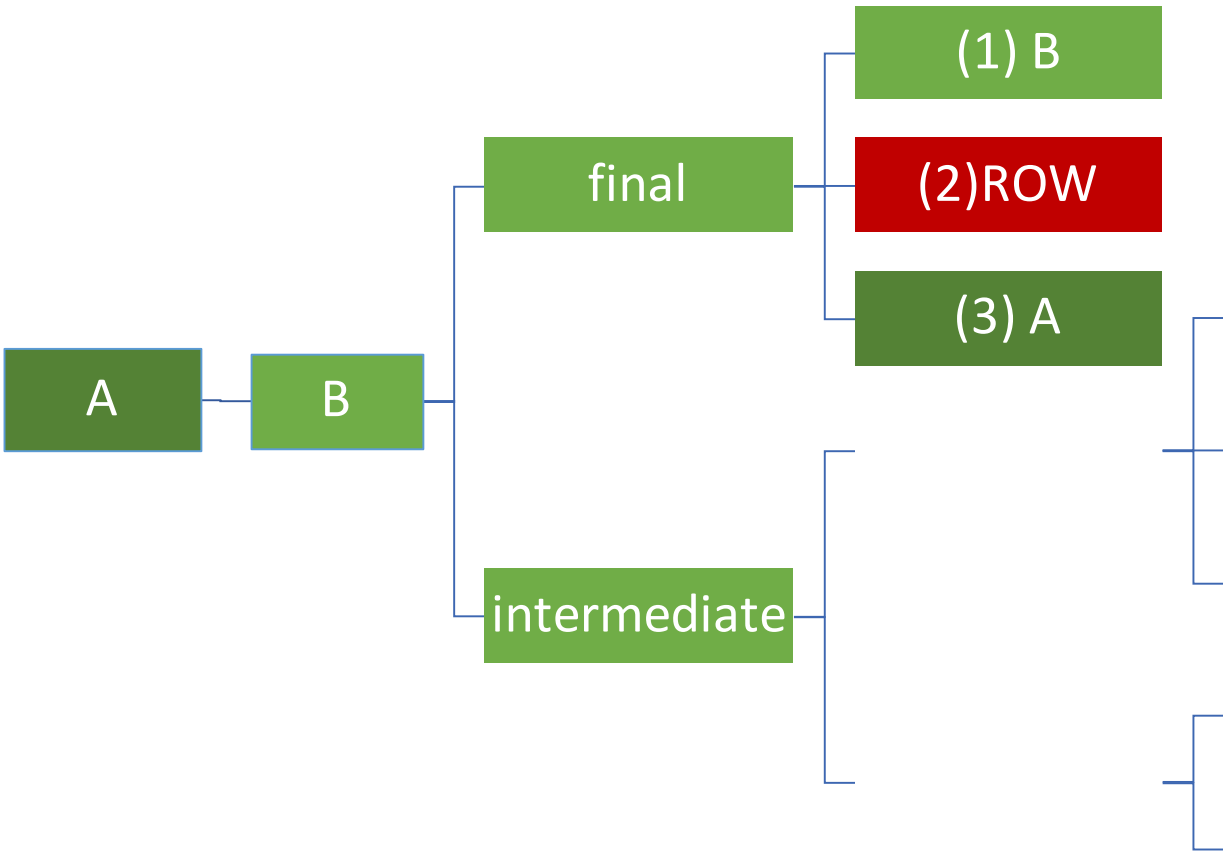

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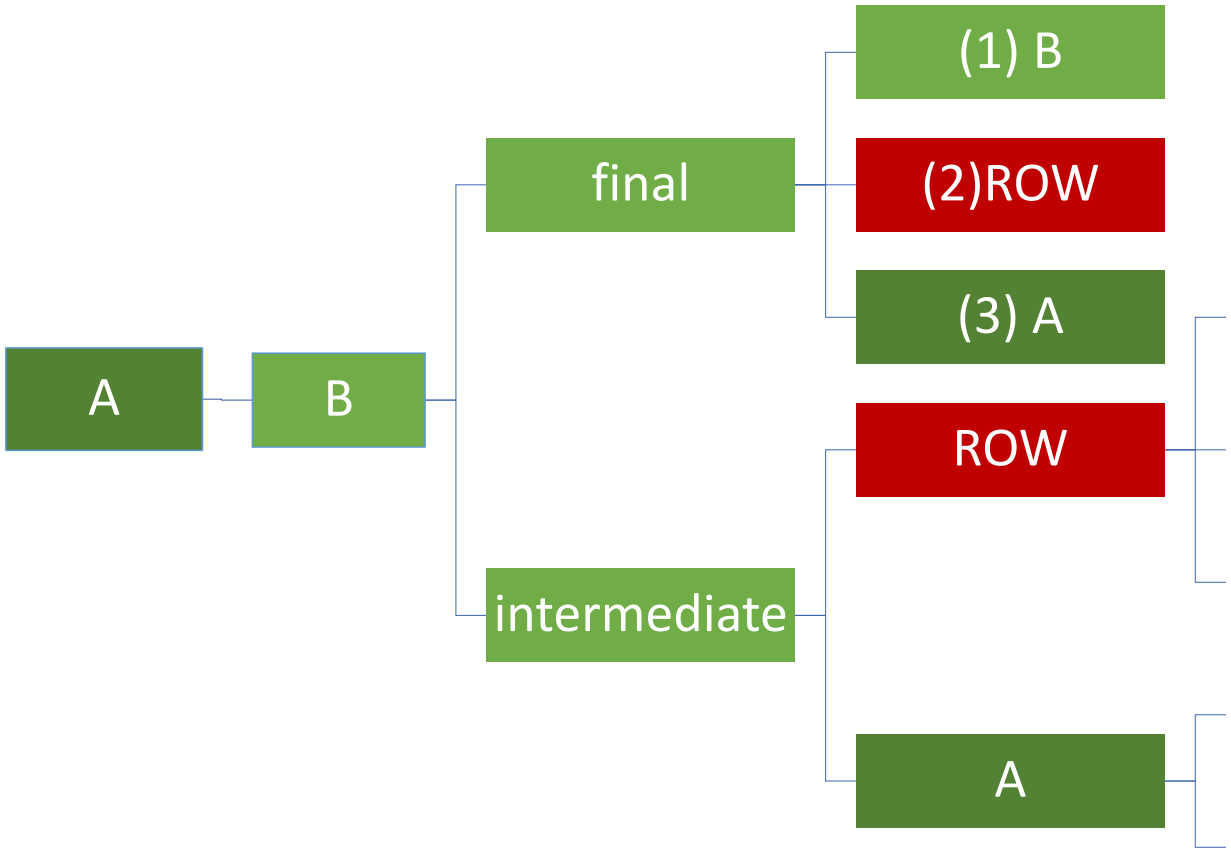

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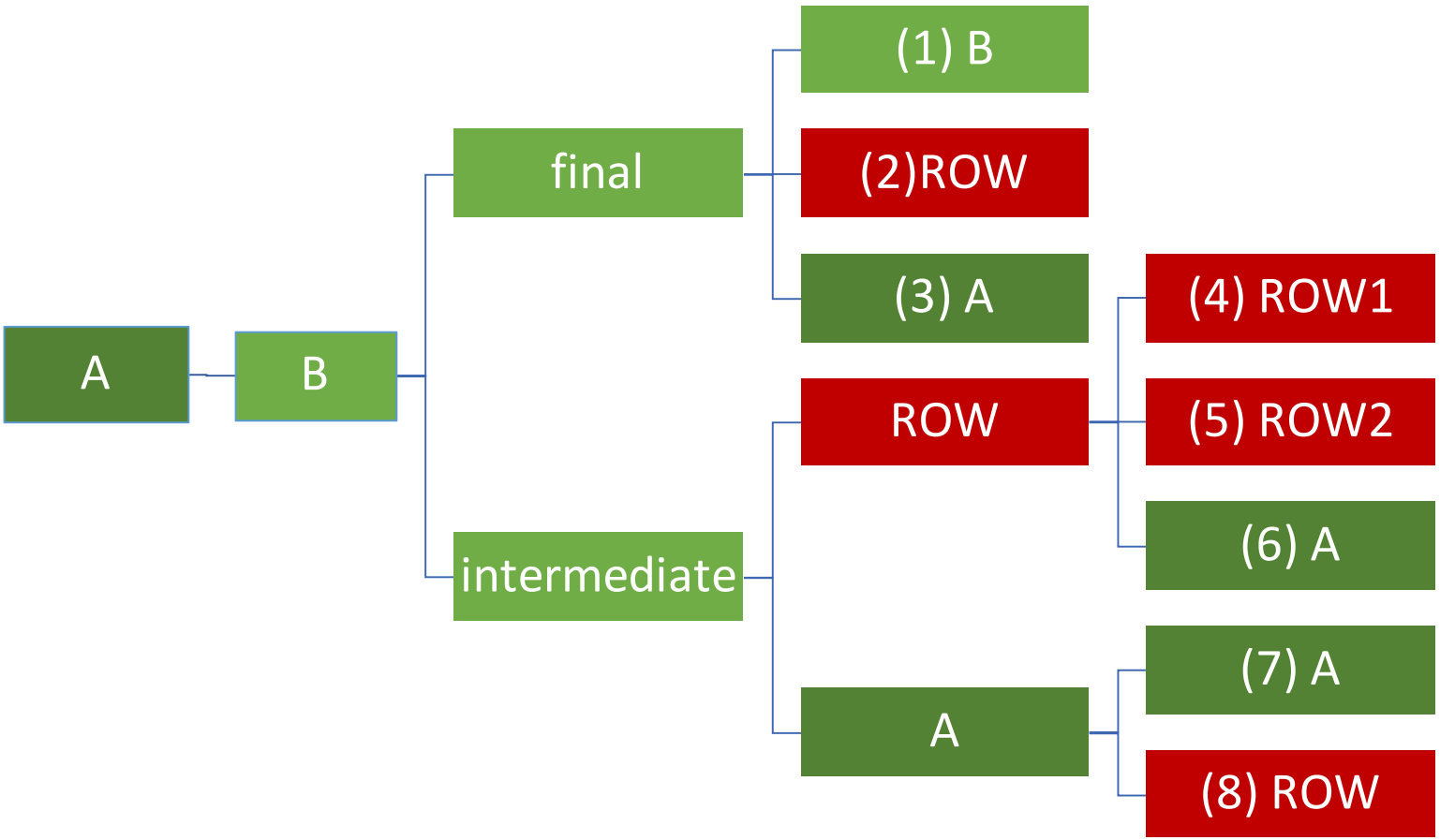
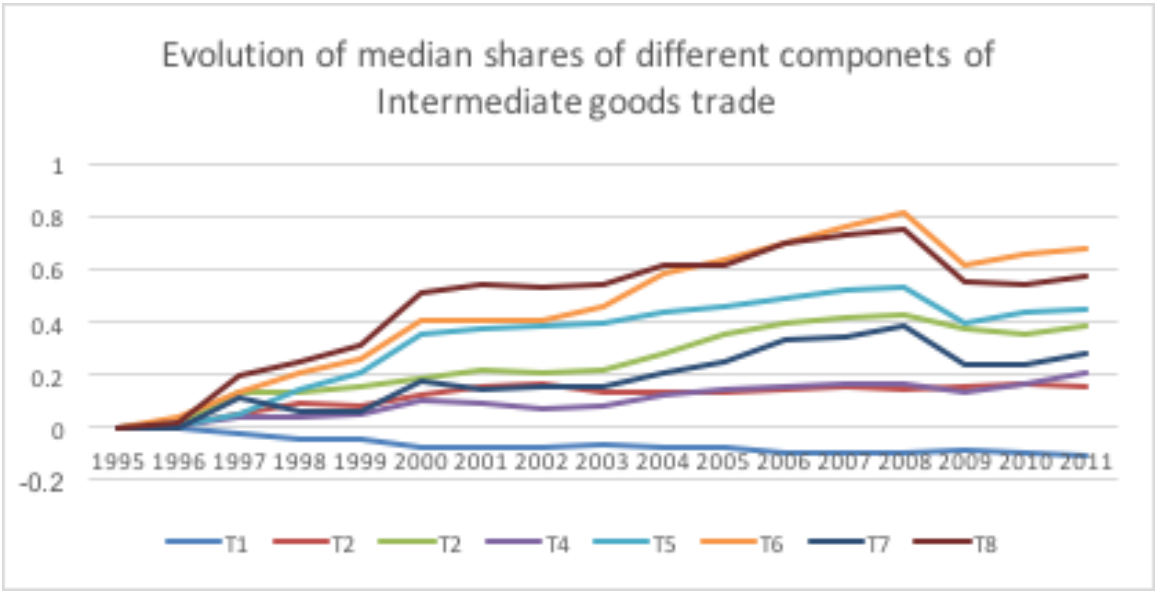
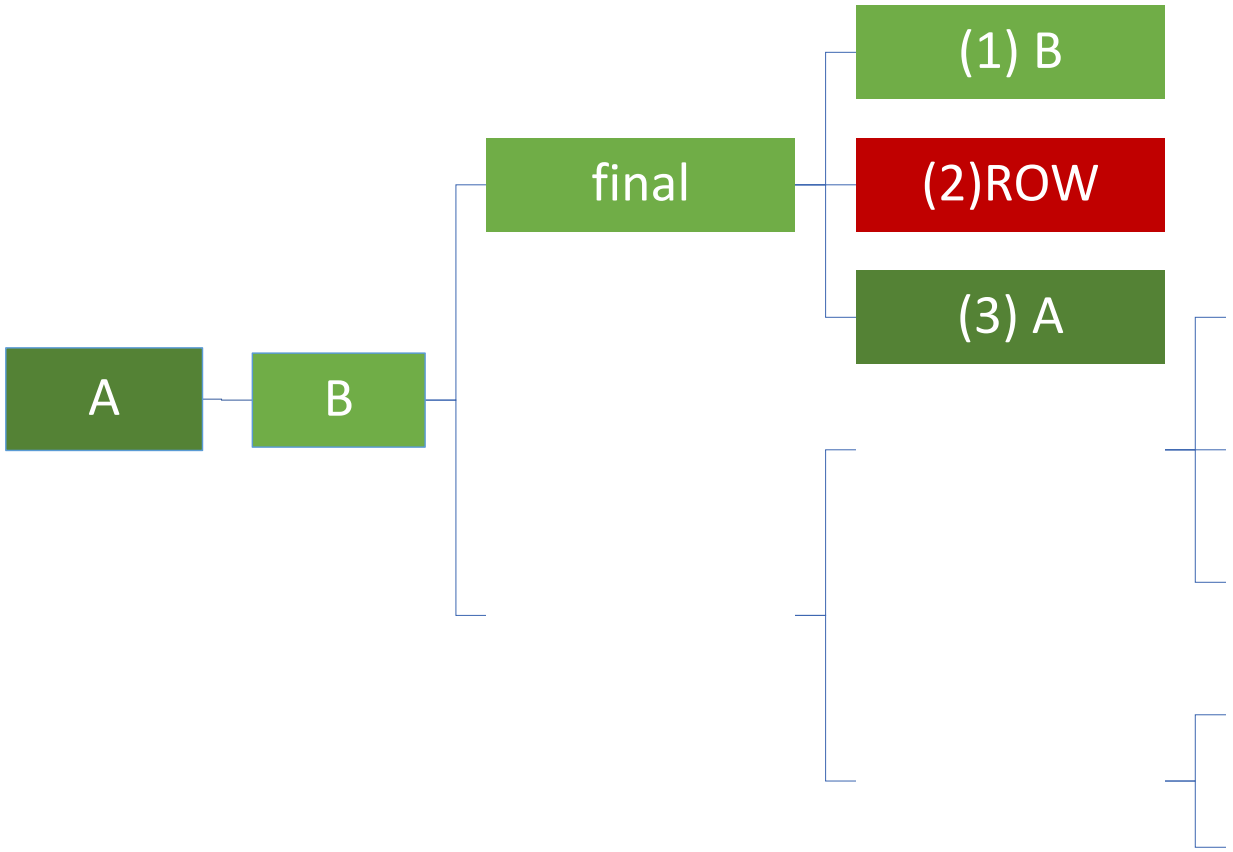


# Summary statistics: 8 term decomposition of bilateral intermediate goods shipments (sample median)

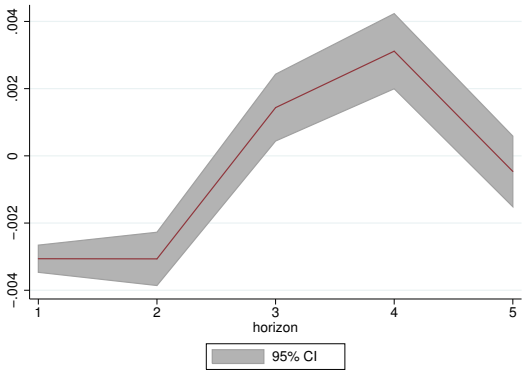
| Year | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 |
|---|---|---|---|---|---|---|---|---|
| 1995 | **69.38** | 11.09 | 0.05 | 14.54 | 2.74 | 0.02 | 0.09 | 0.02 |
| 2011 | **62.46** | 12.91 | 0.07 | 17.81 | 4.27 | 0.04 | 0.12 | 0.03 |



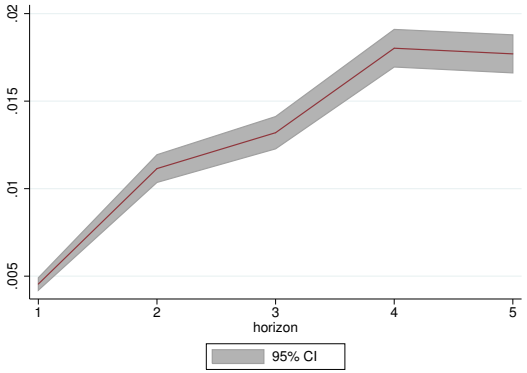
# Tracing the journey of intermediate exports



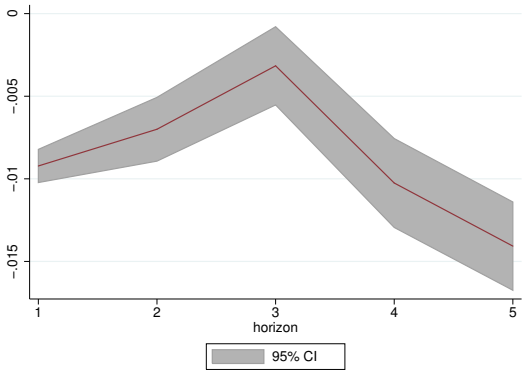
Response of intermediate exports used by direct importer to produce final goods..




..(1) B: consumed domestically (i.e by the direct importer)



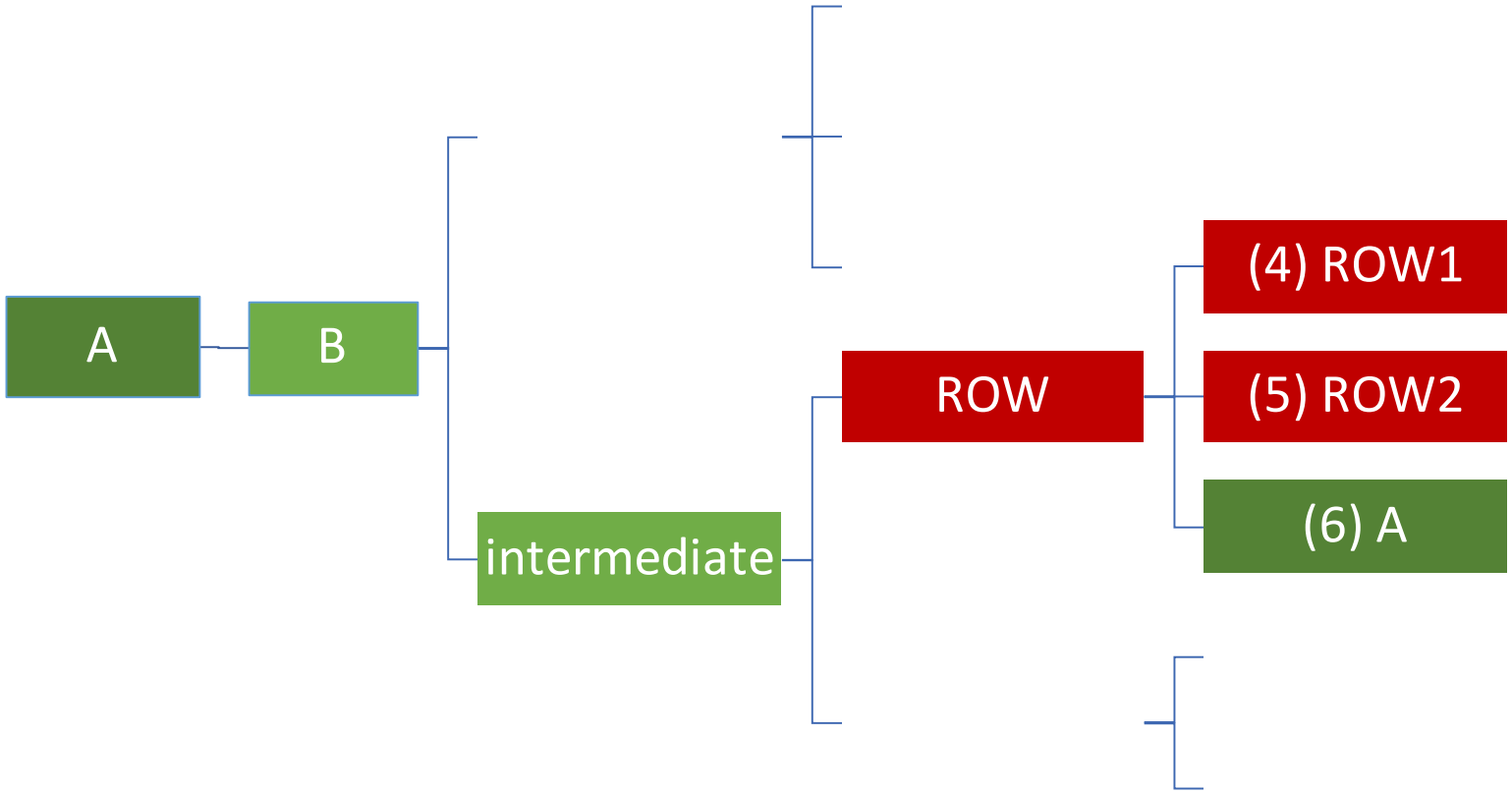

..(2) ROW: exported to third countries



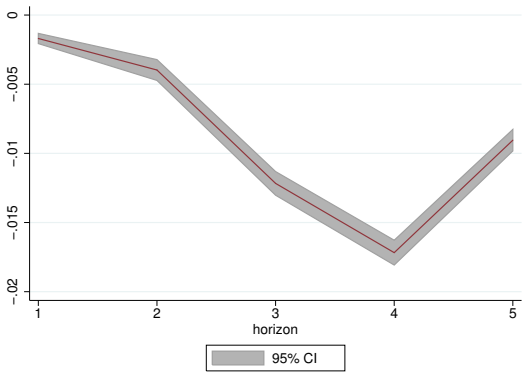

..(3) A: exported back to the source country

▸ More

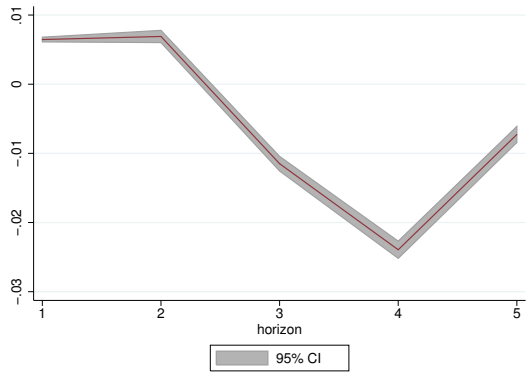
# Tracing the journey of intermediate exports



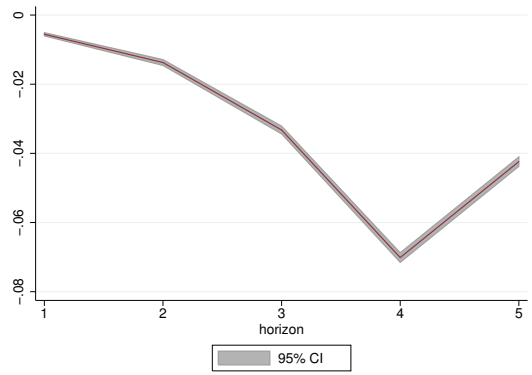
Response of intermediate exports first used by direct importer to produce intermediate goods exports then used by third countries to produce final goods..




..(4) ROW: consumed domestically (by third country)



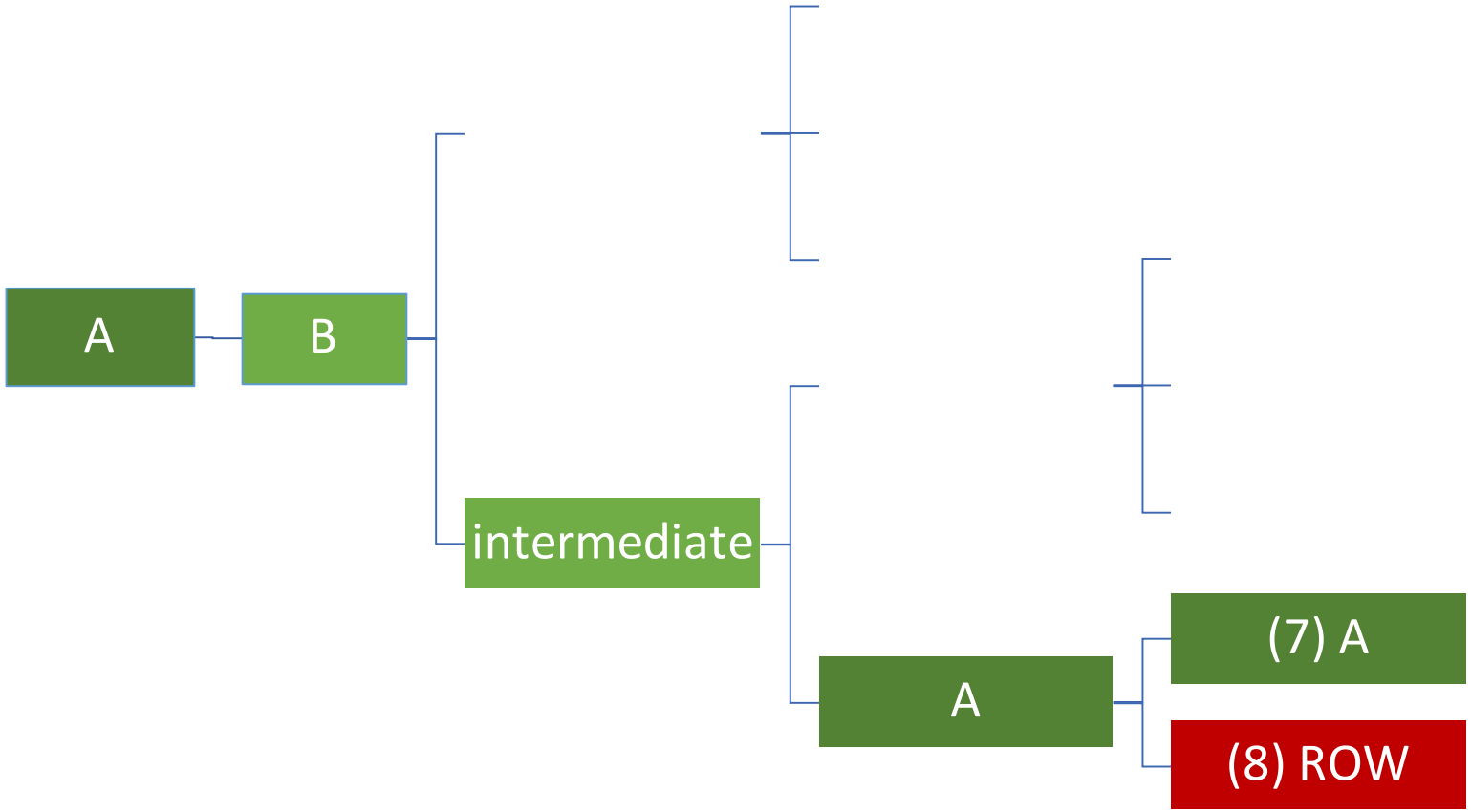

..(5) ROW: exported final goods consumed by countries other than the source country(exporting country)



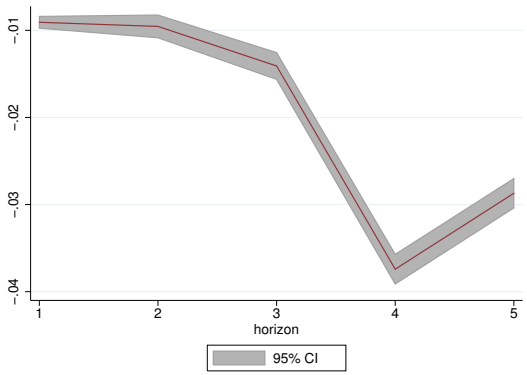

..(6) A: exported final goods consumed by the source (exporting) country

▸ More

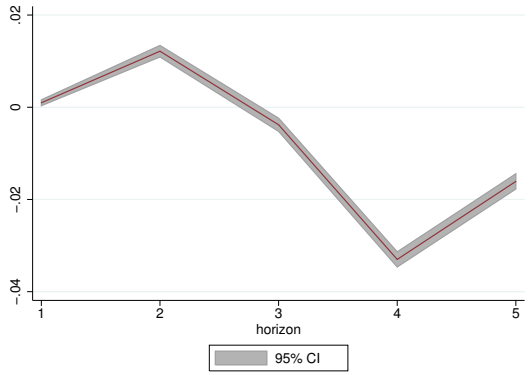
# Tracing the journey of intermediate exports



Response of intermediate exports first used by direct importer to produce intermediate exports shipped back to the source (exporting) country as intermediate imports to produce final goods



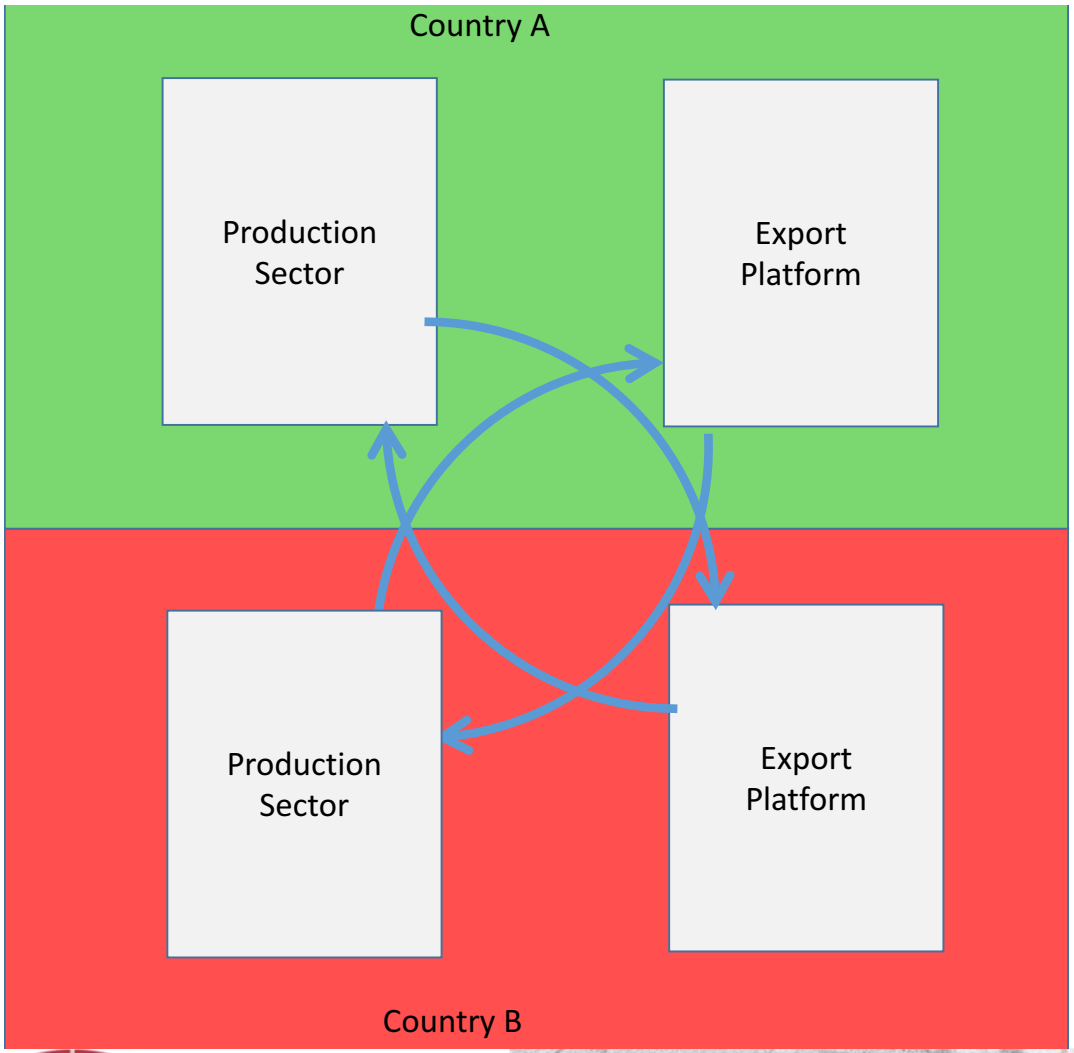

..(7) A:domestic final goods consumed by the source (exporting) country




...(8) ROW:exported final goods consumed by other countries

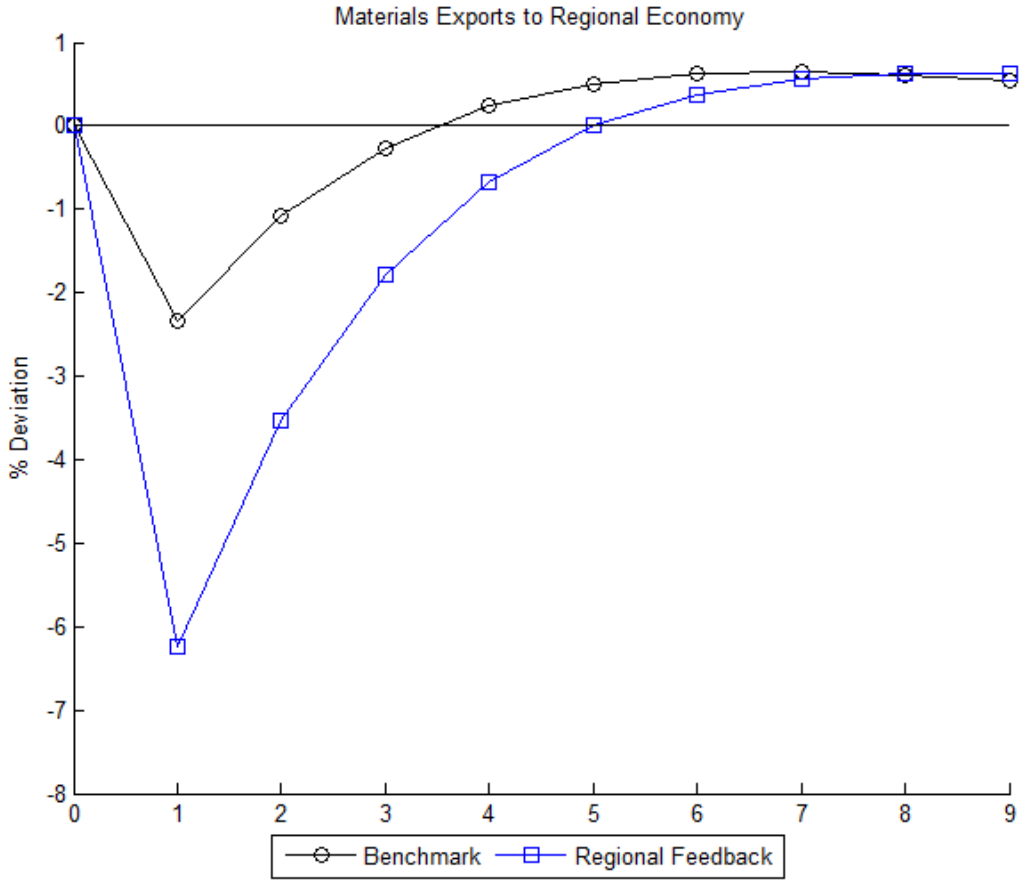
▸ More

# Model with round-about trade between the regional economies




Feedback

Final Goods

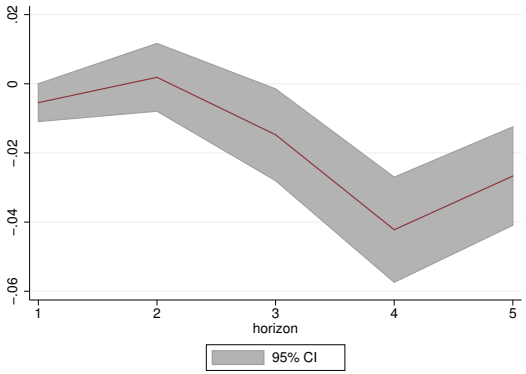

Materials Exports to Regional Economy
% Deviation
1
0
-1
-2
-3
-4
-5
-6
-7
-8
0
1
2
3
4
5
6
7
8
9
Benchmark
Regional Feedback

# Evidence from data on value added trade

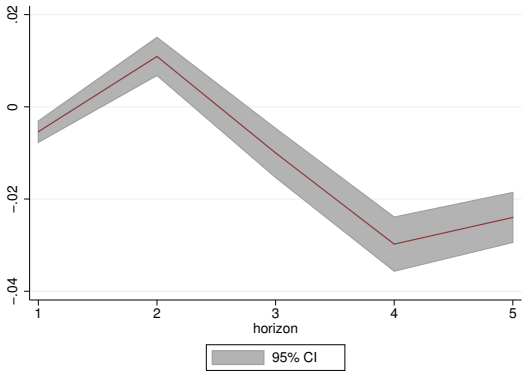
- We look at the following two measures of value added exports
  - Value added exports
  - Indirect value by third countries
- In each case, we compare the parentage change in ratio of exports to a non-US trading partner divided by exports to the US
- Shocks to US monetary policy are now identified using instruments in Gertler and Karadi (2015).
- Consider only non EU exporters



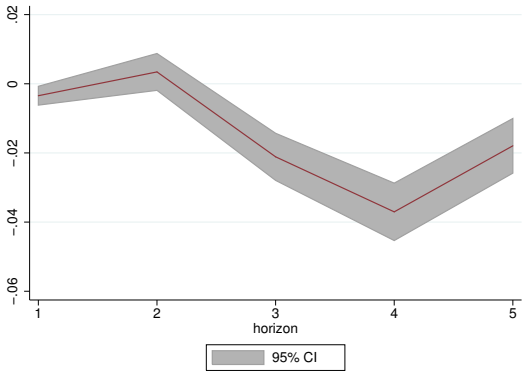
Figure: Value added exports (forward)




Primary sectors




Secondary sectors




Tertiary sectors

# Policy Implications

- Monetary policy
  - Flexible exchange rates (inflation targeting) continue to perform better than fixed exchange rates even in the presence of dollar invoicing

- Industrial policy
  - GVCs cushion the impact of interest rate shocks on the domestic economy
  - provides an additional (cyclical) benefit of GVCs, in addition to structural ones like productivity gains (Del Prete et al (2017) and World Bank (2017))
  - rationale for policies promoting GVC participation, including liberalizing FDI?

# Policy Implications

- Monetary policy
  - Flexible exchange rates (inflation targeting) continue to perform better than fixed exchange rates even in the presence of dollar invoicing
- Industrial policy
  - GVCs cushion the impact of interest rate shocks on the domestic economy
  - provides an additional (cyclical) benefit of GVCs, in addition to structural ones like productivity gains (Del Prete et al (2017) and World Bank (2017))
  - rationale for policies promoting GVC participation, including liberalizing FDI?

# Summary and Conclusion

- Unlike the Mundell Fleming and subsequent frameworks, international trade is best categorized with dollar invoicing
- We consider the general equilibrium implications of this phenomenon under interest rate shocks in small open economies.
- Theory
  - 3 country new Keynesian model
  - Main insight: Final goods trade and global value chain trade respond differently to shocks
- Data
  - Use granular decomposition of bilateral trade flows at the sector level
  - Document evidence broadly in line with predictions of the model
  - Final goods and regional trade flows respond more to shocks than than global value chain related trade.



Thank You!



# Appendix

Extra Slides

# List of countries

Australia (non EU) Austria Belgium Bulgaria, Brazil(non EU) Canada (non EU) China (non EU) Cyprus Czech Republic Germany Denmark Spain Estonia Finland France United Kingdom Greece Hungary Indonesia (non EU) India (non EU) Ireland Italy Japan (non EU) Korea (non EU) Lithuania Luxembourg Latvia Mexico (non EU) Malta Netherlands Poland Portugal Romania Russia (non EU) Slovak Republic Slovenia Sweden Turkey(non EU) Taiwan(non EU) United States (non EU)

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# List of sectors: Primary

| WIOD sector | Sector description | NACE code |
|---|---|---|
| c01 | AGRICULTURE, HUNTING, FORESTRY AND FISHING | AtB |
| c02 | MINING AND QUARRYING | C |
| c03 | FOOD , BEVERAGES AND TOBACCO | 15t16 |

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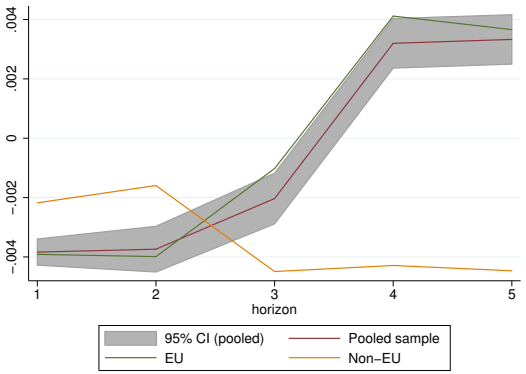
# List of sectors: Secondary

| WIOD sector | Sector description | NACE code |
|---|---|---|
| c04 | Textiles and textile | 17t18 |
| c05 | Leather, leather and footwear | 19 |
| c06 | WOOD AND OF WOOD AND CORK | 20 |
| c07 | PULP, PAPER, PAPER , PRINTING AND PUBLISHING | 21t22 |
| c08 | Coke, refined petroleum and nuclear fuel | 23 |
| c09 | Chemicals and chemical | 24 |
| c10 | Rubber and plastics | 25 |
| c11 | OTHER NON-METALLIC MINERAL | 26 |
| c12 | BASIC METALS AND FABRICATED METAL | 27t28 |
| c13 | MACHINERY, NEC | 29 |
| c14 | ELECTRICAL AND OPTICAL EQUIPMENT | 30t33 |
| c15 | TRANSPORT EQUIPMENT | 34t35 |
| c16 | MANUFACTURING NEC; RECYCLING | 36t37 |
| c17 | ELECTRICITY, GAS AND WATER SUPPLY | E |
| c18 | CONSTRUCTION | F |

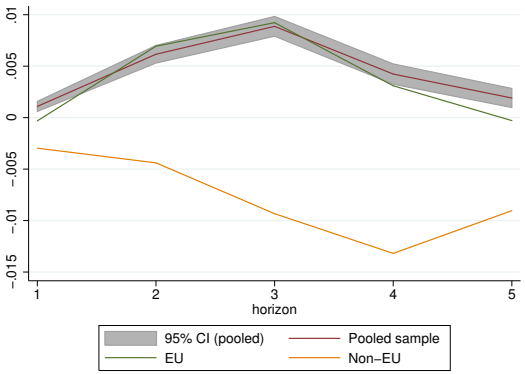
# List of sectors: Tertiary

| WIOD sector | Sector description | NACE code |
|---|---|---|
| c19 | Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel | 50 |
| c20 | Wholesale trade and commission trade, except of motor vehicles and motorcycles | 51 |
| c21 | Retail trade, except of motor vehicles and motorcycles; repair of household goods | 52 |
| c22 | HOTELS AND RESTAURANTS | H |
| c23 | Other Inland transport | 60 |
| c24 | Other Water transport | 61 |
| c25 | Other Air transport | 62 |
| c26 | Other Supporting and auxiliary transport activities; activities of travel agencies | 63 |
| c27 | POST AND TELECOMMUNICATIONS | 64 |
| c28 | FINANCIAL INTERMEDIATION | J |
| c29 | Real estate activities | 70 |
| c30 | Renting of m&eq and other business activities | 71t74 |
| c31 | PUBLIC ADMIN AND DEFENSE; COMPULSORY SOCIAL SECURITY | L |
| c32 | EDUCATION | M |
| c33 | HEALTH AND SOCIAL WORK | N |
| c34 | OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES | O |
| c35 | PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS | P |

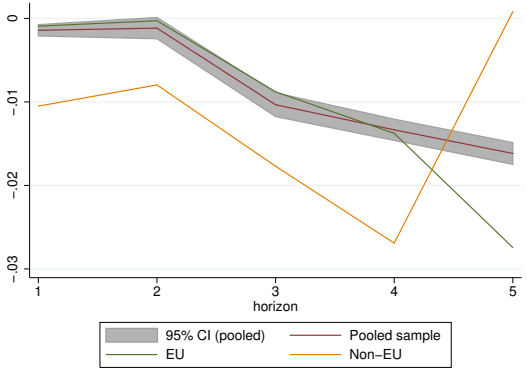
# Response of intermediate exports used by direct importer to produce final goods..




..consumed domestically (i.e by the direct importer)

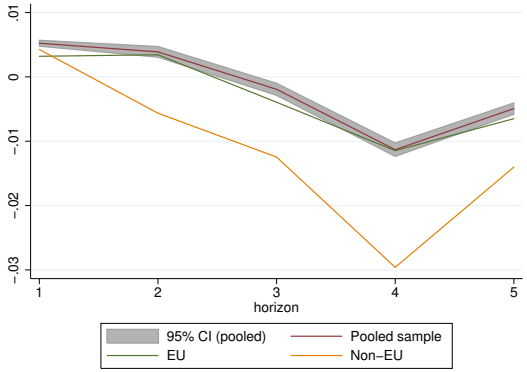



..exported to third countries

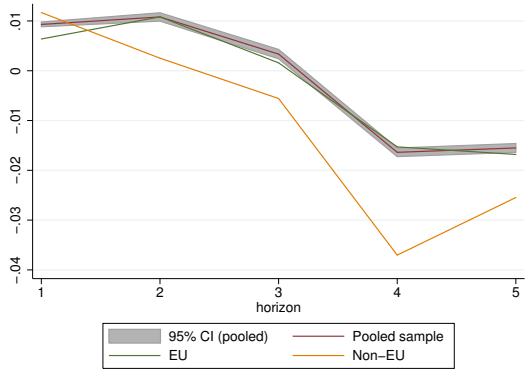



..exported back to the source country

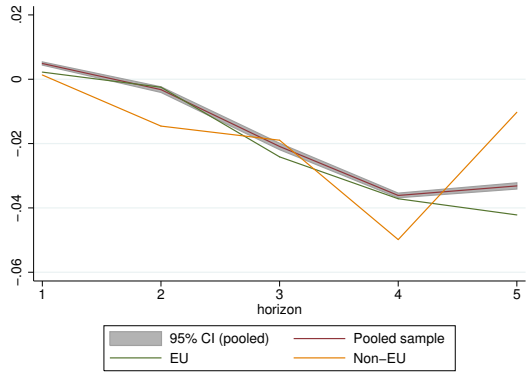
Response of intermediate exports first used by direct importer to produce intermediate goods exports then used by third countries to produce final goods..




..consumed domestically (by third country)

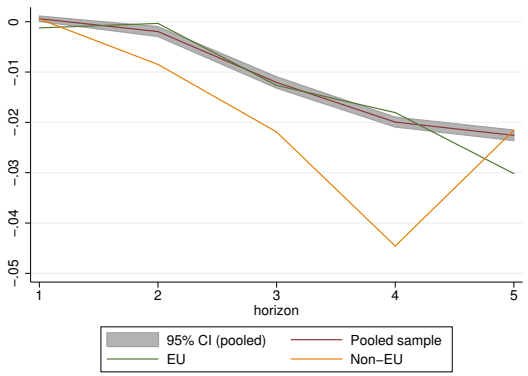



..exported final goods consumed by countries other than the source country(exporting country)

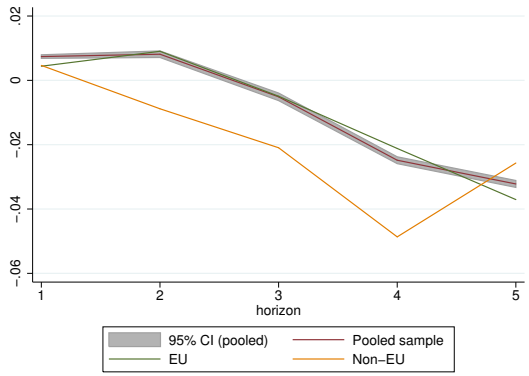



..exported final goods consumed by the source (exporting) country

Response of intermediate exports first used by direct importer to produce intermediate exports shipped back to the source (exporting) country as intermediate imports to produce final goods




..domestic final goods consumed by the source (exporting) country




...exported final goods consumed by other countries

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# Country-level analysis

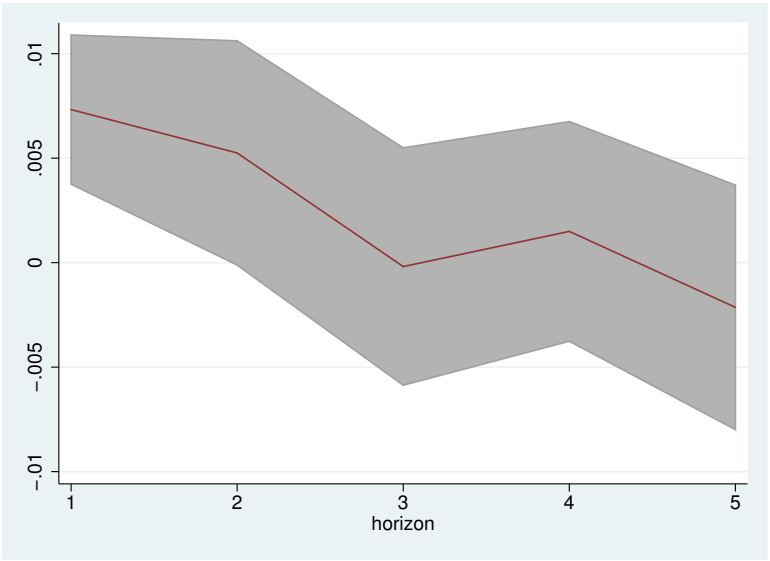
- Specification

$$\triangle Y_{i,j,t} = \alpha_{i,j} + \triangle Y_{i,j,t-1} + \beta i_{us,t} + \triangle E_{i,j,t} + \delta X_t$$

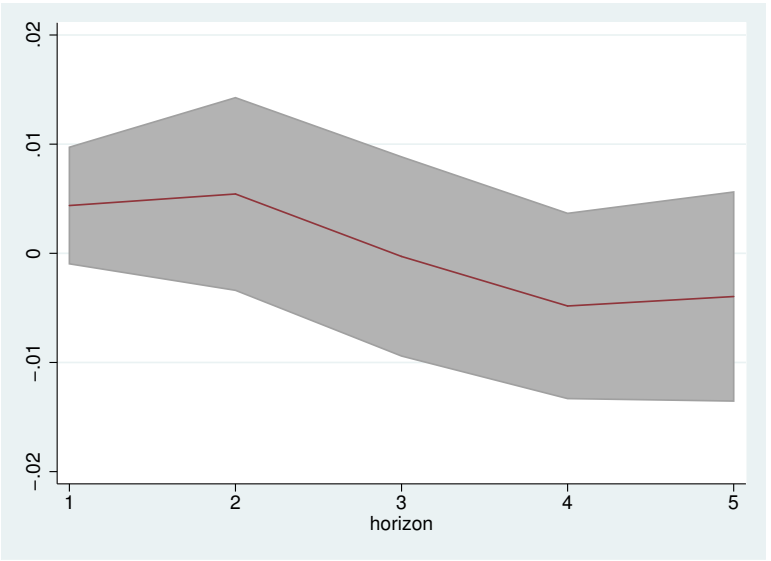
- $\triangle Y_{i,j,t}$: Intermediate exports, final exports or share of value added to gross exports
- $i_{us,t}$: US policy stance (shadow fed funds rate from Lombardi and Zhu, 2014)
- $\triangle E_{i,j,t}$ : bilateral exchange rate
- $X_t$ is a vector of additional controls including current and lagged values of GDP growth and inflation (both country and partner), growth in world trade, a dummy for financial crisis (set equal to 1 for 2008 and 2009) and the financial crisis dummy interacted with partner GDP growth.
- Impulse responses are computed from the above specification using the local projection method in Jorda (2005)

# Response of ratio of intermediate to final goods exports to US monetary contraction

Full Sample




Non-EU countries

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Thank You

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