Open-Economy DSGE Modelling

Intermediate-Goods Trade, Global Value Chain Integration and Cross-Border Spillovers

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These slides draw on numerous pieces of work, joint with Giancarlo Corsetti, Lucio D'Aguanno, Luca Dedola, Aydan Dogan, Emile Marin and Rana Sajedi.

The views expressed here do not necessarily reflect the position of the Bank of England.

Plan for Today

#1 High-level overview of open-economy DSGE modelling

- Citations throughout and lots of resources online, e.g.:
  `https://sites.google.com/view/splloyd/teaching/ccbs-open-economy-macro`

#2 Building a model with intermediate-goods trade and Global Value Chains (GVCs)

- Draw on:
  - Corsetti, G., L. D'Aguanno, A. Dogan, S. Lloyd, & R. Sajedi, 2024. "Global Value Chains and International Risk Sharing," Working Paper.

#3 Implications of GVC integration for international policy debates

- Draw on:
  - D'Aguanno, L., O. Davies, A. Dogan, R. Freeman, S. Lloyd, D. Reinhardt, R. Sajedi, & R. Zymek, 2021. "Global Value Chains, Volatility and Safe Openness: Is Trade a Double-Edged Sword?," *Bank of England Financial Stability Paper*, No. 46.

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Open-Economy Macroeconomic Modelling

The Building Blocks

Open-Economy Macroeconomic Modelling

- Broad literature, confronting a range of 'stylised facts', including:
  - *Striking similarities in business cycles across countries*
    - Consumption less variable than output, while investment more variable
    - Net exports and current account tend to be counter-cyclical: external deficits grow in booms
  - *Cross-country co-movement and business-cycle synchronisation*
    - Output and employment typically more correlated across countries than consumption and investment
    - Trade co-movement: countries that trade more, tend to have more correlated business cycles
  - *Volatility of international relative prices driven by nominal exchange rates*
    - Implications for conduct of domestic monetary policy in face of foreign shocks
  - *Exchange-rate disconnect*
    - Hard to explain nominal exchange-rate moves with macroeconomic fundamentals
  - *Dollar dominance and unique role for US in international financial system*
    - Particular role for USD in international-trade invoicing and international financing
    - US monetary policy plays outsized role in 'Global Financial Cycle'

$\Rightarrow$ Lots of modelling choices!

Open-Economy Models: The Building Blocks

- **Country Size**: large- or small-open economies?
  - Small-open economy takes world prices and interest rates as given; large-open economy can influence international relative prices
  - Today: two large-open economies $\{H, F\}$, building on:
    - Cole, H. L. & M. Obstfeld, 1991. "Commodity trade and international risk sharing: How much do financial markets matter?," *Journal of Monetary Economics*.
    - Corsetti, G. & P. Pesenti, 2001. "Welfare and Macroeconomic Interdependence," *Quarterly Journal of Economics*.
    - Corsetti G., L. Dedola, & S. Leduc, 2008. "International Risk Sharing and the Transmission of Productivity Shocks," *Review of Economic Studies*.
  - 'Classic' small-open economy reference:
    - Galí, J. & T. Monacelli, 2005. "Monetary Policy and Exchange Rate Volatility in a Small Open Economy," *Review of Economic Studies*.

Open-Economy Models: The Building Blocks

- **Consumption**: Representative agents in each countries or within-country heterogeneity?
  - Heterogeneous households can introduce variation in marginal propensities to consume
  - Today: Representative agents deriving utility from final consumption $C_t^{(*)}$ at Home (Foreign)

$$U_t = \mathbb{E}_t \sum_{\tau=0}^{\infty} \beta^\tau u(C_{t+\tau})$$

  where $\beta \in (0,1)$, $u(C) = \frac{C^{1-\sigma}-1}{1-\sigma}$ and, for simplicity, $\beta^* = \beta$, $\sigma^* = \sigma$; also, abstract from labour
  - Examples of heterogeneous-agent open-economy models (a developing literature):
    - de Ferra, S., K. Mitman, & F. Romei, 2020. "Household Heterogeneity and the Transmission of Foreign Shocks," *Journal of International Economics*.
    - Auclert, A., M. Rognlie, M. Souchier, & L. Straub, 2021. "Exchange Rates and Monetary Policy with Heterogeneous Agents: Sizing up the Real Income Channel," Working Paper.
    - Chan, J., S. Diz, & D. Kanngiesser, 2024. "Energy Prices and Household Heterogeneity: Monetary Policy in a Gas-TANK," *Journal of Monetary Economics*.

Open-Economy Models: The Building Blocks

- **Investment**: country-specific capital stocks
  - References:
    - Backus, D. K., P. J. Kehoe, & F. E. Kydland, 1992. “International Real Business Cycles,” *Journal of Political Economy*.
    - Stockman, A. C. & L. L. Tesar, 1995. “Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements," *American Economic Review*.

- **Government**: government spending and taxation
  - References:
    - Corsetti, G., A. Meier, & G. J. Müller, 2014. “What determines government spending multipliers?” *Economic Policy*.
    - Born, B., F. D’Ascanio, G. J. Müller, & J. Pfeifer, 2023. “Mr. Keynes meets the Classics: Government Spending and the Real Exchange Rate,” *Journal of Political Economy*.

Today: Abstract from both investment and government spending

Open-Economy Models: The Building Blocks

- **Pricing**: a 'real' model or nominal rigidities? if nominal rigidities, which ones?
  - Price rigidities: in which currency?
  - 'Producer Currency Pricing' (PCP) $\Rightarrow$ Full exchange-rate pass through
    - Obstfeld, M. & K. Rogoff, 1995. "Exchange Rate Dynamics Redux," *Journal of Political Economy*.
  - 'Local Currency Pricing' (LCP) $\Rightarrow$ No exchange-rate pass through
    - Betts, C. & M. Devereux, 2000. "Exchange rate dynamics in a model of pricing-to-market," *Journal of International Economics*.
  - 'Dominant Currency Pricing' (DCP) $\Rightarrow$ Asymmetric pass through
    - Gopinath, G., E. Boz, C. Casas, F. J. Díez, P.-O. Gourinchas, & M. Plagborg-Møller, 2020. "Dominant Currency Paradigm," *American Economic Review*.
  - Wage rigidities: scope for overborrowing and capital-flow taxation
    - Schmitt-Grohé, S. & M. Uribe, 2016. "Downward Nominal Wage Rigidity, Currency Pegs, and Involuntary Unemployment," *Journal of Political Economy*.

Today: Abstract from nominal rigidities, to focus on a real model

Open-Economy Models: The Building Blocks

- **Monetary Policy**: if there are nominal rigidities, how is monetary policy set?
  - Simple rules:
    - Clarida, R., J. Galí, & M. Gertler, 2001. "A simple framework for international monetary policy analysis," *Journal of Monetary Economics*.
    - Benigno, G. & P. Benigno, 2006. "Designing targeting rules for international monetary policy cooperation," *Journal of Monetary Economics*.
  - Optimal policy:
    - Corsetti, G., L. Dedola, & S. Leduc, 2010. "Optimal Monetary Policy in Open Economies," *Handbook of Monetary Economics*.
    - Corsetti, G., L. Dedola, & S. Leduc, 2022. "Exchange rate misalignment and external imbalances : what is the optimal monetary policy response?" *Journal of International Economics*.
    - Mukhin, D. & K. Egorov, 2023. "Optimal Policy under Dollar Pricing," *American Economic Review*.
  - QE-type policies:
    - Dedola. L., P. Karadi, & G. Lombardo, 2013. "Global implications of national unconventional policies," *Journal of Monetary Economics*.

Today: Since no nominal rigidities, also abstract from monetary policy

Open-Economy Models: The Building Blocks

- **International Financial Markets**: how do agents smooth consumption across periods?
  - Today: focus on three possibilities
  - Complete Markets (CM): complete set of Arrow-Debreu securities to insure against each state of nature $\Rightarrow RER$ adjusts to ensure perfect risk sharing
  - Financial Autarky (FA): international asset trade not permitted $\Rightarrow RER$ adjusts to balance trade
  - Bond Economy (BE): single non-contingent bond $\Rightarrow RER$ adjusts to ensure risk sharing on avg.
  - Also international financial frictions for studying global financial intermediation
    - Gabaix, X. & M. Maggiori, 2015. "International Liquidity and Exchange Rate Dynamics," *Quarterly Journal of Economics*.
    - Itskhoki, O. & D. Mukhin, 2023. "Mussa Puzzle Redux," Working Paper.
  - Scope for capital-flow taxes
    - Costinot, A., G. Lorenzoni, & I. Werning, 2014. "A Theory of Capital Controls as Dynamic Terms-of-Trade Manipulation," *Journal of Political Economy*.

Today: abstract from additional financial frictions or capital-flow taxes

Open-Economy Models: The Building Blocks

- **Goods Trade**: how do consumers allocate spending between Home and Foreign goods?
  - Today: CES/Armington aggregation of Home and Foreign goods:

$$C_t \equiv \left[a_H^{\frac{1}{\phi}} C_{H,t}^{\frac{\phi-1}{\phi}} + a_F^{\frac{1}{\phi}} C_{F,t}^{\frac{\phi-1}{\phi}} \right]^{\frac{\phi}{\phi-1}}$$

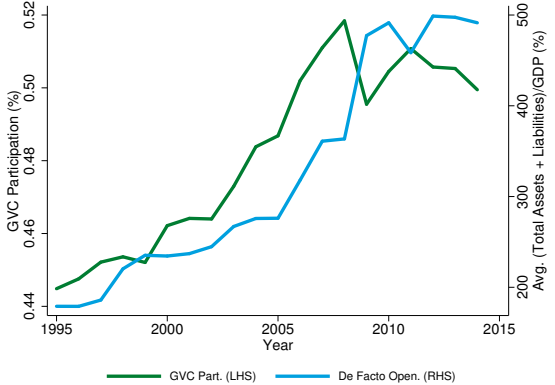
  - Exact choice largely irrelevant for macro outcomes:
    - Lisack, N., S. Lloyd, & R. Sajedi, 2023. "Aggregation Across Each Nation: Trade and Macroeconomic Dynamics," Working Paper.
  - Also scope to add trade tariffs, which could interact with other policies
    - Bergin, P. & G. Corsetti, 2023. "The Macroeconomic Stabilization of Tariff Shocks: What is the Optimal Monetary Response?" *Journal of International Economics*.
    - Lloyd, S. & E. Marin, 2024. "Capital Controls and Trade Policy," *Journal of International Economics*.

Today: abstract from trade tariffs

A Model with Global Value Chains

Motivation

- Global Value Chains (GVCs) are now a prominent feature of international macro landscape
- GVC integration has also gone hand-in-hand with financial integration



Notes: Avg. reliance on GVCs (WDR, 2020). Avg. total assets (excl. gold) + total liabilities as % GDP (Lane & Milesi-Ferretti, 2018)

An Analytically Tractable Model of GVCs

- Two symmetric countries, Home & Foreign, with endowment of value added, V_H and V_F^*
- Gross Output produced by combining (fixed) value added and intermediates:

$$Y_{H,t} = A_{H,t} V_H^{\alpha} X_t^{1-\alpha}$$

  where $A_{H,t}$ is the country-specific TFP shock
  - $\alpha = 1$ embeds the standard Endowment economy
  - $\alpha < 1$ introduces intermediate inputs to this model
- Roundabout production – intermediates are made up of the same period's gross output
- Price of each good given by $P_{H,t}$ and $P_{F,t}$ (assume LOOP)
- Define the Terms of Trade $TOT_t = P_{F,t}/P_{H,t}$: an increase is a deterioration

Standard Model: Trade in Final Goods

- Households in each country consume a CES bundle of both goods:

$$C_t \equiv \left({a_H}^{\frac{1}{\phi}} {C_{H,t}}^{\frac{\phi-1}{\phi}} + {a_F}^{\frac{1}{\phi}} {C_{F,t}}^{\frac{\phi-1}{\phi}} \right)^{\frac{\phi}{\phi-1}}$$

  where $a_F = 1 - a_H$ and $a_H > 0.5$ for 'home bias'
- $\phi > 0$ elasticity of substitution between Home and Foreign goods, **trade elasticity**
- Gives rise to familiar demand functions and definition of CPI, P_t and P_t^*
- Define the Real Exchange Rate $RER_t = P_t^*/P_t$
- So long as $a_H > 0.5$, RER and TOT co-move

Consumption-Based Price Index

- P_t (P_t^*) is price of a single unit of the aggregate consumption basket in the Home (Foreign) economy, defined such that

$$P_t \equiv \min_{C_{H,t}, C_{F,t}} P_{H,t}C_{H,t} + P_{F,t}C_{F,t} \quad \text{subject to} \quad C_t = 1$$

- By solving associated minimisation problem, the price index is:

$$P_t = \left[a_H P_{H,t}^{1-\phi} + a_F P_{F,t}^{1-\phi} \right]^{\frac{1}{1-\phi}}$$

- Demand for each good can also be derived:

$$C_{H,t} = a_H \left(\frac{P_{H,t}}{P_t} \right)^{-\phi} C_t, \qquad C_{F,t} = a_F \left(\frac{P_{F,t}}{P_t} \right)^{-\phi} C_t$$

which says that consumption of both goods is proportional to aggregate consumption

Complementarity and Substitutability

- C_H and C_F are **substitutes** if the marginal utility of one good is decreasing in the quantity of the other. Mathematically this is defined as:

$$\frac{\partial U^2}{\partial C_H \partial C_F} = \frac{\partial U^2}{\partial C_F \partial C_H} < 0$$

  They are **complements** if the opposite is true.
- One can show that when:
  - $\sigma\phi > 1$, the goods are **substitutes**
  - $\sigma\phi < 1$, the goods are **complements**

Exchange Rates and Relative Prices

- **Nominal Exchange Rate** $\mathcal{E}_t$: Home currency price of Foreign currency

  $\Rightarrow \uparrow \mathcal{E}_t \Leftrightarrow$ Depreciation of Home currency

- **Terms of Trade** TOT_t: the relative price of imports to the price of exports, where both are written in terms of Home currency

$$TOT_t = \frac{P_{F,t}}{\mathcal{E}_t P^*_{H,t}}$$

  $\Rightarrow \uparrow TOT_t \Leftrightarrow \uparrow$ Relative Price of Imports $\Leftrightarrow$ *Worsening* of Home Terms of Trade

- **Real Exchange Rate** RER_t: relative price of consumption; the price of the Foreign basket in Home-currency terms relative to Home basket price

$$RER_t = \frac{\mathcal{E}_t P^*_t}{P_t}$$

  $\Rightarrow \uparrow RER_t \Leftrightarrow$ Depreciation of Home Real Exchange Rate

Law of One Price and Purchasing Power Parity

- **Law of One Price** (LOOP): price of the same good is equal in each country, after conversion to same currency units

$$P_{H,t} = \mathcal{E}_t P^*_{H,t}$$
$$P_{F,t} = \mathcal{E}_t P^*_{F,t}$$

- **Purchasing Power Parity** (PPP): price of consumption bundles is equal across countries

$$P_t = \mathcal{E}_t P^*_t$$

- But LOOP is not sufficient for PPP to hold

Breaking Purchasing Power Parity

- Consider the components of the PPP relationship in this model

$$P_t = \left[a_H P_{H,t}^{1-\phi} + a_F P_{F,t}^{1-\phi} \right]^{\frac{1}{1-\phi}}$$

$$\mathcal{E}_t P_t^* = \mathcal{E}_t \left[a_H^* P_{H,t}^{*\,1-\phi} + a_F^* P_{F,t}^{*\,1-\phi} \right]^{\frac{1}{1-\phi}}$$

- PPP will hold if **two conditions** are satisfied:
  1. The LOOP holds in *both* goods markets
  2. Consumption baskets are identical, such that $a_H = a_H^*$

  So deviations from PPP reflect *either* deviations from LOOP *or* differences in preferences across countries
- PPP holding would be equivalent to saying $RER = 1$
- At least two ways to break PPP:
  1. **Home bias in consumption** (here): $a_H = 1 - a_F > 0.5$ and $a_F^* = a_H$ such that $a_H \neq a_H^*$
  2. Introduce **non-tradable goods**

Relationship Between RER and TOT

- Definition of RER and consumption-based price indices:

$$RER_t^{1-\phi} \equiv \left(\frac{\mathcal{E}_t P_t^*}{P_t}\right)^{1-\phi} = \frac{a_H^*(\mathcal{E}_t P_{H,t}^*)^{1-\phi} + a_F^*(\mathcal{E}_t P_{F,t}^*)^{1-\phi}}{a_H P_{H,t}^{1-\phi} + a_F P_{F,t}^{1-\phi}}$$

- Using $a_H = a_F^* = 1 - a_H^*$ and LOOP, and then rearranging:

$$RER_t^{1-\phi} = \frac{(1-a_H)P_{H,t}^{1-\phi} + a_H P_{F,t}^{1-\phi}}{a_H P_{H,t}^{1-\phi} + a_F P_{F,t}^{1-\phi}} = \frac{(1-a_H) + a_H\left(\frac{P_{F,t}}{P_{H,t}}\right)^{1-\phi}}{a_H + a_F\left(\frac{P_{F,t}}{P_{H,t}}\right)^{1-\phi}}$$

- Defining $\mathcal{E}_t = 1$ as the numéraire and using the definition of TOT

$$RER_t^{1-\phi} = \frac{(1-a_H) + a_H TOT_t^{1-\phi}}{a_H + a_F TOT_t^{1-\phi}}$$

Home Bias: RER and TOT Co-movement

$\Rightarrow$ PPP can break down *even when* LOOP holds

$$RER_t^{1-\phi} = \frac{(1-a_H) + a_H TOT_t^{1-\phi}}{a_H + a_F TOT_t^{1-\phi}}$$

- Up to a first-order approximation around a steady state with $\overline{RER} = \overline{TOT} = 1$, this can be written:

$$\widehat{RER}_t = (2a_H - 1)\widehat{TOT}_t$$

$\Rightarrow$ Co-movement of RER and TOT depends on degree of home bias a_H:

- *Positive co-movement* with home bias, $a_H > 1/2$
- *Zero co-movement* when $a_H = 1/2$, i.e. PPP holds
- *Negative co-movement* when foreign bias, $a_H < 1/2$

New Mechanism: Trade in Intermediate Inputs

- Firms in each country use a CES bundle of both intermediate inputs:

$$X_t = \left(b_H^{\frac{1}{\varphi}} X_{H,t}^{\frac{\varphi-1}{\varphi}} + b_F^{\frac{1}{\varphi}} X_{F,t}^{\frac{\varphi-1}{\varphi}} \right)^{\frac{\varphi}{\varphi-1}}$$

- Importantly, this means Gross Output is a function of TOT:

$$Y_{H,t} = A_{H,t}^{1/\alpha} V_H (1-\alpha)^{\frac{1-\alpha}{\alpha}} \left[b_H + b_F TOT_t^{1-\varphi} \right]^{-\frac{1}{1-\varphi}\frac{1-\alpha}{\alpha}}$$

- This is the marginal productivity effect: movements in TOT due to supply shocks in one country induce changes in supply both at home and abroad
- Note $b_H = 1$ and $\alpha = 1$ have similar impact

World Goods Market Equilibrium

- Equilibrium in the Home and Foreign goods markets require

$$Y_{H,t} = C_{H,t} + C^*_{H,t} + X_{H,t} + X^*_{H,t} \qquad Y^*_{F,t} = C_{F,t} + C^*_{F,t} + X_{F,t} + X^*_{F,t}$$

where

$$C_{H,t} = a_H \left(\frac{P_{H,t}}{P_t}\right)^{-\phi} C_t \qquad C_{F,t} = (1 - a_H) \left(\frac{P_{F,t}}{P_t}\right)^{-\phi} C_t$$

$$X_{H,t} = b_H \left(\frac{P_{H,t}}{P_t}\right)^{-\varphi} X_t \qquad X_{F,t} = (1 - b_H) \left(\frac{P_{F,t}}{P_t}\right)^{-\varphi} X_t$$

International Financial Markets and Risk Sharing

- Structure of international asset markets will influence the determination of the RER and the transmission of international shocks in global macroeconomic equilibrium
- Different types of financial market structure:
  - #1 **Complete Markets** (CM): complete set of Arrow-Debreu securities to insure against each state of nature
    - $\Rightarrow$ RER adjusts to ensure *perfect* risk sharing
  - #2 **Incomplete Markets** (IM):
    - (i) **Financial Autarky** (FA): international asset trade not permitted
    - $\Rightarrow$ RER adjusts to balance trade
    - (ii) **Bond Economy** (BE): single non-contingent bond
    - $\Rightarrow$ RER adjusts to ensure risk sharing *on average*

International Risk Sharing

- The perfect risk-sharing condition under Complete Markets is:

$$\mathcal{W}_t \equiv \left(\frac{C_t}{C_t^*}\right)^{\sigma} \frac{1}{RER_t} = 1$$

- Incomplete markets give rise to inefficient fluctuations in the demand gap, $\mathcal{W}_t$
- $\mathcal{W}_t - 1$ is a welfare-relevant wedge capturing international risk-sharing imperfections
- Assuming Financial Autarky, the dynamics of this wedge have a simple analytical form:

$$\widehat{\mathcal{W}}_t^{FA} = \sigma\left(\widehat{C}_t - \widehat{C}_t^*\right) - (2a_H - 1)\,\widehat{TOT}_t$$

- Must understand how the TOT and Relative Consumption $\left(\widehat{C}_t - \widehat{C}_t^*\right)$ respond to shocks

Assessing Policy Implications

D'Aguanno, L., O. Davies, A. Dogan, R. Freeman, S. Lloyd, D. Reinhardt, R. Sajedi, & R. Zymek, 2021. "Global Value Chains, Volatility and Safe Openness: Is Trade a Double-Edged Sword?," *Bank of England Financial Stability Paper*, No. 46.

#1 **What is the impact of GVC integration on output volatility? Can GVC integration be a double-edged sword?**

Input Trade, Productivity and Volatility

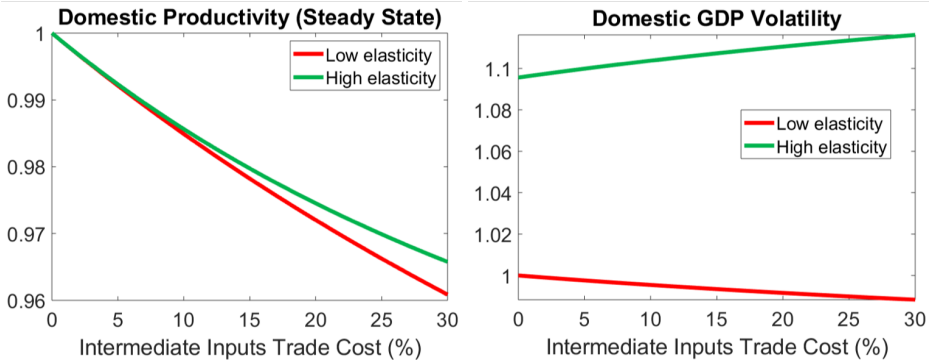
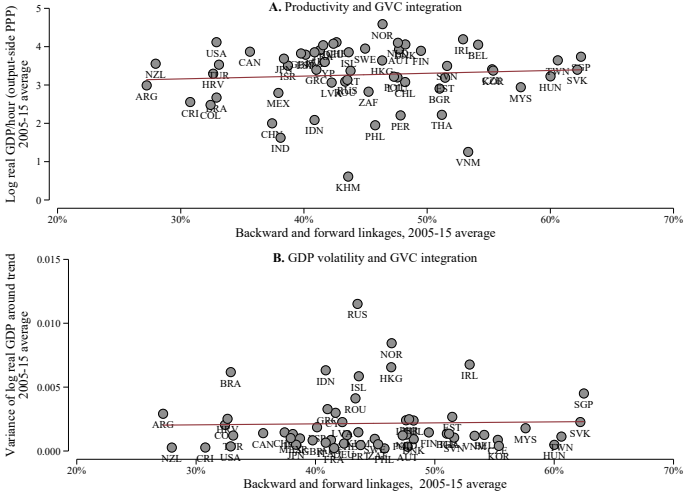


Figure: "Low elasticity" value normalised to 1. "Low" $\varphi = 1.5$, "High" $\varphi = 3$

#1 Input-trade barriers unambiguously lower productivity

#2 Input-trade barriers may raise or lower GDP volatility.

Macro Correlations: Evidence is Weak and Non-Causal



Sectoral Regression Analysis

Provide stronger evidence on the impact of GVC integration on economic outcomes

- **Insight**: Sectors differ greatly in their reliance on intermediate inputs
- **Strategy**: Exploit sector variation in input-intensity to explore whether a country's GVC integration benefits input-dependent sectors ("treated") relative to their non-input-dependent counterparts ("control"). "High" sector input dependence: input share > 0.4

$$y_{cs} = \beta(High_s \times \ln BFL_c) + \delta_c + \delta_s + \varepsilon_{sc}$$

- **FEs**: Control for structural differences between countries (e.g. capital stocks or workforce skills) and sectors (e.g. sector-specific nature of production technologies)
- **Theory-Based Predictions**: Productivity effect from GVC integration should be most pronounced in highly input-dependent sectors. Volatility effect: ambiguous.

Regression Results

	(1)	(2)	(3)	(4)
Sample:	All sectors	Goods only	All sectors	Goods only
Dep. variable:	$\ln\left(\text{VA/Hour}\right)_{cs}$		$\text{Var}\left(\ln \text{VA} - \text{Trend}\right)_{cs}$	
$High_s \times$	0.320**	0.565*	0.016	0.036
$\ln BFL_c$	(0.143)	(0.298)	(0.012)	(0.035)
R^2	0.82	0.81	0.30	0.31
Observations	1,448	756	1,512	788
Countries	45	45	48	48
Sectors	36	20	36	20
Control variables:	Country fixed effects, sector fixed effects			

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. "High" sector input dependence: input share > 0.40.

Policy Lessons

GVC integration need not be a double-edged sword:

- more integration can come hand-in-hand with lower volatility
- productivity gains dwarf volatility effects

GVC diversification can reduce volatility, but the welfare impact is unclear without a microfoundation of the formation of (international) production networks, and possible inherent market failures

Absent market failures, policy interventions may not be able to improve welfare relative to observed diversification patterns.

However, there may be a case for policy reforms:

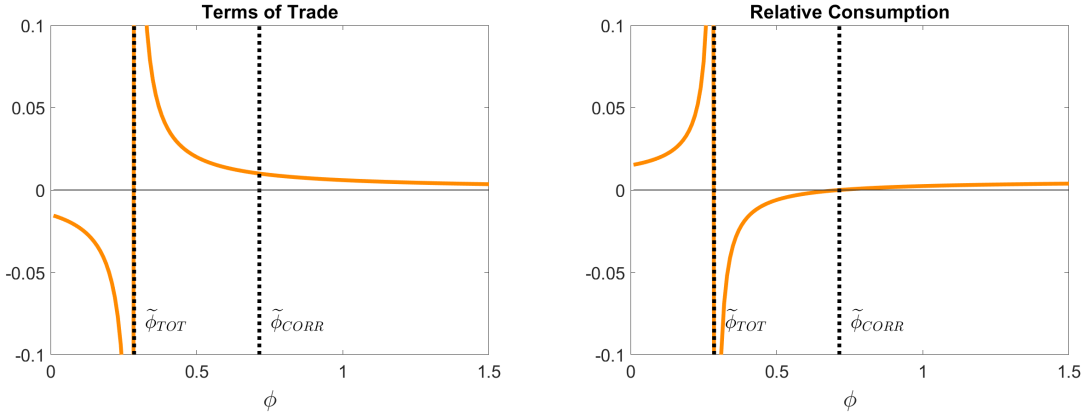
- enhanced collection and sharing of data on (firms in) GVCs
- stress-testing frameworks
- multilateral cooperation on regulation and standards

Assessing Policy Implications

Corsetti, G., L. D'Aguanno, A. Dogan, S. Lloyd, & R. Sajedi, 2024. "Global Value Chains and International Risk Sharing," Working Paper.

#2 **How do GVCs influence the international transmission of productivity shocks and what does this imply for the degree of risk sharing across borders?**

Impact Responses: No GVC Baseline ($\alpha = 1$)



Note: Positive shock to $A_{H,t}$ with $a_H = 0.7$, under FA.

- For $\widetilde{\phi}_{TOT} < \phi < \widetilde{\phi}_{CORR}$, there is "immiserising growth"

Trade Elasticity Thresholds: No GVCs

- Following Corsetti, Dedola and Leduc (2008), we can derive the thresholds analytically using the log-linearised model equations under FA
- When $\alpha = 1$:

$$\widehat{TOT}_t = \frac{1}{1 - 2a_H(1-\phi)} \left(\widehat{Y}_{H,t} - \widehat{Y}^*_{F,t} \right) \qquad \widehat{C}_t - \widehat{C}^*_t = (2a_H\phi - 1)\, \widehat{TOT}_t$$

- Define the thresholds:

$$\widetilde{\phi}_{TOT} = 1 - \frac{1}{2a_H} \qquad \widetilde{\phi}_{CORR} = \frac{1}{2a_H}$$

- For $\phi < \widetilde{\phi}_{TOT}$, the TOT appreciate in response to a positive relative supply shock
- For $\phi < \widetilde{\phi}_{CORR}$, C/C^* is negatively correlated with the TOT following supply shocks

Trade Elasticity Thresholds with GVCs: Special Case I

Same home bias and trade elasticity in consumption goods and intermediates

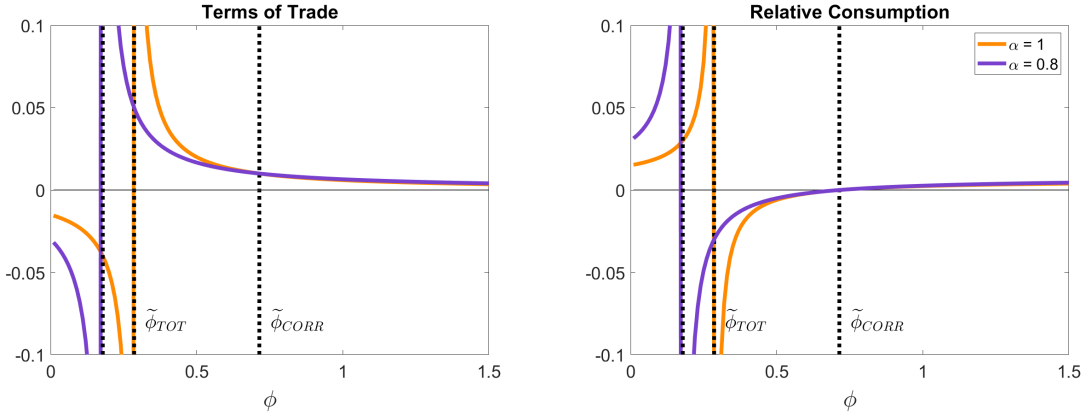
- Assume $b_H = a_H$ and $\varphi = \phi$
- Demand side of the economy is independent of $\alpha \Rightarrow \widetilde{\phi}_{CORR}$ is unchanged
- TOT response now depends on α due to supply-side effects:

$$\widehat{TOT}_t = \frac{1}{\alpha\left(1 - 2a_H(1-\phi) + 2a_F\frac{1-\alpha}{\alpha}\right)}\left(\widehat{A}_{H,t} - \widehat{A}^*_{F,t}\right)$$

- The threshold for a TOT reversal is now an increasing function of α:

$$\widetilde{\phi}_{TOT}(\alpha) = 1 - \frac{1}{2a_H} - \frac{a_F}{a_H}\frac{1-\alpha}{\alpha}$$

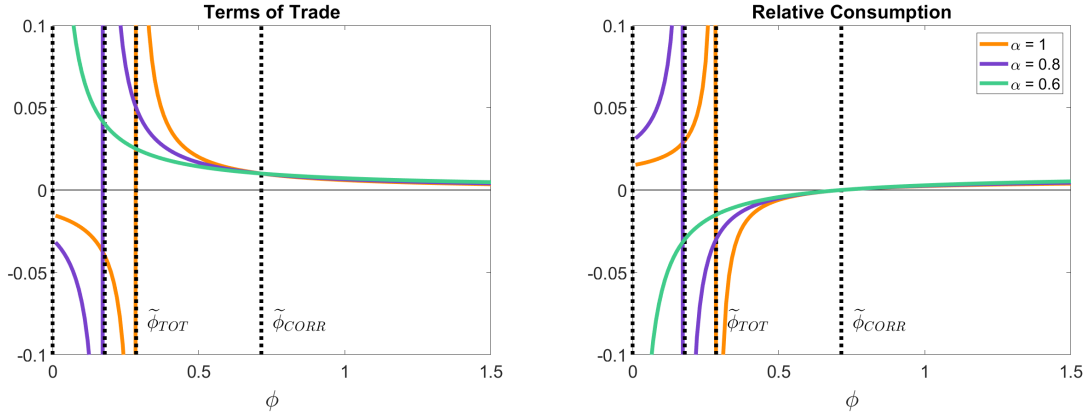
Impact Responses with and without GVCs



Note: Positive shock to $A_{H,t}$ with $a_H = 0.7$, under FA.

- Raising the intermediates share of output (i.e. lowering α) shifts $\widetilde{\phi}_{TOT}$ leftwards

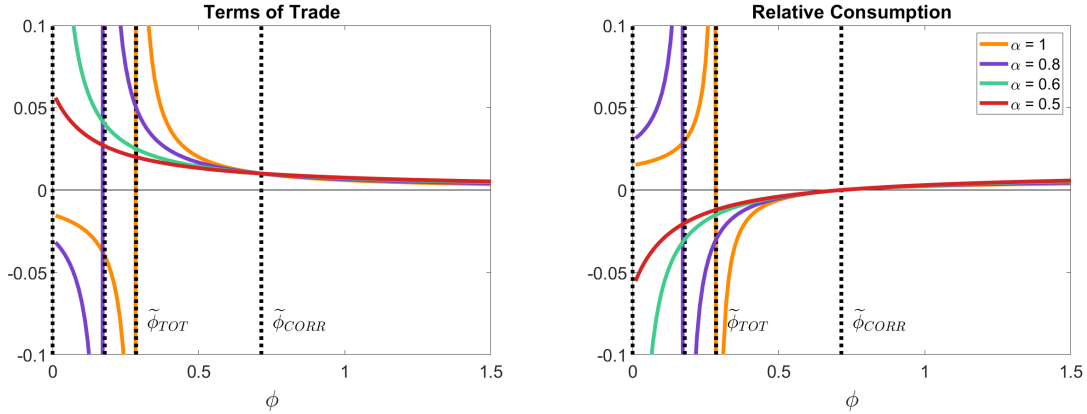
GVCs can rule out TOT appreciation



Note: Positive shock to $A_{H,t}$ with $a_H = 0.7$, under FA.

- When $\alpha = \widetilde{\alpha}$, the asymptote is at zero, and there is no reversal

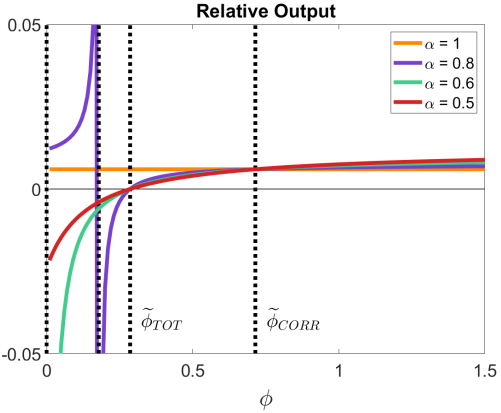
GVCs can rule out TOT appreciation



Note: Positive shock to $A_{H,t}$ with $a_H = 0.7$, under FA.

- When $\alpha < \widetilde{\alpha}$, there is no asymptote, and no reversal

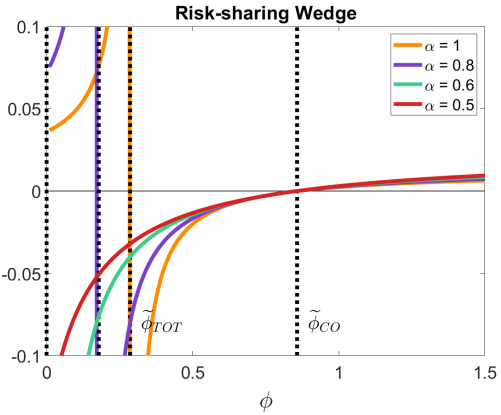
Key Mechanism: Supply-Side Effects



Note: Positive shock to $A_{H,t}$ with $a_H = 0.7$, under FA.

- Output adjusts endogenously due to marginal productivity effect

International Risk Sharing



Note: Positive shock to $A_{H,t}$ with $a_H = 0.7$, under FA.

- At low elasticities, GVCs reduce the risk-sharing wedge

Back to Reality: Preliminary Empirical Evidence

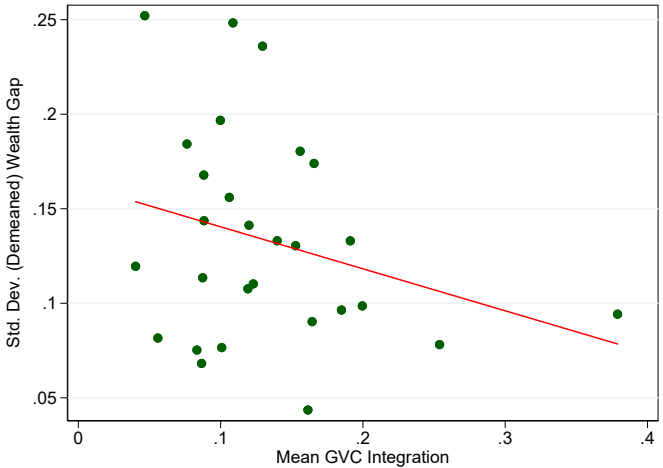
Model has shown:

- **Intermediate-input linkages can affect countries' ability to share risks under incomplete financial markets, even when GVCs are frictionless**
- Sign and size of this depends on trade elasticity—notoriously difficult to estimate

To take this to the data, we:

- Construct a model-consistent measure of risk sharing Var$(\mathcal{W})$, using $C^{(*)}$ and RER data (à la Corsetti, Dedola, Viani, 2012a,b), period 2000:Q1-2014:Q4
- Combine with measures of GVC integration (the share of imported intermediate inputs in gross output) – data from WIOT, 2000-2014
- Only advanced countries

Preliminary Empirical Evidence



Policy Lessons

- The presence of GVCs has both demand-side and supply-side implications
- The supply-side implications alone affect the threshold elasticity below which the terms of trade appreciate in response to relative supply shocks
- Sufficient levels of GVC integration can rule out terms-of-trade appreciations altogether
- With low trade elasticities, GVC integration mutes the inefficiency from incomplete markets
- In this sense, **GVC integration affects risk sharing even when trade itself is frictionless**

Conclusions

#1 Introduced a high-level overview of open-economy DSGE modelling

- Citations throughout and lots of resources online, e.g.:
  `https://sites.google.com/view/splloyd/teaching/ccbs-open-economy-macro`

#2 Built a model with intermediate-goods trade and Global Value Chains (GVCs)

- Draw on:
  - Corsetti, G., L. D'Aguanno, A. Dogan, S. Lloyd, & R. Sajedi, 2024. "Global Value Chains and International Risk Sharing," Working Paper.

#3 Used model to assess implications of GVC integration for international policy debates

- Draw on:
  - D'Aguanno, L., O. Davies, A. Dogan, R. Freeman, S. Lloyd, D. Reinhardt, R. Sajedi, & R. Zymek, 2021. "Global Value Chains, Volatility and Safe Openness: Is Trade a Double-Edged Sword?," *Bank of England Financial Stability Paper*, No. 46.

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