

Connected for Better or Worse?

The Role of Production Networks in Financial Crises

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Workshop on Networks and Firm Heterogeneity in Macro and Trade
Barcelona Summer Forum
June 17–18, 2026

Disclaimer: *Views are those of the authors and not necessarily those of the International Monetary Fund, the Federal Reserve Bank of Boston, or any other person affiliated with the Federal Reserve System.*

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- ▶ **Question:**

- Can **production structure** account for differential fragility between EMs/AEs?
 - Yes, part of it

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- ▶ **Policy:**
 - We evaluate *non-state contingent* debt and sectoral taxes
 - Policy gains depend on networks and financial depth: There is no one-size-fits-all
 - Planner may trade production efficiency for crisis resilience

Simple Perfect Foresight Model

A Perfect Foresight Economy

- ▶ Households:

$$\max_{\{c_t^N, c_t^T, b_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma} - 1}{1-\sigma} \quad \text{s.t.}$$

$$c_t = [\omega(c_t^T)^{-\eta} + (1-\omega)(c_t^N)^{-\eta}]^{-\frac{1}{\eta}},$$

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- ▶ Production: for each $i \in \{N, T\}$:

$$\pi_t^i = \max_{\{m_{jt}^i\}_{j \in \{N, T\}}} p_t^i A^i z_t^i \prod_{j \in \{N, T\}} (m_{jt}^i)^{\alpha_j} - \sum_{j \in \{N, T\}} p_t^j m_{jt}^i, \quad \sum_{j \in \{N, T\}} \alpha_j \in (0, 1)$$

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- ▶ Market clearing:

$$y_t^N = c_t^N + \sum_{i \in \{N, T\}} m_{Nt}^i, \quad y_t^T = c_t^T + \sum_{i \in \{N, T\}} m_{Tt}^i + q b_{t+1} - b_t$$

Equilibrium and Analytic Sudden Stops

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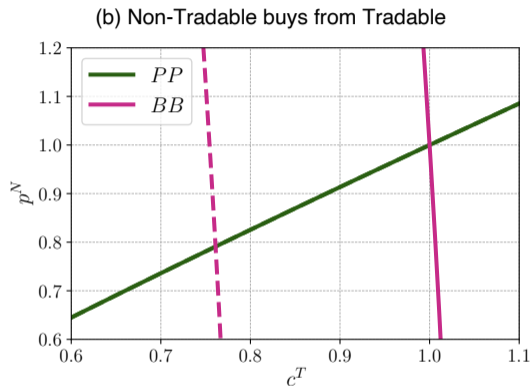
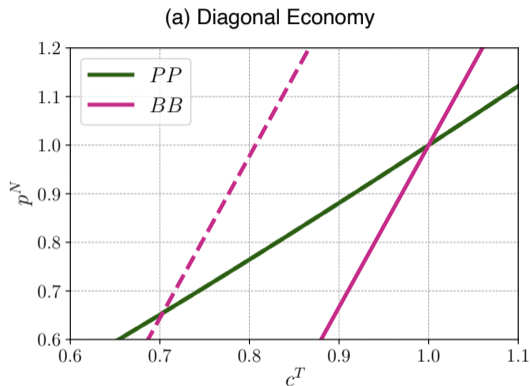
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- ▶ Exercise:
 - Assume $\beta R = 1$
 - Sudden Stop: *wealth-neutral* tradable productivity shock z_t^T around steady state

Graphical Illustration of Main Proposition



- ▶ Experiment: 10% decline in tradable sector productivity
- ▶ Intersectoral linkages hedge adverse shocks
- ▶ Input prices buffer profits and support borrowing capacity

Sufficient Statistic

Cross-Country Production Structure

Data

- ▶ OECD 2021 input-output data Country Groups Sectoral Classification
 - 37-country network sample: 20 AEs, 17 EMs
 - 44 sectors grouped into commodity, tradable, and nontradable
 - Tradables: gross trade intensity above 20%; commodities split within tradables
- ▶ Baseline cross-country moments use 1995, the first year with IO data
- ▶ Focus on domestic linkages across sectors
 - Consistent with small open economy view
- ▶ Main takeaways: Details
 - **EMs** rely more on **commodities** for production
 - **AEs** rely more on **nontradable** inputs for production

Network Structure and Sudden Stops

► Estimate

$$y_{ct} = \alpha + \alpha_c + \alpha_t + \beta_0 \text{SS}_{ct} + \sum_{i \neq j} \beta_{ij} \text{SS}_{ct} \times \omega_{j,c}^i + \sum_k \beta_k \text{SS}_{ct} \times \text{Size}_{k,c} + \varepsilon_{ct},$$

- y_{ct} : outcome variable for country c in year t
- $\text{SS}_{ct} = 1$ during a sudden stop
- $\omega_{j,c}^i$: sector j 's share in sector i 's intermediate inputs
- $\text{Size}_{k,c} = \text{Sales}_{k,c} / \text{nGDP}_c$: Domar weight of sector k
- IO shares and sector sizes are fixed at 1995 values
- Size variables are demeaned
- Country and year fixed effects: α_c and α_t

[Bianchi and Mendoza, 2020]

Network Structure affects Sudden Stops Severity

	Consumption		GDP		CA/GDP	
	(1)	(2)	(3)	(4)	(5)	(6)
SS × EM	-0.0528***		-0.0654***		0.0069	
SS × $\omega_{T,c}^C$		0.3020		0.3513		-0.1967
SS × $\omega_{NT,c}^C$		1.0094***		0.2429		0.5918
SS × $\omega_{C,c}^T$		0.1171		-0.0088		-0.0748
SS × $\omega_{NT,c}^T$		-0.7235*		-0.4517		-0.9499***
SS × $\omega_{C,c}^{NT}$		-1.6905***		-1.4465**		0.8668**
SS × $\omega_{T,c}^{NT}$		1.0007***		0.7962***		-0.5752**
SS	-0.0112***	-0.2176***	-0.0026	-0.1477	0.0106	0.1836***
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared within	0.059	0.091	0.070	0.094	0.003	0.017
Observations	1463	1463	1517	1517	1434	1434

Note: 1979–2019 annual data. Two-way clustered standard errors at the country and year level. The panel is unbalanced and includes 37 countries: 17 EMs and 20 AEs.

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- ▶ Spain gets about 0.10 log points of GDP mitigation; Chile: 0.04

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- ▶ Chile's network overturns the baseline CA improvement; Spain's nearly cancels it.

Quantitative Model

Environment - New Features

- ▶ Extend to 3 sectors
 - Commodity c^C , tradable non-commodity c^X , and nontradable c^N
 - Capture better production asymmetries in the data.
 - Key: differentiated good

$$\hat{c}_t^X = \Gamma \left(\frac{p_t^X}{p_t^T} \right)^{-\frac{1}{1+\eta_T}} .$$

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- ▶ Exercise:
 - Compare advanced economy with advanced economy + *EM network structure*

Production Networks affect long-run moments

Moment	EM	AE	AE + EM Network
$E(b/Y)$ %	-30.77	-46.68	-46.23
$\Pr(\text{SS})$ %	3.33	0.88	1.47
$\Pr(\mu_t > 0)$ %	43.68	15.84	29.64
ΔGDP_{SS} %	-12.23	-3.8	-4.94
$\Delta CA/GDP_{SS}$ %	3.9	1.91	2.44

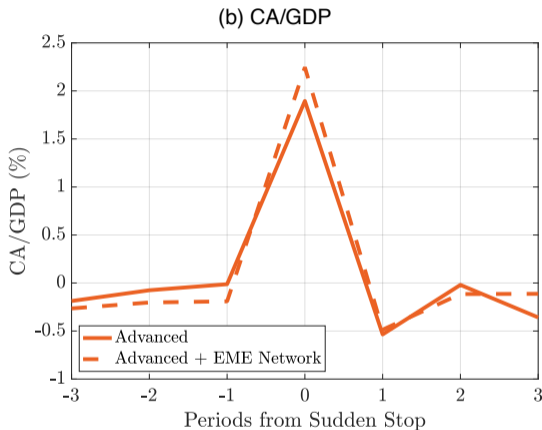
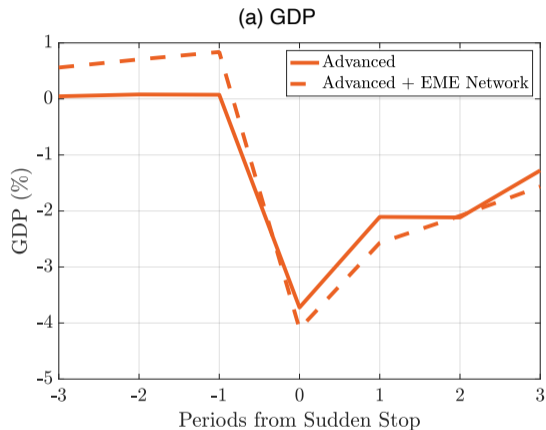
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ΔGDP_{SS} %	-12.23	-3.8	-4.94
$\Delta CA/GDP_{SS}$ %	3.9	1.91	2.44

- ▶ EM supports **less debt** and has a **higher probability of sudden stops** than AE
- ▶ AE and AE + EM Network have:
 - **Similar debt**
 - **50% higher probability of experiencing a sudden stop** [$\approx 0.6\text{pp}$]

Role of Networks - Sudden Stops



- ▶ EM networks amplify GDP drops by 30% and CA reversals by 28%
- ▶ More diversified network structures provide a hedging mechanism
- ▶ Shock nature matters: not all Sudden Stops are created equal

Policy Exercises

Policy: Simple Instruments

- ▶ Pecuniary externalities create room for macroprudential and sectoral policy

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Policy: Simple Instruments

- ▶ Pecuniary externalities create room for macroprudential and sectoral policy
- ▶ We study two kinds of policies:
 - A flat non-state contingent tax on borrowing
 - Flat non-state contingent taxes on inputs

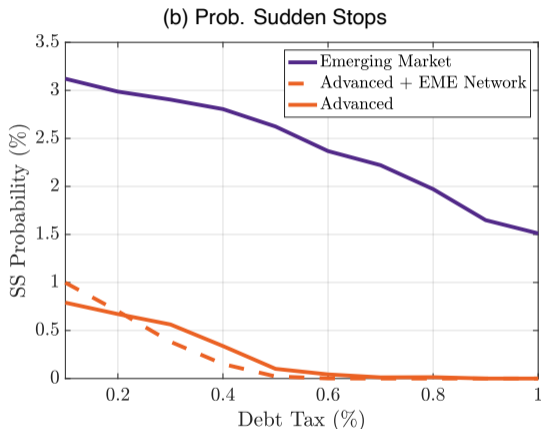
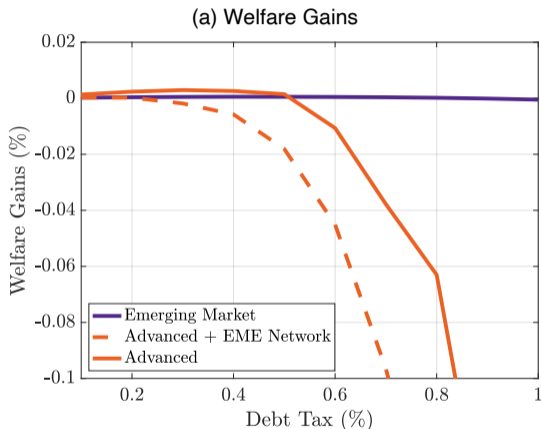
Planner Setup Planner FOCs

Policy: Simple Instruments

- ▶ Pecuniary externalities create room for macroprudential and sectoral policy
- ▶ We study two kinds of policies:
 - A flat non-state contingent tax on borrowing
 - Flat non-state contingent taxes on inputs
- ▶ Goal:
 - What are their welfare gains?
 - How does the probability of sudden stops change?

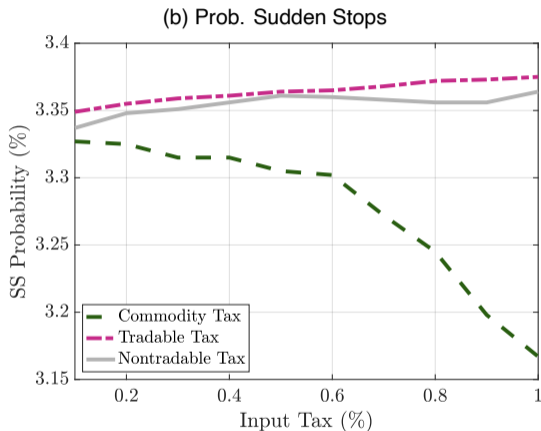
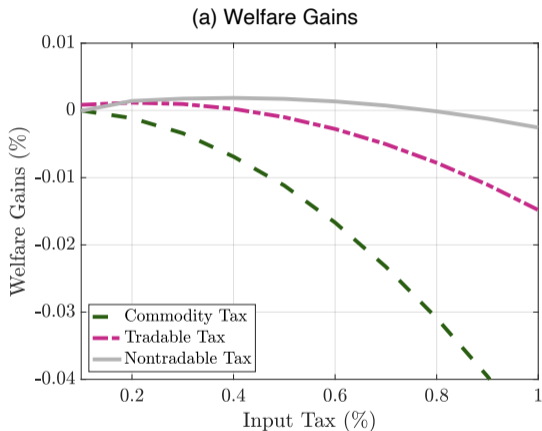
Planner Setup Planner FOCs

A simple debt tax policy is not one-size-fits-all



- ▶ Effect depends on financial development and network structure
- ▶ It can hurt financially developed economies with EM-style networks

Sectoral Input Taxes can help



- ▶ No welfare gains from commodity input tax
- ▶ Other sectoral taxes raise welfare but increase crisis risk slightly

Conclusion

- ▶ Sudden Stops differ in severity and frequency across EMs and AEs
- ▶ Potential explanations in the literature: fin. development and volatility of shocks
- ▶ Our paper emphasizes different **production network structures**
- ▶ **Takeaway:** production networks
 - account for 30% of the severity of Sudden Stops
 - increase the frequency of sudden stops by 50%
- ▶ Simple policies can generate welfare gains
 - but depend on financial development and production network structure

Conclusion

- ▶ Sudden Stops differ in severity and frequency across EMs and AEs
- ▶ Potential explanations in the literature: fin. development and volatility of shocks
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- ▶ **Takeaway:** production networks
 - account for 30% of the severity of Sudden Stops
 - increase the frequency of sudden stops by 50%
- ▶ Simple policies can generate welfare gains
 - but depend on financial development and production network structure
- ▶ Ongoing: optimal policy + more data work + your comments!

Thank you!

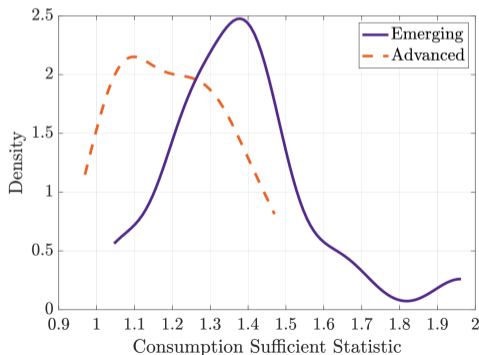
asilvub.github.io

Appendix

Sufficient Statistic in the Data

$$\frac{d \log c_t}{d \log z_t^T} = \mathcal{S}_c(\text{IO shares, profit shares, consumption shares}; \kappa, \eta)$$

- ▶ The plot shows the total-consumption response to a tradable shock
- ▶ Uses IO, profit, and consumption shares; fix $\kappa = 0.3$ and $1/(1 + \eta) = 0.83$



Calibration - Summary

Parameter	Description	EM	AE
β	subjective discount factor	0.90	0.95
κ	collateral constraint parameter	0.32	0.46
ω_C^C	importance of commodity inputs in commodity production	0.5	0.5
ω_X^C	importance of tradable inputs in commodity production	0.37	0.35
ω_N^C	importance of nontradable inputs in commodity production	0.13	0.15
ω_C^X	importance of commodity inputs in tradable production	0.20	0.13
ω_X^X	importance of tradable inputs in tradable production	0.61	0.59
ω_N^X	importance of nontradable inputs in tradable production	0.19	0.28
ω_C^N	importance of commodity inputs in nontradable production	0.18	0.06
ω_X^N	importance of tradable inputs in nontradable production	0.35	0.34
ω_N^N	importance of nontradable inputs in nontradable production	0.47	0.60
$\{z_L^C, z_H^C\}$	Low-High productivity C	{1.9, 2.05}	{1.735, 1.745}
$\{z_L^X, z_H^X\}$	Low-High productivity X	{1.95, 2.05}	{1.71, 1.77}
$\{z_L^N, z_H^N\}$	Low-High productivity N	{1.98, 2.05}	{1.71, 1.77}

- ▶ Key differences: **impatience**, **finance**, and **production structure**

Long-Run Moments

Moment	Emerging	Advanced
$E(b/Y)$ %	-30.77	-46.68
$\sigma(CA/Y)$ %	1.25	0.84
Share C Inputs to Total C Inputs %	48.06	45.39
Share N Inputs to Total C Inputs %	13.91	16.74
Share C Inputs to Total X Inputs %	18.78	11.1
Share N Inputs to Total X Inputs %	19.48	29.39
Share C Inputs to Total N Inputs %	16.59	5.00
Share N Inputs to Total N Inputs %	47.57	61.5
Pr(SS)	3.33	0.88
$Pr(\mu_t > 0)$	43.68	15.84
ΔGDP_{SS}	-12.23	-3.8
$\Delta CA/GDP_{SS}$	3.90	1.91

- ▶ EMs are more volatile and crisis-prone despite lower debt
- ▶ **Role of production structure?**

Role of Networks

- ▶ Embed the EM network in the AE calibration; keep shocks fixed

Moment	EM	AE + EM Network	AE
$E(b/Y)$ %	-30.77	-46.23	-46.68
$\sigma(CA/Y)$ %	1.25	0.73	0.84
Share C Inputs to Total C Inputs %	48.06	47.81	45.39
Share N Inputs to Total C Inputs %	13.91	13.9	16.74
Share C Inputs to Total X Inputs %	18.78	18.7	11.1
Share N Inputs to Total X Inputs %	19.48	19.48	29.39
Share C Inputs to Total N Inputs %	16.59	16.52	5.00
Share N Inputs to Total N Inputs %	47.57	47.57	61.5
Pr(SS) %	3.33	1.47	0.88
$Pr(\mu_t > 0)$ %	43.68	29.64	15.84
ΔGDP_{SS} %	-12.23	-4.94	-3.8
$\Delta CA/GDP_{SS}$ %	3.9	2.44	1.91

- ▶ Similar debt, but about 50% more crisis-prone

Policy: Social Planner's Problem

- ▶ Pecuniary externality: agents ignore price effects of their decisions

[Mendoza (2005), Bianchi (2011), Benigno, Chen, Otrok, Rebucci & Young (2013)]

- ▶ This opens space for debt taxes, reserves, and sectoral policy

[Arce et al. (2025), Benigno et al. (2023), Ottonello et al. (2024), Bianchi & Sosa-Padilla (2024)]

$$V(b, e) = \max_{\{c, m, b'\}} U(c^C, c^X, c^N) + \beta E(V(b', e')),$$

subject to

$$c^C + m_C^C + m_C^X + m_C^N + qb' = y^C + p^X(c)\hat{c}^X(p^X(c)) + b \quad (\lambda_1),$$

$$c^X + \hat{c}^X(p^X(c)) + m_X^C + m_X^X + m_X^N = y^X \quad (\lambda_2),$$

$$c^N + m_N^C + m_N^X + m_N^N = y^N \quad (\lambda_3),$$

$$qb' \geq -\kappa(\pi^C(p(c)) + \pi^X(p(c)) + \pi^N(p(c))) \quad (\mu).$$

Social Planner's Problem

- ▶ Bonds Euler equation:

$$\lambda_1 = \beta R \mathbb{E}[\lambda'_1] + \mu,$$

$$\lambda_1 = U_C + \underbrace{\frac{\mu\kappa \left(\sum_{i \in C, T, N} \frac{\partial \pi^i}{\partial c^C} \right)}{1 - \frac{\partial p^X}{\partial c^C} \hat{c}^X \frac{\eta_T}{1 + \eta_T}}}_{\text{Pecuniary Externality}} + \underbrace{\frac{U_C \frac{\partial p^X}{\partial c^C} \hat{c}^X \frac{\eta_T}{1 + \eta_T} - \lambda_2 \frac{\partial \hat{c}^X}{\partial c^C}}{1 - \frac{\partial p^X}{\partial c^C} \hat{c}^X \frac{\eta_T}{1 + \eta_T}}}_{\text{Terms of Trade Manipulation}}$$

- ▶ Production FOC (commodity input in nontradable production)

$$p^N \frac{\partial y^N}{\partial m^N_C} = \frac{\lambda_1 + \mu\kappa}{U_C + \mu\kappa \left(1 + \sum_{i \in C, T, N} \frac{\partial \pi^i}{\partial c^N} \frac{1}{p^N} \right)}$$

- ▶ Production structure affects both distorted first-order conditions

Country Groups

Emerging	Advanced
Argentina	Australia
Bulgaria	Austria
Brazil	Canada
Chile	Switzerland
China	Germany
Colombia	Denmark
Croatia	Spain
Hungary	Finland
Indonesia	France
Korea	United Kingdom
Morocco	Greece
Mexico	Iceland
Malaysia	Italy
Peru	Japan
Philippines	Netherlands
Poland	Norway
Russian Federation	New Zealand
Thailand	Portugal
Tunisia	Sweden
Turkiye	United States
South Africa	

Sectoral Classification

Tradable	Commodity	Non-Tradable
mining support services	agriculture	electricity and gas
food, beverages, tobacco	fishing and aquaculture	water and waste
textiles	energy mining	construction
wood	non-energy mining	postal and courier
paper and printing	basic metals	accommodation and food
refined petroleum		publishing and broadcasting
chemicals		telecommunications
pharmaceuticals		finance and insurance
rubber and plastics		real estate
non-metallic minerals		professional services
fabricated metals		administrative support
electronics		public administration
electrical equipment		education
machinery		health and social work
motor vehicles		arts and recreation
other transport equipment		other services
manufacturing n.e.c.		
wholesale/retail		
land, water, and air transport		
warehousing		
IT and information services		

Tradable sectors are defined as those with exports share of revenues at least 20%.

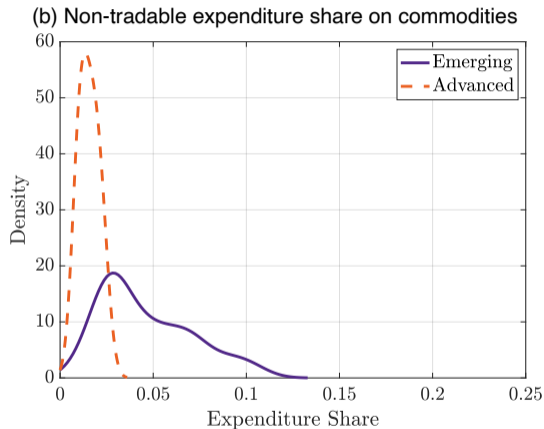
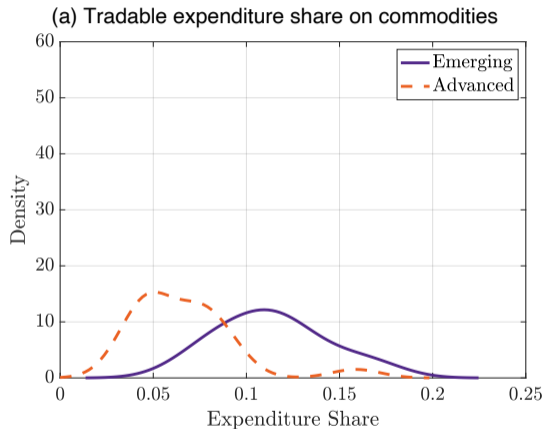
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Average expenditure share across sectors

- ▶ Average expenditure shares differ markedly across economies.

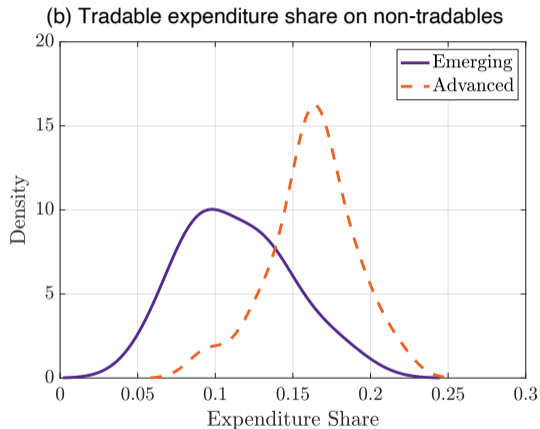
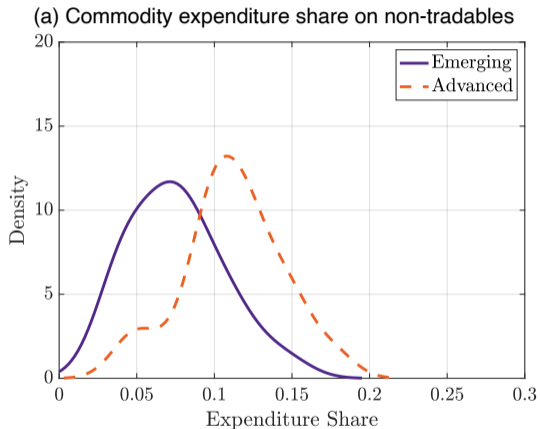
	Emerging	Advanced
ω_C^C	26.59	29.48
ω_X^C	19.87	22.14
ω_N^C	7.53	11.18
ω_C^X	11.37	6.66
ω_X^X	34.68	32.60
ω_N^X	11.36	16.22
ω_C^N	4.61	1.55
ω_X^N	17.19	13.51
ω_N^N	18.43	24.72

Emerging markets rely more on commodities for production



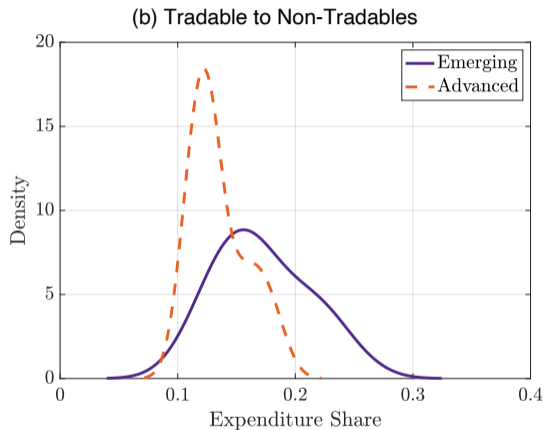
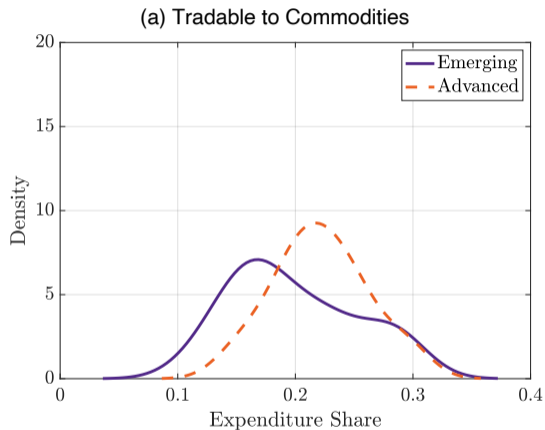
- Commodity expenditure shares by sector across countries.

Advanced economies rely more on non-tradable inputs



- ▶ NT input use by commodity and tradable sectors; solid = EM, dashed = AE.

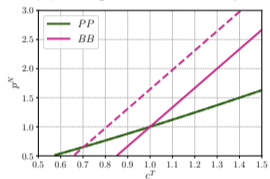
Tradable usage



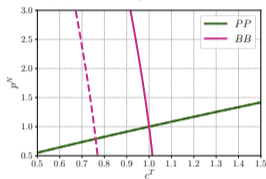
- ▶ Tradable input use by commodity and nontradable sectors; solid = EM, dashed = AE.

PP curve is always upward sloping

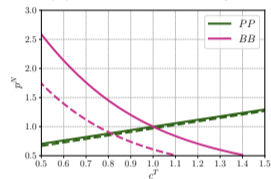
(a) Diagonal Economy



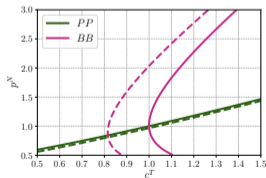
(b) NT buys from T



(c) Dense Economy

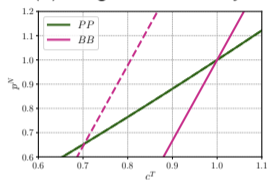


(d) T buys from NT

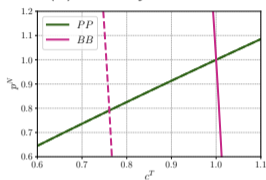


BB curve slope depends on the network structure

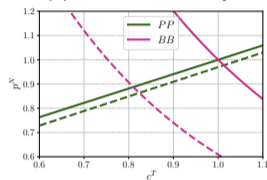
(a) Diagonal Economy



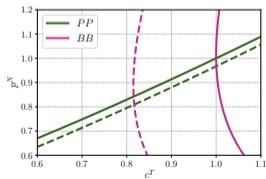
(b) NT buys from T



(c) Dense Economy



(d) T buys from NT



Quantitative Model - Details

$$\max \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t u(c_t) \right], \quad \text{where } \beta \in (0, 1).$$

subject to

$$c_t^C + p_t^X c_t^X + p_t^N c_t^N + q b_{t+1} = b_t + \pi_t^C + \pi_t^X + \pi_t^N$$

$$q b_{t+1} \geq -\kappa (\pi_t^C + \pi_t^X + \pi_t^N)$$

$$c_t = \left((1 - \omega)(c_t^N)^{-\eta} + \omega(c_t^T)^{-\eta} \right)^{-\frac{1}{\eta}}, \quad c_t^T = \left[\omega_T (c_t^C)^{-\eta_T} + (1 - \omega_T)(c_t^X)^{-\eta_T} \right]^{-\frac{1}{\eta_T}}.$$

Production:

$$y_t^i = z_t^i \left[\left(\sum_{j \in \{C, X, N\}} (\omega_j^i)^{\frac{1}{\chi^i}} (m_{jt}^i)^{\frac{\chi^i - 1}{\chi^i}} \right)^{\frac{\chi^i}{\chi^i - 1}} \right]^{\gamma^i}.$$

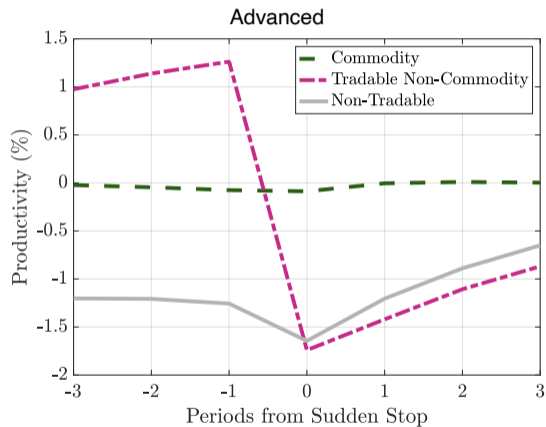
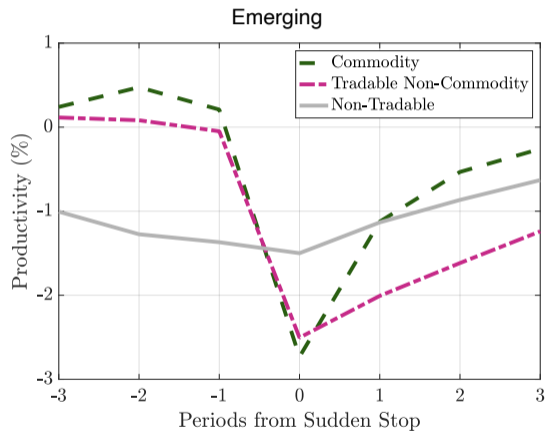
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Calibration - Additional Parameters

Parameter	Description	Value
σ	curvature of utility	2
ω	consumption weight of tradables	0.165
ω_T	weight of non-commodity tradables within tradables	0.20
γ	decreasing returns to scale	0.80
χ	elasticity of substitution among varieties	0.60
$1/(1 + \eta) = 1/(1 + \eta_T)$	trade elasticity	0.83
R^*	steady-state world interest rate	1.04
P_C	probability of remaining at low z^C	0.75
P_X	probability of remaining at low z^X	0.90
P_N	probability of remaining at low z^N	0.88

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Sudden Stops - Shocks



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Network Structure and Sudden Stops (Full Table)

	Consumption		GDP		CA/GDP	
	(1)	(2)	(3)	(4)	(5)	(6)
SS × EM	-0.0528***		-0.0654***		0.0069	
SS × $\omega_{T,c}^C$		0.3020		0.3513		-0.1967
SS × $\omega_{NT,c}^C$		1.0094***		0.2429		0.5918
SS × $\omega_{C,c}^T$		0.1171		-0.0088		-0.0748
SS × $\omega_{NT,c}^T$		-0.7235*		-0.4517		-0.9499***
SS × $\omega_{C,c}^{NT}$		-1.6905***		-1.4465**		0.8668**
SS × $\omega_{T,c}^{NT}$		1.0007***		0.7962***		-0.5752**
SS × Tradable Size		-0.0087		0.0236		-0.0120
SS × Nontradable Size		-0.1656*		-0.0021		-0.0051
SS × Commodity Size		-0.1405*		-0.0602		-0.2499***
SS	-0.0112***	-0.2176***	-0.0026	-0.1477	0.0106	0.1836***
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared within	0.059	0.091	0.070	0.094	0.003	0.017
Observations	1463	1463	1517	1517	1434	1434

1979–2019 annual data. Two-way clustered standard errors at the country and year level. The panel is unbalanced and includes 37 countries: 17 EMs and 20 AEs.

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