

# Beyond Bilateral Flows: Indirect Connections and Exchange Rates\*

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*\*The views are those of the authors and are not necessarily those of the Bank of England.*

# Introduction



Today's global economy is deeply interconnected ...

# Introduction



... But capital flows among countries are more complex than ever!

## A Simple Example

European carmakers source advanced parts from Japan,  
but capital is largely intermediated via the U.S.

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direct connection  
US-Eurozone

indirect connection  
Eurozone-Japan via the US

# Objectives

We study the importance of **financial connection** for exchange rate determination

- Financial connections capture how elastically capital can flow between countries.
- We differentiate between direct and indirect forms of financial connection.

What is **direct connection**? Does it matter for exchange rates?

- The elasticity of capital flows between my country and its trading partners,
- Higher direct connection mitigates the response of exchange rates to trade shocks.

What is **indirect connection**? Does it affect exchange rates?

- The elasticity of capital flows between my trading partners and their counterparties,
- Unclear whether/how indirect connection impacts exchange rates amid trade shocks.

# Summary

## What do we do?

- A simple model that relates indirect connection to future exchange rate returns,
- Cross-border banking claims & liabilities from the **restricted LBS by residence** database,
- We **construct eigenvector centrality**, before isolating direct and indirect effects.

## What do we find? (*so far*)

- A higher degree of indirect connection mitigates the sensitivity of future exchange rate returns to *foreign trade shocks*.
- A higher degree of indirect connection amplifies the sensitivity of future exchange rate returns to *domestic trade shocks*.

# Our Theory

# Setup

Our model builds on Gabaix & Maggiori (2015)

- Two periods indexed with  $t = \{0, 1\}$  and no uncertainty about future variables,
- $N$  countries of different size  $h_j$  and interest rates set to zero.

**Households** in the model

- Consume domestic tradeable/nontradable goods and imported tradable goods,
- The exchange rate  $e_{j,t}$  is the relative price of country  $j$ 's nontradable good against the US,
- Trade only riskless bonds in local currency with themselves or financiers,
- Hold exogenous/inelastic net positions in foreign bonds  $f_j$  (not central to today's talk).

# Setup

**Financiers** trade international bonds and organized in groups

- Each group runs long/short trading strategies between countries  $i$  and  $j$

$$Profit_{ij} = \left( \frac{e_{i,1}}{e_{i,0}} - \frac{e_{j,1}}{e_{j,0}} \right) Q_{ij},$$

where the dollar value of the position is

$$|Q_{ij}| \leq \Lambda_{ij} \left| \frac{e_{i,1}}{e_{i,0}} - \frac{e_{j,1}}{e_{j,0}} \right|.$$

- Their demand for bonds in each currency is downward sloping due to limited commitment.

The **elasticity of capital flows** between countries  $i$  and  $j$  is captured by  $\Lambda_{ij}$

- $\uparrow \Lambda_{ij}$  means **higher elasticity** and lower compensation via exchange rate changes,
- $\Lambda_{ij}$  measures the strength of the financial connection between  $i$  and  $j$ .

# Our Theory

We define the balance of payments identities in dollars for country  $j$  as

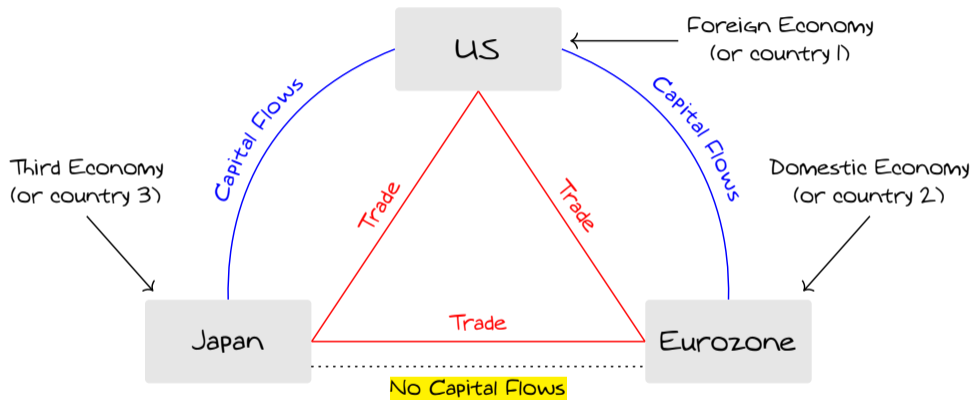
$$t = 0 : \underbrace{NX_{j,0}}_{\text{net exports}} - \underbrace{f_j}_{\text{net portfolio flows}} + \underbrace{\sum_{i \neq j} \Lambda_{ji} e_{sj,0} \left( \frac{e_{j,1}}{e_{j,0}} - \frac{e_{i,1}}{e_{i,0}} \right)}_{\text{net borrowing from financiers}} = 0,$$

$$t = 1 : \underbrace{NX_{j,1}}_{\text{net exports}} + \underbrace{f_j}_{\text{net portfolio flows}} - \underbrace{\sum_{i \neq j} \Lambda_{ji} e_{sj,0} \left( \frac{e_{j,1}}{e_{j,0}} - \frac{e_{i,1}}{e_{i,0}} \right)}_{\text{net repayments to financiers}} = 0.$$

In equilibrium, exchange rates must adjust so that these identities hold for all countries.

Let's Fix Ideas

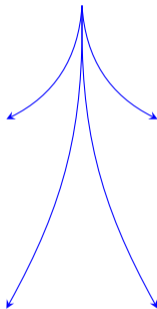
# A Simple Setup



A world with 3 countries and balanced external accounts  
(ignoring net capital flows for simplicity)

# A Simple Setup

Do **higher indirect connections** affect the sensitivity of  $\text{€}/\text{\$}$  to a trade shock?



Scenario 1:

A positive trade shock in the U.S.

Scenario 2:

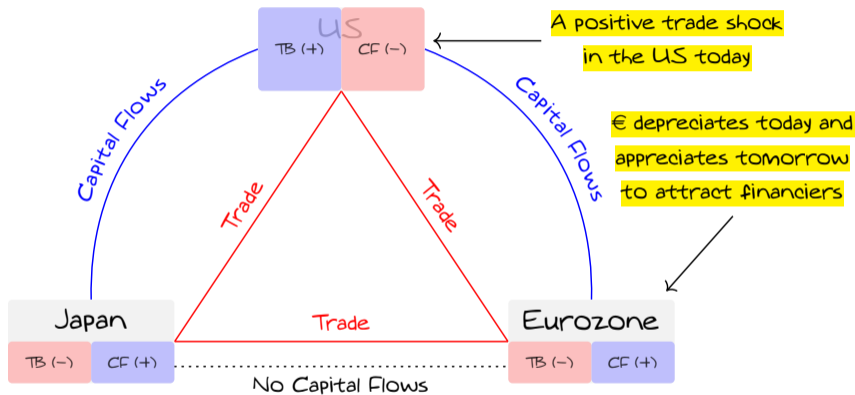
A negative trade shock in the Eurozone.

What happens? Mitigation effect.

What happens? Amplification effect.

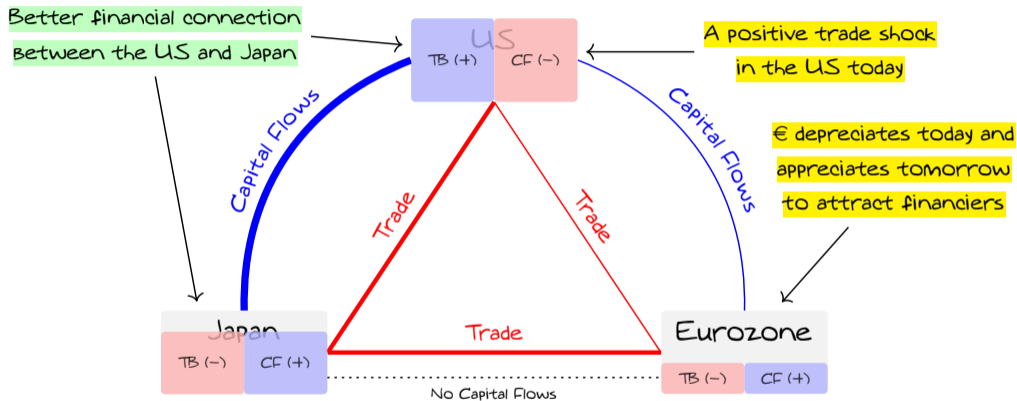
## Scenario I: Trade Shock ABroad

# Scenario 1: Direct Connection



Higher direct connection mitigates the current depreciation of the € in response to a positive trade shock abroad (Lemma 1).

# Scenario I: Indirect Connection



Higher indirect connection mitigates the current depreciation of the € in response to a positive trade shock abroad (**Proposition 1**).

# Scenario I: Summary

$$\frac{de_{2,0}}{dl_{1,0}} > 0$$

€ depreciates today following a negative import demand shock in the US

$$\frac{d^2 e_{2,0}}{dl_{1,0} d\Lambda_{12}} < 0$$

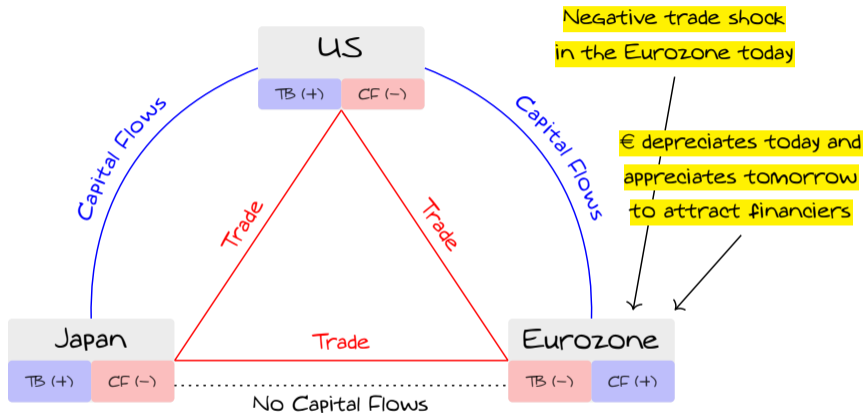
Higher direct connection mitigates the € depreciation conditional on the import demand shock abroad

$$\frac{d^2 e_{2,0}}{dl_{1,0} d\Lambda_{13}} < 0$$

Higher indirect connection mitigates the € depreciation conditional on an import demand shock abroad

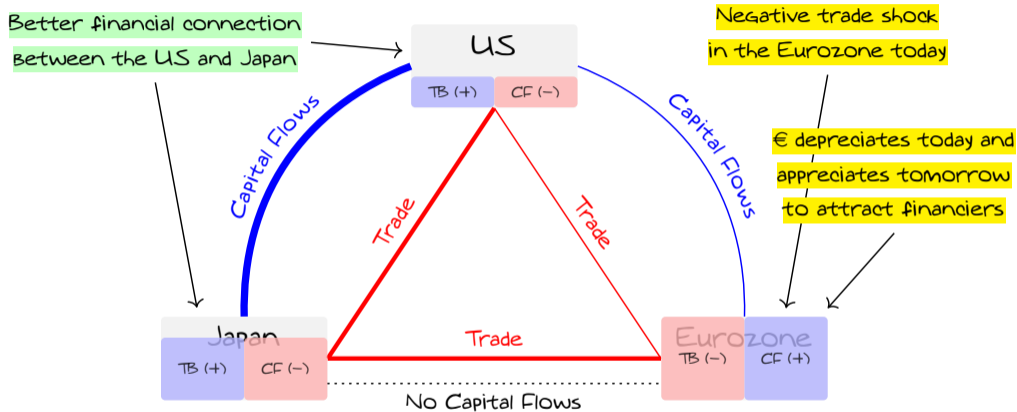
## Scenario 2: Trade Shock at Home

## Scenario 2: Direct Connection



Higher direct connection mitigates the current depreciation of the € in response to a negative trade shock at home (Lemma 1).

## Scenario 2: Indirect Connection



Higher indirect connection amplifies the current depreciation of the € in response to a negative trade shock at home (**Proposition 1**).

## Scenario 2: Summary

$$\frac{de_{2,0}}{dl_{2,0}} < 0$$

€ depreciates today following a positive import demand shock at home

$$\frac{d^2 e_{2,0}}{dl_{2,0} d\Lambda_{12}} > 0$$

Higher direct connection mitigates the € depreciation conditional on an import demand shock at home

$$\frac{d^2 e_{2,0}}{dl_{2,0} d\Lambda_{13}} < 0$$

Higher indirect connection amplifies the € depreciation conditional on an import demand shock at home

# Our Empirical predictions

**Prediction 1.** *An increase in a country's indirect connection mitigates the impact of a large import demand shock abroad on its future exchange rate return.*

**Prediction 2.** *An increase in a country's indirect financial connection amplifies the impact of a large import demand shock at home on its future exchange rate return. This effect goes to zero as the country becomes small.*

# Our Data

# Key Datasets

## **Cross-border Banking Activity** from BIS

- Restricted Locational Banking Statistics by residence from Dec-1983 to Dec-2019,
- Aggregate cross-border financial claims and liabilities of internationally active banks located in 45 reporting countries against counterparties in more than 200 countries.
- Quarterly claims and liabilities disaggregated by currency of denomination.

## **Exchange Rate Data** from Datastream

- Daily spot and forward exchange rates for 71 countries,
- Exchange rates are defined as units of dollars per unit of foreign currency,
- We sample end-of-month rates between December 1983 and January 2020.

# Ingredient I: Trade Shocks

Trade shocks extracted using a latent factor model

$$NX_{j,t} = \alpha_j + \beta_j' P_t + \varepsilon_{j,t}$$

net exports over GDP of country  $j$

principal components from the cross-section of  $NX_j$

trade shock of country  $j$

# Ingredient I: Trade Shocks

A shock to US trade surplus

$$\text{Shock}_{us,t}^+ = \varepsilon_{j,t} \quad \text{for } j = \text{US}$$

$$\text{Shock}_{j,t}^- = -\varepsilon_{j,t} \quad \text{for } j \neq \text{US}$$

A shock to country's  $j$  trade deficit

## Ingredient 2: Network Centrality

For each country  $j$ , we compute eigenvector centrality at time  $t$  as follows

$$C_{j,t} = \lambda_t^{-1} \sum_{i=1}^N A_{ji,t} C_{i,t},$$

Centrality of country  $j$   
(counterparty country)

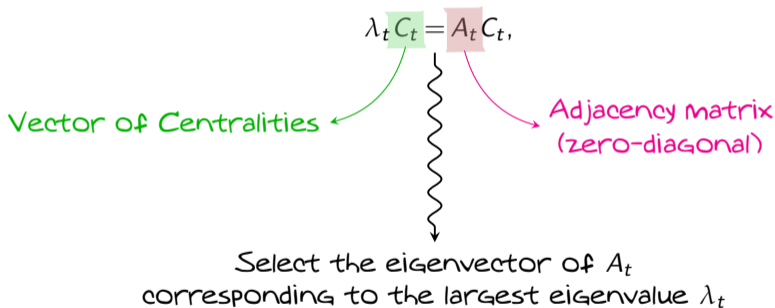
Scaling parameter

Centrality of country  $i$   
(reporting country)

Claims & liabilities  
of Banks in country  $j$   
against Banks in country  $i$

## Ingredient 2: Network Centrality

We can rewrite the system of equations as



## Ingredient 2: Network Centrality

Bonacich (1987) shows that eigenvector centrality converges to power centrality, i.e., the infinite sum of weighted paths activated directly and indirectly by each node in a network as

$$C_t = \sum_{\ell=0}^{\infty} \lambda_t^{-\ell} A_{ji,t}^{\ell+1} \mathbf{1}_N,$$

Direct connection is defined as (for  $\ell = 0$ )

$$\text{Dir}_t = A_{ji,t} \mathbf{1}_N,$$

Indirect connection is computed as (for  $\ell > 0$  up to  $\bar{\ell}$ )

$$\text{Ind}_t = \lambda_t^{-1} A_{ji,t}^2 \mathbf{1}_N + \lambda_t^{-2} A_{ji,t}^3 \mathbf{1}_N + \dots + \lambda_t^{-\bar{\ell}} A_{ji,t}^{\bar{\ell}} \mathbf{1}_N.$$

## Our Empirical Evidence

# Elasticity of Exchange Rates

Gross banking positions as a proxy for financiers' intermediation capacity

- $\Lambda_{ji}$  exogenously determines how elastic exchange rates are to bilateral capital flows.
- $\Lambda_{ji}$  depends on unobserved factors like regulation or risk-taking capacity.
- We assume that  $\Lambda_{ji}$  correlates with the size of gross bilateral banking positions.

Why gross banking positions?

- Financiers differ in beliefs, or hedging needs, and may take offsetting positions.
- The size of gross positions reflects both constraints and dispersion across financiers.
- When exchange rates are more elastic to flows, we have *larger* gross positions; with low elasticity, gross positions remain *small*.

# A Simple Testable Hypothesis

Is gross banking positions a good proxy for financiers' intermediation capacity?

- Gabaix and Maggiori (2015) show that an exogenous net demand for local currency assets by foreign investors causes a local currency appreciation.
- The weaker the intermediation capacity, the stronger the appreciation.

If intermediation capacity is positively correlated with Gross Banking positions



the exchange rate return to exogenous portfolio flows should decline with higher levels of Gross Banking positions.

# Do Gross Banking Positions Proxy for Lambda?

$$y_{j,t} = \alpha \text{Position}_{j,t} + \beta \text{Equity}_{j,t} + \beta (\text{Equity}_j \times \text{Dummy}_j)_t + \text{Controls}_{j,t} + fe + \varepsilon_{j,t}$$

current exchange rate return

Interaction between Gross Banking positions and Granular equity flow

Net portfolio equity flow based on micro-level equity holdings from international mutual funds and ETFs instrumented via GLV

Financial openness index, forward premium, and share of world GDP

# Do Gross Banking Positions Proxy for Lambda?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Equity <sub>j,t</sub>	1.477*** (0.568)	1.576*** (0.509)	1.463 (1.020)	1.688* (0.882)	1.999*** (0.766)	2.169*** (0.715)	1.675*** (0.613)	1.747*** (0.543)
Equity <sub>j,t</sub> × Position <sub>j,t</sub>	-0.580 (0.531)	-0.642 (0.411)						
Equity <sub>j,t</sub> × Dummy <sub>{Position<sub>j</sub>&gt;0}</sub>			-0.148 (1.213)	-0.376 (1.040)				
Equity <sub>j,t</sub> × Dummy <sub>{Position<sub>j</sub>&gt;0.5σ}</sub>					-1.730** (0.857)	-1.989** (0.790)		
Equity <sub>j,t</sub> × Dummy <sub>{Position<sub>j</sub>&gt;1σ}</sub>							-1.531* (0.793)	-1.472** (0.656)
R <sup>2</sup>	0.57	0.59	0.57	0.59	0.58	0.59	0.58	0.59
Obs	890	890	890	890	890	890	890	890
Time fe	✓	✓	✓	✓	✓	✓	✓	✓
Country fe	✓	✓	✓	✓	✓	✓	✓	✓
Controls		✓		✓		✓		✓
F-stat (First Stage)	4892	543	4892	524	4914	526	4867	520

Standard errors (in parentheses) clustered by country. \*\*\* $p < .01$ , \*\* $p < .05$ , \* $p < .10$ .

# Indirect Connection and Exchange Rates

$$y_{j,t+1} = \alpha \text{Ind}_{j,t} + \beta (\text{Ind}_j \times \text{Shock}_{us}^+) + \gamma (\text{Ind}_j \times \text{Shock}_j^-) + \delta (\text{Ind}_j \times \text{Shock}_j^- \times \text{Large}_j) + \text{Controls}_{j,t} + \text{fe} + \varepsilon_{j,t+1}$$

future exchange rate return

indirect connection times a trade shock abroad

Indirect connection times a trade shock at home

Indirect connection times a trade shock at home (top 5% by global trade)

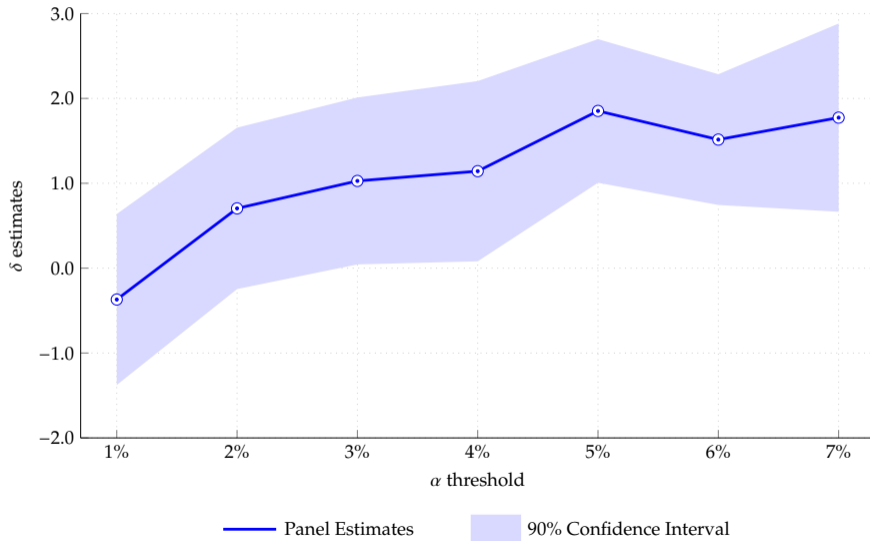
Financial openness, forward premium, trade centrality, direct connection, trade deficit, and share of world GDP

# Indirect Connection and Exchange Rates

	(1)	(2)	(3)	(4)	(5)	(6)
$Ind_j$	-0.813*** (0.272)	-0.880*** (0.310)	-0.815*** (0.274)	-0.871*** (0.313)	-0.754** (0.350)	-0.932** (0.382)
$Ind_j \times Shock_{US}^+$			-0.672*** (0.214)	-0.677*** (0.220)	-0.566*** (0.213)	-0.552** (0.217)
$Ind_j \times Shock_j^-$	-0.167 (0.277)	-0.320 (0.281)		-0.276 (0.285)	-0.259 (0.305)	-0.286 (0.307)
$Ind_j \times Shock_j^- \times Large_j$		1.823*** (0.576)		1.896*** (0.627)	1.603*** (0.544)	1.833*** (0.519)
$R^2$	0.40	0.40	0.40	0.40	0.40	0.39
<i>Time fe</i>	✓	✓	✓	✓	✓	✓
<i>Country fe</i>	✓	✓	✓	✓	✓	
<i>Controls</i>					✓	✓

Standard errors (in parentheses) clustered by country. \*\*\* $p < .01$ , \*\* $p < .05$ , \* $p < .10$ .

# Different Thresholds for Large Dummy



# Controlling for Pegged Currencies

	(1)	(2)	(3)	(4)	(5)	(6)
Ind <sub><i>j</i></sub>	-0.813*** (0.272)	-0.880*** (0.310)	-0.815*** (0.274)	-0.871*** (0.313)	-2.106*** (0.632)	-2.249*** (0.663)
Ind <sub><i>j</i></sub> × Shock <sub><i>US</i></sub> <sup>+</sup>			-0.672*** (0.214)	-0.677*** (0.220)	-1.146*** (0.438)	-1.128** (0.439)
Ind <sub><i>j</i></sub> × Shock <sub><i>j</i></sub> <sup>-</sup>	-0.167 (0.277)	-0.320 (0.281)		-0.276 (0.285)	-0.291 (0.514)	-0.387 (0.522)
Ind <sub><i>j</i></sub> × Shock <sub><i>j</i></sub> <sup>-</sup> × Large <sub><i>j</i></sub>		1.823*** (0.576)		1.896*** (0.627)	2.026** (0.935)	2.216** (0.902)
R <sup>2</sup>	0.40	0.40	0.40	0.40	0.40	0.40
Time fe	✓	✓	✓	✓	✓	✓
Country fe	✓	✓	✓	✓	✓	
Controls					✓	✓

Standard errors (in parentheses) clustered at the country level. Other regressors/interactions not reported to save space.

# Conclusions

We study the role of financial connection on the determination of exchange rates

- We extend the model of Gabaix & Maggiori (2015),
- Multiple countries with heterogeneous intermediation capacity and country size.

We measure the elasticity of capital flows using gross activity of global banks

- We construct the eigenvector centrality based on cross-border claims and liabilities,
- We disentangle direct connection from indirect connection.

We show that indirect financial connection matters for the determination of exchange rates

- Mitigation or amplification effects depending on the source of the trade shock.

The FX market doesn't care who you borrow from.  
It cares who they borrow from.