Rethinking Exchange Rate Exposure in Equity Markets Through International Trade Networks

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How do currency fluctuations affect stock returns?

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- A classical question of interest
- The traditional goods market theory:
  - Firms are net exporters, so stock returns should generally be positive when local currency depreciates.
  - Limited empirical evidence
- Recent studies highlight the role of international capital flows.
  - e.g., Hau and Rey (2006), Camanho, Hau, and Rey (2022), Rey, Stavrakeva, and Tang (2024).
  - Portfolio rebalancing in the equity market

Challenging the Trade-Based View of Currency Effects

- Hau and Rey (2006, RFS):

  "The empirical literature has unambiguously shown that goods market variables do not explain exchange rate movements at short- to medium-run frequencies."

- Cenedese, Payne, Sarno, and Valente (2016, RF):

  "We find that exchange rate movements are, in fact, unrelated to differentials in country-level equity returns."

Literature: Hau and Rey (2006)

Table 2
Daily correlations of exchange rate and foreign stock market excess returns

High E = Appreciation relative to USD

Equity return of US

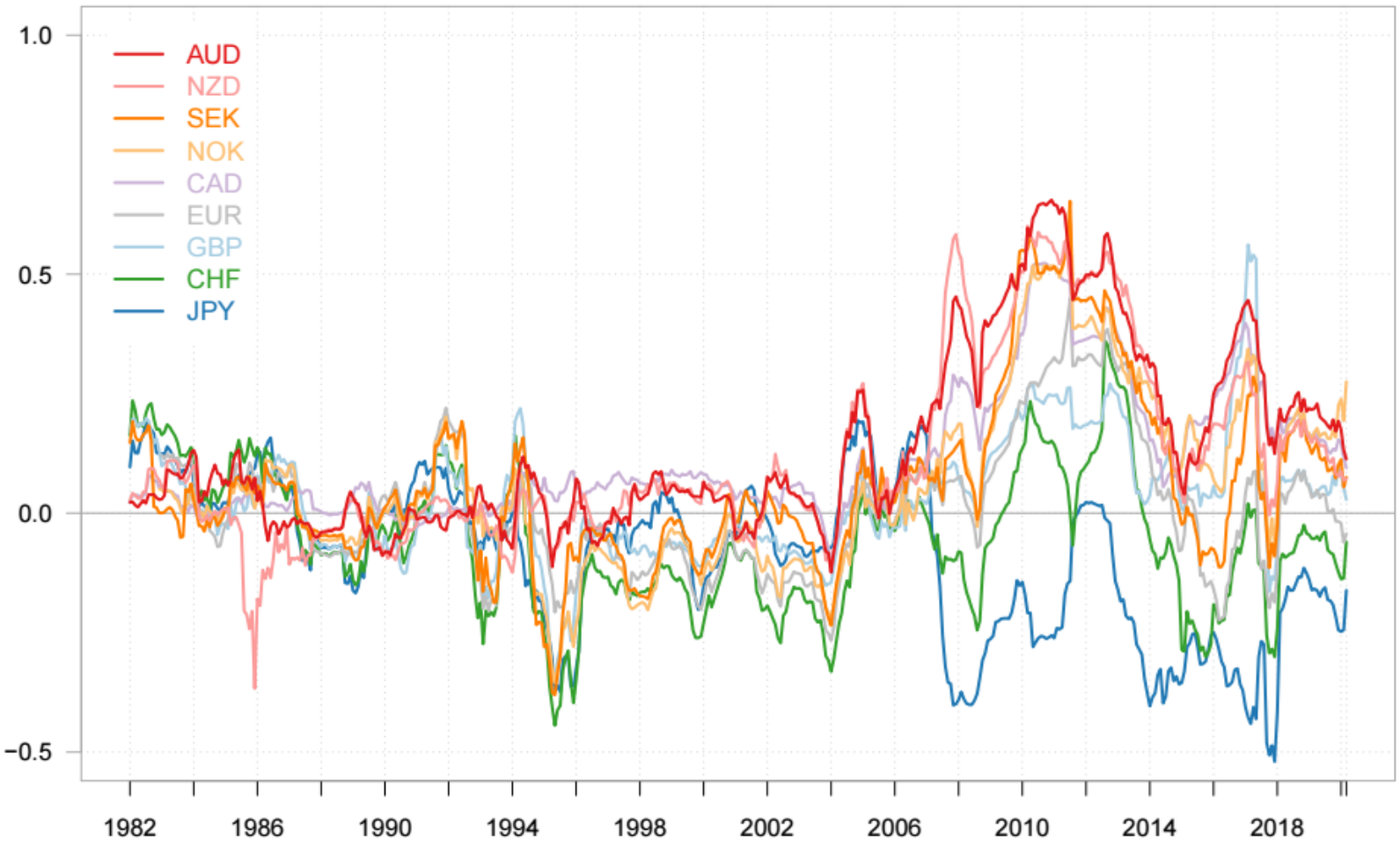
$$\text{corr}\left[-dE_t, \left(dR_t^{f^*} - dR_t^h\right)/\overline{P}\right]$$

	(a) January 1, 1980–December 31, 2001	(b) January 1, 1990–December 31, 2001	(c) January 1, 1995–December 31, 2001
Australia	0.0558***	0.0304*	0.0242
Austria	−0.0186	−0.0291	−0.0201
Belgium-Luxembourg	−0.0438***	−0.0388**	−0.0226
Denmark	−0.0368***	−0.0495***	−0.0452*
Finland	−0.0954***	−0.1263***	−0.1847***
France	−0.1026***	−0.1638***	−0.1760***
Germany	−0.0805***	−0.1021***	−0.1448***
Ireland	−0.1003***	−0.0883***	−0.0739***
Italy	−0.0385***	−0.0353**	−0.0539**
Japan	0.0636***	0.0723***	0.0587**
Netherlands	−0.1674***	−0.2194***	−0.2052***
Norway	−0.0629***	−0.0956***	−0.0128
Portugal	−0.0253	−0.0339*	−0.0140
Spain	−0.0645***	−0.1301***	−0.1116***
Sweden	−0.0677***	−0.0510***	−0.0163
Switzerland	−0.1240***	−0.1632***	−0.1655***
U.K.	−0.0173	−0.1024***	−0.1042***
Mean	−0.0545	−0.0780	−0.0746
SD	0.0586	0.0728	0.0792
Pooled data	−0.0530***	−0.0761***	−0.0735***

- ▷ Hau and Rey (2006, *RFS*): Exchange rate movements are driven by capital flows, not goods-market fundamentals.
- ▷ Cho, Choi, Kim, and Kim (2016, *JBF*): This relationship is positive for emerging markets, suggesting stronger portfolio flow effects.

Lilley and Rindali (2020)

(a) Exchange rates bilaterally with the US dollar



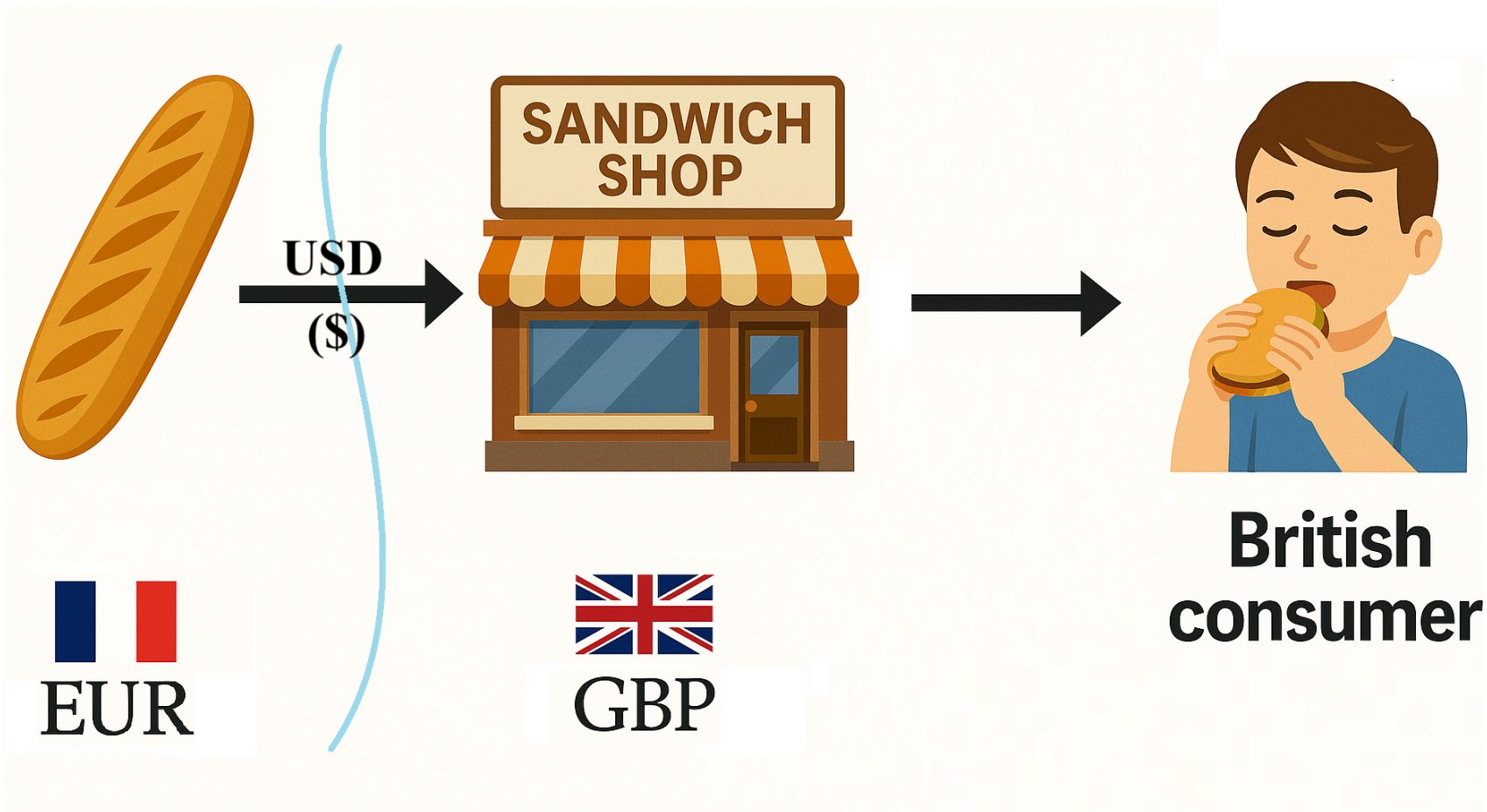
$$\Delta e_t^i = \alpha_{i,t} + \beta^i r_t^m + \epsilon_{i,t}$$

Research Questions

Building on the literature, we ask two central questions:

- ▷ Is there a relationship between currency returns and stock returns, as implied by standard international trade theory?
  - Traditional benchmark: exchange rates relative to the USD/trade weight
  - Our approach: trade-weighted exchange rates computed *separately* for export and import partners.
    - ✓ Different from using trade-weights for currency returns
- ▷ Is this form of currency risk priced in the equity market?

Sandwich shop example



Setup of the Model

- One French baguette producer and a single Sandwich shop in UK.
- Profit function for the British shop in GBP:

$$\Pi_{GB} = P_S \cdot Q_S - Q_S \cdot \frac{P_B}{e_P}$$

- Profit function for the French Baguette shop in EUR:

$$\Pi_{FR} = \frac{P_B}{e_E} \cdot Q_S - w \cdot Q_S$$

- Demand for the sandwich in the UK: $P_S = a - bQ_S$
- Exchange rates: e_P, e_E = GBP and EUR per invoicing currency (e.g., USD)

Optimization Problem

- The British sandwich shop chooses quantity Q to maximize profits:
  - Optimal output and price:

$$Q_S^* = \frac{1}{2b}\left(a - \frac{P_B}{e_P}\right), \quad P_S^* = \frac{1}{2}\left(a + \frac{P_B}{e_P}\right)$$

- The French bakery sets the baguette price (P_B):
  - Optimal baguette price:

$$P_B^* = \frac{1}{2}(a \cdot e_P + w \cdot e_E)$$

Equilibrium Profits

- Long-run profits solved by plugging in into the objective function:

$$\Pi^*_{FR} = \frac{1}{8b}\left(a\frac{e_P}{e_E} - w\right)\left(a - w\frac{e_E}{e_P}\right)$$

$$\Pi^*_{GB} = \frac{1}{16b}\left(a - w\frac{e_E}{e_P}\right)^2$$

- Stock prices determined as the present value of expected profits.
- Increase in e_P relative to e_E:
  - French bakery profits $\uparrow$ and British sandwich shop profits $\downarrow$
  - Exchange rate changes against USD *alone* irrelevant if e_P/e_E unchanged.
- The volatility of the relative currency value affects the variability of firms' profit.

Sticky Prices and Trade Invoicing

- When prices are sticky (e.g., Taylor, 1980), contracted prices adjust slowly.
- A substantial share of global trade is invoiced in US dollars (e.g., Goldberg and Tille, 2008, 2009).
- In the short run:
  - Nominal prices remain fixed in the invoicing currency.
  - Bilateral exchange rates play a smaller role in determining real profits.

Profit Functions Under Sticky Prices

- Under sticky prices, firm-level profits reflect fixed invoicing prices:

$$\Pi_{GB} = \bar{P}_S \cdot Q - Q \cdot \frac{\bar{P}_B}{e_P}$$

$$\Pi_{FR} = \frac{\bar{P}_B}{e_E} \cdot Q - w \cdot Q$$

- USD invoicing weakens the link between bilateral exchange rates and firm profits.

- Dominant currency pricing (e.g., invoicing in USD) reduces the relevance of bilateral FX movements for firms' short-run profit.

  (consistent with recent literature, e.g., Gopinath, et. al. 2020 *AER*)

Main Empirical Predictions and Findings

- **Export vs. Import Currency Effects**:
  - Appreciation relative to export partners ⇒ lower stock returns.
  - Appreciation relative to import partners ⇒ higher stock returns.
  - Inconsistent results relative to USD.
- **Heterogeneity Across Sectors and Countries**:
  - Effects are stronger in tradable sectors (e.g., manufacturing).
  - USD-invoiced trade reduces sensitivity to bilateral exchange rate movements.
- **Currency Volatility and Risk Premia**:
  - Higher export/import-based exchange rate volatility ⇒ higher expected returns.

Data Overview

- **Trade Data**:
  - OECD Input-Output Tables (1995–2020)
  - IMF Direction of Trade Statistics (1990–2023)
- **Currency Returns**: Datastream and Compustat
- **Stock Returns**:
  - Firm-level: Datastream (1996–2021)
  - Country-level: MSCI indices (1991–2024)
- **Sample**:
  - 40 countries, aggregated to industry level (ISIC classification)
  - 189,750 unique country-industry-year observations

Trade-Weighted Currency Returns

- A positive currency return indicates an appreciation of the focal country's currency.
- For each country-industry pair (c, i), we construct export- and import-weighted currency returns:

$$FX^{\text{EX}}_{c,i,t} = FX^{\text{USD}}_{c,t} - \sum_{d} w^{\text{EX}}_{c,i,d} FX^{\text{USD}}_{d,t}$$

$$FX^{\text{IM}}_{c,i,t} = FX^{\text{USD}}_{c,t} - \sum_{d} w^{\text{IM}}_{c,i,d} FX^{\text{USD}}_{d,t}$$

- FX^{USD} is the return of each currency relative to the USD. Weights w^{EX} and w^{IM} are based on export and import shares between country c and partner d at the industry level.

Empirical Specification

Pooled panel regression specification:

$$R_{c,i,t} = \alpha_{c,i} + \beta FX^{EX}_{c,i,t} + \gamma FX^{IM}_{c,i,t} + \delta FX^{USD}_{c,t} + \text{Controls}_{c,i,t} + \epsilon_{c,i,t}$$

- FX^{EX}: Export-weighted currency return (expect $\beta < 0$)
- FX^{IM}: Import-weighted currency return (expect $\gamma > 0$)
- FX^{USD}: Currency return relative to USD

Controls:

- Global stock returns (MSCI World, S&P 500)
- Country-level stock index returns
- World industry-level returns (USD)
- Country-industry and month fixed effects

FX exposure of country industries

	$R_{c,i,t}$							
$FX_{c,t}^{USD}$	0.425	−0.072				−0.026	0.003	0.016
	(73.02)	(−12.59)				(−4.36)	(0.03)	(1.64)
$FX_{c,t}^{EX}$			−0.335	−0.246	−0.197	−0.196	−0.278	−0.214
			(−4.85)	(−4.43)	(−3.96)	(−3.94)	(−4.32)	(−4.38)
$FX_{c,t}^{IM}$			2.649	0.457	0.198	0.377	0.551	0.242
			(36.10)	(7.76)	(3.56)	(5.46)	(5.83)	(3.07)
$R_{WLD,t}$		0.839		0.814				
		(231.40)		(241.91)				
$R_{US,t}$								
$R_{c,t}$					0.668	0.668		0.673
					(242.39)	(242.62)		(225.92)
$R_{i,t}^{USD}$					0.276	0.279		0.464
					(71.23)	(70.43)		(52.90)
Ctr. × Ind. FE	N	N	N	N	N	N	N	Y
Month FE	N	N	N	N	N	N	Y	Y
Adj-R^2	0.031	0.245	0.011	0.244	0.483	0.483	0.013	0.264
N	189,750	189,750	189,750	189,750	189,748	189,748	189,750	189,748

FX exposure of country industries

Panel A. Using value-weighted country-industry returns

	$R_{c,i,t}$							
$FX_{c,t}^{USD}$	0.425	−0.072				−0.026	0.003	0.016
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Tradable vs. Non-Tradable Sectors

- ▷ Effects possibly stronger in manufacturing (tradable sector).
- ▷ Service sectors may show weaker or insignificant effects.

Panel A.: manufacturing sector (N=11,468)					Panel B.: non-tradable sectors (N=68,436)			
	$R_{c,i,t}$				$R_{c,i,t}$			
$FX^{USD}_{c,t}$	−0.165		−0.319	−0.315	−0.088		−0.253	−0.254
	(−9.01)		(−11.59)	(−11.49)	(−8.50)		(−17.31)	(−17.24)
$FX^{EX}_{c,t}$		−1.903	−0.954	−0.991		−1.960	−1.447	−1.113
		(−6.22)	(−2.94)	(−3.06)		(−2.18)	(−1.62)	(−1.40)
$FX^{IM}_{c,t}$		1.734	2.224	2.290		0.530	2.607	2.666
		(5.31)	(6.87)	(7.08)		(3.80)	(13.90)	(13.99)
$R_{WLD,t}$	0.827	0.789	0.846	0.845	0.864	0.833	0.880	0.879
	(70.70)	(72.35)	(71.18)	(71.32)	(132.55)	(137.18)	(133.82)	(134.01)
Ctr × Ind FE	N	N	N	Y	N	N	N	Y
Month FE	N	N	N	N	N	N	N	N
Adj-R^2	0.321	0.319	0.327	0.326	0.228	0.227	0.231	0.229

Currency Return Volatility and Returns

- Firms are exposed to currency risk via both import and export channels.
- **Question:** Are these risks priced in the cross-section?
- We examine this using portfolio sorts based on:
  - Export volatility
  - Import volatility
  - USD volatility

FX Volatility Sorts: Export vs. Import Partners

- Portfolios sorted on trade-partner FX volatility show systematic return differences.

Panel A. Country industries sorted by export volatility

	Low	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	High	High−Low
$R^{USD,VW}_{c,i,t}$	0.51%	0.49%	0.44%	0.51%	0.56%	0.67%	0.70%	0.54%	0.68%	0.97%	0.45%
	(1.65)	(1.62)	(1.72)	(1.81)	(1.84)	(2.34)	(2.62)	(2.07)	(2.62)	(3.31)	(3.35)
$R^{USD,EW}_{c,i,t}$	0.97%	0.93%	1.08%	1.11%	1.00%	1.11%	1.13%	1.13%	1.18%	1.30%	0.33%
	(3.13)	(3.07)	(3.72)	(3.88)	(3.32)	(3.83)	(3.81)	(3.77)	(4.07)	(4.01)	(3.14)
ICAPM α^{VW}	−0.20%	−0.30%	−0.25%	−0.14%	−0.21%	−0.13%	0.07%	−0.20%	−0.02%	0.28%	0.47%
	(−1.01)	(−1.65)	(−1.58)	(−0.86)	(−1.15)	(−0.72)	(0.42)	(−1.36)	(−0.16)	(1.92)	(2.82)
ICAPM α^{EW}	0.06%	0.11%	0.21%	0.38%	0.17%	0.28%	0.26%	0.26%	0.35%	0.45%	0.38%
	(0.36)	(0.68)	(1.26)	(2.41)	(1.04)	(1.78)	(1.57)	(1.60)	(2.32)	(2.46)	(3.87)

Panel B. Country industries sorted by import volatility

	Low	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	High	High−Low
$R^{USD,VW}_{c,i,t}$	0.53%	0.56%	0.49%	0.43%	0.71%	0.74%	0.85%	0.86%	0.81%	0.93%	0.39%
	(1.64)	(1.95)	(1.76)	(1.63)	(2.58)	(2.75)	(3.11)	(3.19)	(2.89)	(2.84)	(1.65)
$R^{USD,EW}_{c,i,t}$	0.82%	1.01%	1.00%	0.97%	1.13%	1.12%	1.16%	1.19%	1.18%	1.35%	0.54%
	(2.64)	(3.30)	(3.37)	(3.39)	(3.84)	(3.83)	(3.93)	(3.95)	(3.71)	(3.88)	(2.68)
ICAPM α^{VW}	−0.40%	−0.18%	−0.26%	−0.29%	−0.01%	0.01%	0.20%	0.18%	0.08%	0.24%	0.65%
	(−1.70)	(−0.99)	(−1.52)	(−1.81)	(−0.06)	(0.06)	(1.38)	(1.28)	(0.59)	(1.39)	(2.63)
ICAPM α^{EW}	−0.02%	0.22%	0.24%	0.16%	0.29%	0.27%	0.35%	0.38%	0.31%	0.40%	0.42%
	(−0.09)	(1.17)	(1.40)	(1.04)	(1.83)	(1.74)	(2.15)	(2.26)	(1.74)	(1.95)	(2.15)

FX Volatility Sorts: USD-Based Volatility

- Portfolios sorted by USD-based volatility do not exhibit consistent return patterns.

Panel C. Country industries sorted by USD-based return volatility

	Low	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	High	High−Low
$R_{c,i,t}^{USD,VW}$	0.68%	0.67%	0.62%	1.05%	0.92%	0.87%	0.74%	0.74%	0.93%	1.08%	0.40%
	(2.00)	(2.10)	(1.99)	(3.20)	(2.78)	(2.71)	(2.38)	(2.28)	(2.60)	(2.70)	(1.14)
$R_{c,i,t}^{USD,EW}$	1.07%	1.01%	1.01%	1.01%	0.91%	1.26%	1.05%	1.08%	1.15%	1.37%	0.30%
	(3.56)	(3.07)	(3.12)	(3.12)	(2.77)	(3.77)	(3.24)	(3.27)	(3.49)	(3.35)	(0.93)
ICAPM α^{VW}	0.02%	0.03%	−0.11%	0.29%	0.21%	0.07%	−0.22%	−0.12%	0.02%	0.13%	0.10%
	(0.08)	(0.17)	(−0.58)	(1.39)	(0.83)	(0.34)	(−1.09)	(−0.53)	(0.09)	(0.48)	(0.27)
ICAPM α^{EW}	0.34%	0.35%	0.14%	0.29%	0.36%	0.33%	0.19%	0.26%	0.31%	0.18%	−0.16%
	(1.67)	(1.65)	(0.66)	(1.34)	(1.46)	(1.46)	(0.79)	(1.10)	(1.37)	(0.68)	(−0.54)

Volatility and Pricing

- We also consider a panel regression:

$$R_{c,i,t+1} = \alpha_{c,i} + \beta_{c,i}\sigma^{EX}_{c,i,t} + \gamma_{c,i}\sigma^{IM}_{c,i,t} + FE_{c,i,t} + \epsilon_{c,i,t+1}$$

Panel A. Value-weighted country-industry returns						Panel B. Equally-weighted country-industry returns				
	Leading month raw returns					Leading month raw returns				
Export volatility	0.0004		0.0003	0.0002	0.0004	0.0005		0.0003	0.0003	0.0004
	(6.79)		(4.62)	(3.90)	(4.03)	(6.76)		(4.44)	(4.03)	(3.82)
Import volatility		0.0015	0.0012	0.0017	0.0012		0.0019	0.0015	0.0019	0.0016
		(6.64)	(4.74)	(4.91)	(4.20)		(7.59)	(5.64)	(5.44)	(5.61)
Month FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	N	N	N	Y	N	N	N	N	Y	N
Industry FE	N	N	N	N	Y	N	N	N	N	Y
Adj-R^2	−0.001	−0.001	−0.001	0.000	−0.001	−0.001	−0.001	−0.001	0.001	−0.001
N	189,750	189,750	189,750	189,750	189,750	189,750	189,750	189,750	189,750	189,750

From Industry to Country-Level Evidence

- So far, we've shown that stock returns respond to exchange rate movements when measured relative to a firm's trade partners.
- These effects were strongest at the **country-industry level**, particularly in tradable sectors.
- Next, we test whether similar relationships hold at the **aggregate country level**.
- We test this by aggregating country-industry level trade and IMF data

Country-Level Regressions

Panel A. input-output trade database (N=11,549)

	Dependent variable: $R_{c,t}$			
$FX_{c,t}^{USD}$	−0.073			−0.066
	(−3.98)			(−1.56)
$FX_{c,t}^{EX}$		−2.988	−2.988	−1.815
		(−4.55)	(−4.55)	(−2.93)
$FX_{c,t}^{IM}$		3.528	3.593	2.875
		(5.08)	(5.18)	(4.28)
$R_{WLD,t}$	0.944	0.918	0.918	
	(81.26)	(84.88)	(85.02)	
Country FE	N	N	Y	Y
Month FE	N	N	N	Y
Adj-R^2	0.396	0.396	0.395	−0.029

Panel B. DOTS trade data from IMF (N=12,890)

	Dependent variable: $R_{c,t}$			
$FX_{c,t}^{USD}$	−0.100			0.011
	(−5.86)			(0.20)
$FX_{c,t}^{EX}$		−0.627	−0.654	−0.234
		(−4.30)	(−4.50)	(−1.65)
$FX_{c,t}^{IM}$		0.689	0.727	0.292
		(4.73)	(4.99)	(2.04)
$R_{WLD,t}$	0.920	0.891	0.891	
	(82.68)	(85.16)	(85.33)	
Country FE	N	N	Y	Y
Month FE	N	N	N	Y
Adj-R^2	0.377	0.376	0.376	−0.033

USD Invoicing Interaction

- Hypothesis: Higher USD invoicing weakens the relationship between trade-partner exchange rates and stock returns.
- Interactive regression considered in panel data:

$$R_{c,t} = \alpha_c + \beta_c FX_{c,t}^{USD} + \gamma_c FX_{c,t}^{EX} + \delta_c FX_{c,t}^{IM} + \eta_c FX_{c,t}^{EX} \times Invoice_{c,t}^{USD} + \zeta_c FX_{c,t}^{IM} \times Invoice_{c,t}^{USD} + \epsilon_{c,t}$$

  - $\eta > 0$: The negative effect of export appreciation is attenuated by USD invoicing.
  - $\zeta < 0$: The positive effect of import appreciation is attenuated by USD invoicing.

Results: USD Invoicing Interaction

Panel A. Sample using input-output database (N=9,449)

	$R_{c,t}$			
$FX_{c,t}^{EX}$	−17.731	−21.830	−17.646	−21.759
	(−8.21)	(−10.13)	(−8.17)	(−10.10)
$FX_{c,t}^{EX} \times Invoice_{c,t}^{USD}$	0.271	0.292	0.269	0.290
	(8.54)	(9.34)	(8.47)	(9.27)
$FX_{c,t}^{IM}$	17.791	16.708	17.710	16.608
	(7.98)	(7.51)	(7.94)	(7.47)
$FX_{c,t}^{IM} \times Invoice_{c,t}^{USD}$	−0.219	−0.235	−0.216	−0.231
	(−6.39)	(−6.93)	(−6.30)	(−6.82)
$Invoice_{c,t}^{USD}$	0.000	0.000	0.000	0.000
	(1.62)	(1.58)	(−1.65)	(−1.47)
$FX_{c,t}^{USD}$		0.599		0.602
		(17.58)		(17.69)
Country FE	N	N	Y	Y
Adj-R^2	0.026	0.058	0.024	0.056

Panel B. Sample using IMF DOTS database (N=10,451)

	$R_{c,t}$			
$FX_{c,t}^{EX}$	−1.460	−2.555	−1.479	−2.575
	(−3.48)	(−5.98)	(−3.52)	(−6.02)
$FX_{c,t}^{EX} \times Invoice_{c,t}^{USD}$	0.037	0.042	0.037	0.041
	(4.51)	(5.13)	(4.48)	(5.11)
$FX_{c,t}^{IM}$	1.369	1.536	1.396	1.563
	(3.27)	(3.66)	(3.33)	(3.72)
$FX_{c,t}^{IM} \times Invoice_{c,t}^{USD}$	−0.030	−0.030	−0.030	−0.029
	(−3.65)	(−3.67)	(−3.61)	(−3.64)
$Invoice_{c,t}^{USD}$	0.000	0.000	0.000	0.000
	(1.32)	(1.11)	(−2.15)	(−2.07)
$FX_{c,t}^{USD}$		0.522		0.520
		(14.65)		(14.65)
Country FE	N	N	Y	Y
Adj-R^2	0.016	0.038	0.014	0.036

Conclusion and Contributions

- **Trade-weighted currency measures** estimated separately for import and export partners:
  - Capture currency movements relative to trade partners
- **Main Findings**:
  - Appreciation vs. **export partners** $\rightarrow$ lower stock returns
  - Appreciation vs. **import partners** $\rightarrow$ higher stock returns
  - Results are **robust** across specifications and data levels
- **Contribution**:
  - USD invoicing reduces firm-level risk as predicted by the model of Doepke and Schneider (EM 2017)
  - Stock returns react to changes in FX values as predicted by economic theory.