

# Discussion of “Currency Volatility and Global Technological Innovation” by Hsu, Taylor, Wang, and Xu

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# Exchange Rate and Innovation

- a million-dollar question: what drives innovation?
- innovation is the foundation of economic growth
- this paper: the role of exchange rate
- comprehensive data and empirical analysis
- main takeaway: exchange rate volatility lowers innovation
- more so for firms that are
  - more financially constraint, smaller
  - with more foreign debt, with less currency hedging
  - in countries with low financial development and openness

# Exchange Rate Exposure

- measure annual volatility  $Vol_{m,t}$  for currency m as the realized volatility from daily changes
  - robust to GARCH
- measure firm level volatility as sales-weighted, firm f in country m

$$Vol_{f,m,t} = \sum_{m=1}^M Vol_{m,t} \frac{Sales_{f,m,t}}{\sum_{m=1}^M Sales_{f,m,t}}$$

# Exchange Rate Exposure

- ideally, the weight should be the cashflow exchange rate exposure

$$\text{cash flow} = \sum (\text{Sales} - \text{COGS})S + \text{Hedging}(F - S) - \sum \text{debtcost} \cdot S + \dots$$

- firms use derivatives to hedge currency risk in foreign sales
  - indicator from SEC filings and annual reports
- firms expose to exchange rating from debt financing
  - no firm-level data
  - assume firm-level foreign debt share equals the market-level share
- Gopinath et al (2020): dollar invoicing
  - terms-of-trade are uncorrelated with exchange rates

# Innovation Activities

- input: R&D expenditure
- output: number of patents, citation-weighted
  - number of a firm's patents registered in the domestic patent office
  - number of a firm's patents registered in the US
- originality: cite a wide class of technologies
- generality: patents being cited by a wide class of technologies
- exploration ratio: cite patents on new knowledge outside of its existing expertise
- exploitation ratio: cite patents on old knowledge within of its existing expertise

# Sample

- Full sample 748,000 firm-year observations
- 80,400 that have foreign sales
- 49,005 after being merged with volatility data
  - lose 39% of the sample
  - daily volatility is missing for a few currencies
  - why not take GARCH or stochastic volatility?
- 10,624 that have patents
- 1,519 firms in 32 markets, from 1989 to 2018

# Identification

- old days: country-level exchange rate volatility on innovation/growth
- this paper: granular data + fixed effect
- firm fixed effect: control for all firm characteristics
- market-market-year fixed effect: control for all time effect and country effect

## Comment: Exchange Rate Level or Volatility

- If the volatility matters, the level has to matter
- first order first
- one potential issue: export (Sales) or import (COGS)?
- $\sum(Sales - COGS)S$
- differentiate the two cases may recover some level effects



## Comment: Is Exchange Rate Vol More Than Earnings Vol

- in the current mechanism, exchange rate vol contributes to the earnings vol
- the same results should be expected for total earnings vol
  - negatively affect innovation input and output
  - more constraint, smaller firms
  - with more foreign debt, with less currency hedging
  - in countries with low development and openness
- firm-level earnings vol is hard to measure
- or other factors that drives earnings, e.g. inflation vol, interest rate vol, etc
- economics significance: 1 s.d. exchange rate vol reduces R&D and patents by 7%
- how much is the share of total trade/revenue?
- how large could be the effect of total earnings vol?

## Comment: Is Exchange Rate Vol More Than Earnings Vol

- the currency specific interaction: currency hedging
- “High FX volatility may therefore impede high-tech firms exporting their products and importing innovation input materials”
- “For firms using currency derivatives to hedge, their cross-border trading is expected to be less affected by FX volatility”
- $\sum(Sales - COGS)S + Hedging(F - S)$
- direct effect: hedging lowers the risk and sensitivity
- trade slowdown: hedging protects (Sales-COGS)
- how does exchange rate vol affects (Sales-COGS)?

## Comment: Is Exchange Rate Vol More Than Earnings Vol

- earnings vol effect is not international specific
- some mechanisms from international aspect
- Melitz(2003)
- firms pay a fixed cost to export
- high productivity firms export and enjoy the monopoly profits from foreign markets
- let's endogenize productivity: innovation can improve productivity
- marginal cost of innovation = marginal benefit of exporting (related to the exporting cost)
- exchange rate vol increases the exporting cost, lower benefit of exporting
- assume increasing marginal cost of innovation
- innovation goes down with the exchange rate vol
- other predictions: exports decrease, productivity decrease

## Comment: Policy

- a million-dollar question: what drives innovation?
- a half million-dollar question: what policy?
- fixed exchange rate regime?
- back-of-the-envelop calculation:
  - $Vol_{f,m,t}$  mean 0.02, s.d. 0.02
  - going to a fixed exchange rate regime has an effect around 1 s.d.
  - 7% innovation

## Comment: Innovation Spillover

- the comprehensive data are valuable for many questions
- innovation spillover
- how does innovation in one country (AE) affect innovation in other countries (AE/EM)?
- what are the transmission channels?
  - trade/FDI/joint venture/pure learning
- transmission and learning cost:
  - does it matter if a AE firm register a pattern in EM?
- does the followers catch up with the frontier?