Production Chains, Exchange Rate Shocks and Firm Performance

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Very preliminary. Comments welcome.

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Motivation

- Large exchange rate shocks can affect firm performance/activities and cause macroeconomic fluctuations.

  - Lack of evidence on how exchange rate shocks transmit/propagate through supply chains and affect the performance of indirect exporters/imorpters.
  - Lack of good data on production chains to capture a firm's upstream suppliers and downstream customers.

Motivation

- Why indirect exports?
  - Indirect exporters are firms that do not export but at least one of their buyers exports
  - Only 6% of Japanese manufacturing firms export directly but about 52% are indirect exporters in terms of manufacturer-manufacturer pairs.
    - Toyota has about 500 suppliers (tier 1) and more than 9000 sub-suppliers (tier 2) in Japan and its major supplier, Denso, has more than 1500 suppliers (METI, 2013)
  - Indirect exporters account for 36% sales and 46% employment of manufacturing industries.
  - About 19% of manufactures who do not export by themselves but supply their products to at least one exporting wholesaler, and wholesalers account for roughly 25% of export value in Japan (Fujii, Ono and Saito, 2017).

Japan's exchange rate, imports and exports
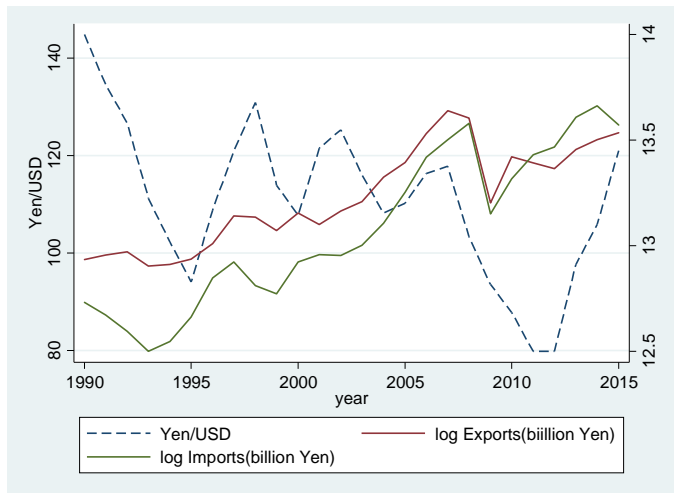
- An increase in Yen/USD exchange rate implies a depreciation of Yen.

Annual changes of exchange rate, exports and imports
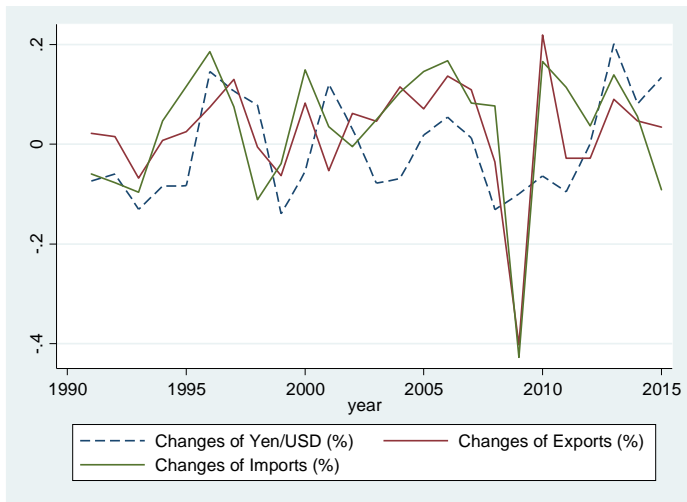
Fluctuations of exchange rates by trading region

- Changes of regional exchange rates:
  $$\Delta RER_{rt} = \sum_r \frac{GDP_{ct}}{GDP_{rt}} \times \Delta \ln RER_{J/c,t}; \; RER_{J/c,t} = \frac{NER_{J/US,t}}{NER_{c/US,t}} \times \frac{CPI_{ct}}{CPI_{Jt}}$$
- c :country, $r = $ (Asia, Europe, Middle East, North America or ROW)

# What we do

- Use Japanese buyer-supplier linkage data combined with trade data to show how exchange rate shocks affect the performance of
  - exporters and their suppliers (indirect exporters)
  - importers and their customers (indirect importers)
- Construct firm-specific export/import exchange rates, changes and exposure
  - regional exports-/imports- weighted
  - own, upstream and downstream

Findings

- A real depreciation of Yen significantly increased the exports, sales and profitability of Japanese firms.
- There are significant responses in sales and profitability of indirect exporters, especially SMEs, to exchange rate exposure of downstream exporters (upstream propagation effect).
- The propagation effects of exchange rate shocks are heterogeneous by firm size (own, upstream and downstream)

Literature

- Exchange rate pass-through
  - Recent studies have linked the exchange rate elasticity/pass-through to firm-level characteristics.
    - Berman, Martin and Mayer (2012) for firm TFP; Chatterjee, Dix-Cameiro and Vichyanond (2013) for multi-product firms; Amiti, Itskhoki and Konings (2014) for intensity of imported inputs; Li, Ma and Xu (2015) for productivity and imports.

- This study links exchange rate to production network and firm performance (sales and profitability) of exporters and indirect exporters.

Literature

- Propagation of (trade) shocks through supply chains
  - Carvalho, Nirei and Saito (2014), Barrot and Sauvagnat (2016), Boehm, Flaaen and Pandalai-Nayar (2016): the propagation and amplification of natural disasters shocks through firm-level linkages.
  - Fujii (2017), Tintelnot, Kikkawa, Mogstad and Dhyne (2017): the import (export) shocks to a firm's suppliers (buyers) affect the total sales of the firm.

- We construct firm-specific export and import exchange rates to capture the substantial variations of exchange rate exposure across firms.

- Firm performance depend on three types of exchange rate shocks: own firm, upstream suppliers, and downstream customers

Upstream/downstream propagation effect of exchange rate shocks

Buyer-supplier linkage data
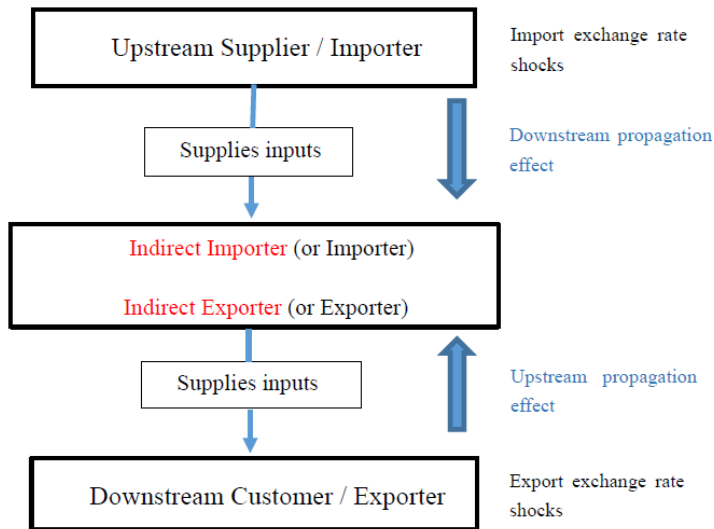
- Production network data (2005, 2010, 2011 and 2013) provided by Tokyo Shoko Research (TSR)
  - Obs: 800,000+ firms and 3,000,000+ buyer-supplier connections each year (no transaction value)
  - Firm-level sales and profits (current year and last year)
  - Trade status is only available in 2013 (no trade value)
  - Each firm reports a list of their most important suppliers (up to 24) and buyers (24).
  - Use info reported by a buyer about its suppliers, and info reported by a supplier about its buyers, to maximize the number of buyer-supplier links.

Firm-level trade data

- Firm-level export and import data (from 2005 to 2013) provided by Ministry of Economy, Trade and Industry (METI)
- Basic Survey of Japanese Business Structure and Activities (Kikatsu)
  - Firms with more than 50 employees and 30 million yen capital in manufacturing and some service sectors.
  - Info on sales, employment, capital, intermediate inputs and industry affiliation etc.
  - Firms report export and import value by major region.
  - Obs: about 20,000 firms each year, a half in manufacturing.

Matched data

- Merge TSR data with Kikatsu data by firm name, address and tel.
    - About 80% of Kikatsu firms can be merged to TSR data in each year (2005, 2010, 2011, 2013)
- We keep that buyer-supplier linkages did not change during 2005-2013 and construct a panel data.
- Matched TSR-Kikatsu data:
    - Number of direct exporters: about 2700 firms in each year
    - For direct exporters, the average number of indirect exporters is 63 (median: 22).
- This study focuses on manufacturing firms and wholesalers.

Matched data: # of firms in 2013

Panel A: Export		Direct	Indirect 1	Indirect 2	Rest	Total
TSR data	# of firms	13,174	132,689	81,387	9,549	236,799
	Share	6%	56%	34%	4%	100%
TSR-Kikatsu 1	# of firms	3,762	125,732	52,426	4,451	186,371
	Share	2%	68%	28%	2%	100%
TSR-Kikatsu 2	# of firms	3,851	5,941		732	10,524
	Share	37%	57%		7%	100%

Panel B: Import		Direct	Indirect 1	Indirect 2	Rest	Total
TSR data	# of firms	20,427	132,011	77,547	6,814	236,799
	Share	9%	56%	33%	3%	100%
TSR-Kikatsu 1	# of firms	3,548	122,997	56,153	3,673	186,371
	Share	2%	66%	30%	2%	100%
TSR-Kikatsu 2	# of firms	3,614	6,115		795	10,524
	Share	34%	58%		8%	100%

Firm-level exchange rate

- We use annual Kikatsu trade data to construct firm *export- and import- weighted effective exchange rate* (changes):

$$\Delta EXEER_{ft} = \sum_R \frac{EX_{frt-1}}{EX_{ft-1}} \times \Delta RER_{rt}, \ \Delta IMEER_{ft} = \sum_R \frac{IM_{frt-1}}{IM_{ft-1}} \times \Delta RER_{rt},$$
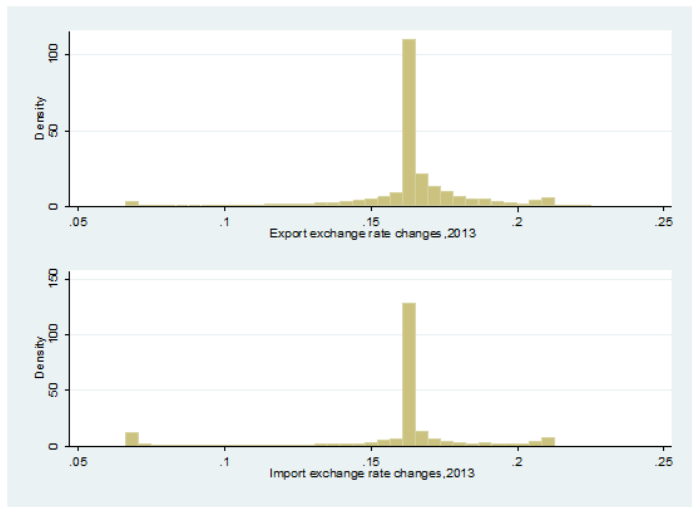
$$\text{where } \Delta RER_{rt} = \sum_r \frac{GDP_{ct}}{GDP_{rt}} \times \Delta \ln RER_{J/c,t};$$

$$RER_{J/c,t} = \frac{NER_{J/US,t}}{NER_{c/US,t}} \times \frac{CPI_{ct}}{CPI_{Jt}}.$$

- f : firm, t : year, c :country, r = (Asia, Middle East, Europe, Northern America, ROW).
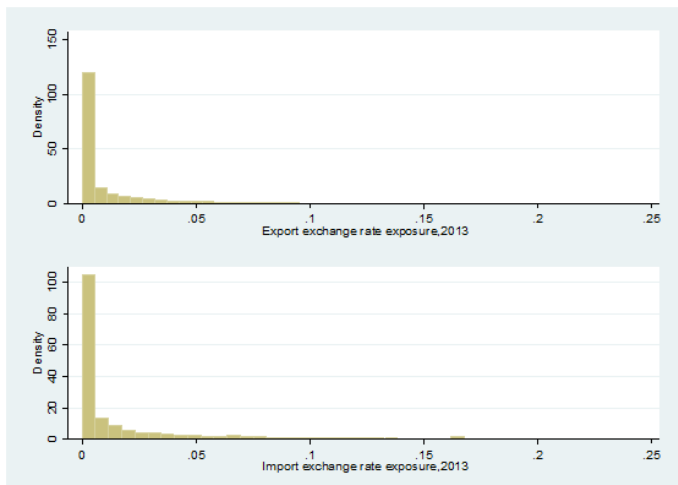- An increase in $EXEER_{ft}$ implies a real depreciation of Yen at firm-level.

Firm-level exchange rate

- Distribution of export and import exchange rate *changes*: $\Delta EXEER_{ft}$ and $\Delta IMEER_{ft}$

Firm-level exchange rate

- Export and import exchange rate *exposure*:
  $\Delta EXEER_{ft} \times (\text{exports/total sales})$, $\Delta IMEER_{ft} \times (\text{imports/total sourcing})$

Direct exporters: Specification

$$
\begin{aligned}
\Delta Y_{ft} =\ & \mu + \alpha_1 \Delta EXEER_{ft} + \alpha_2 \Delta IMEER_{ft} \\
& + \alpha_3 \Delta EXEER_{ft} \cdot exshare_{ft-1} + \alpha_4 \Delta IMEER_{ft} \cdot imshare_{ft-1} \\
& + \beta_1 \Delta \ln TFP_{ft} + \beta_2 \Delta \ln GDP_{ft} + FE_f + FE_{it} + \varepsilon_{ft}
\end{aligned}
$$

- Y: log exports, log sales or profitability (profits/sales).
- $\alpha_1 > 0$, $\alpha_3 > 0$; $\alpha_2 < 0$, $\alpha_4 < 0$ if Yen depreciates.
- Firm-level regional trade-weighted GDP growth rates:

$$
\Delta \ln GDP_{ft} = \sum_R \frac{EX_{frt-1} + IM_{frt-1}}{EX_{ft-1} + IM_{ft-1}} \times \Delta \ln GDP_{rt}
$$

- Standard errors clustered at the firm level.

Dep. Vars:	(1)	(2)	(3)	(4)	(5)	(6)
	Δ lnExports		Δ lnSales		Δ Profitability	
Δ IMEER	0.158	0.162	-0.024	-0.021	-0.013***	-0.014***
	[0.107]	[0.109]	[0.015]	[0.016]	[0.004]	[0.004]
Δ IMEER, t-1		0.096		-0.018		0.003
		[0.104]		[0.015]		[0.004]
Δ IMEER*L.Import share			0.073**	0.073*	-0.025**	-0.024**
			[0.037]	[0.038]	[0.010]	[0.010]
Δ IMEER*L.Import share, t-1				0.019		-0.008
				[0.037]		[0.010]
Δ EXEER	0.921***	0.927***	0.070***	0.063***	0.007*	0.006
	[0.112]	[0.114]	[0.015]	[0.016]	[0.004]	[0.004]
Δ EXEER, t-1		-0.131		-0.007		-0.004
		[0.113]		[0.014]		[0.004]
Δ EXEER*L.Export share			0.206***	0.233***	0.042***	0.046***
			[0.059]	[0.060]	[0.016]	[0.017]
Δ EXEER*L.Export share, t-1				0.131**		-0.017
				[0.061]		[0.016]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85065	76293	85423	76622	85519	76671
R-squared	0.222	0.238	0.447	0.458	0.336	0.346

Direct and indirect exporters: Specification

$$
\begin{aligned}
\Delta Y_{ft} = \; & \mu + \alpha_1 \Delta EXEER_{ft} + \alpha_2 \Delta IMEER_{ft} \\
& + \alpha_3 \Delta EXEER_{ft} \cdot exshare_{ft-1} + \alpha_4 \Delta IMEER_{ft} \cdot imshare_{ft-1} \\
& + \beta_1 \Delta \ln TFP_{ft} + \beta_2 \Delta \ln GDP_{ft} + FE_f + FE_{it} + \varepsilon_{ft} \\
& + \gamma_1 Upstream_{ft} + \gamma_2 Downstream_{ft}
\end{aligned}
$$

- Y: log sales or profitability
- $Upstream_{ft}$ is simple average of the exchange rate changes/exposure of upstream suppliers.
- $Downstream_{ft}$ is simple average of the exchange rate changes/exposure of downstream customers.

Direct and indirect exporters: Main results

Dep. Vars.:	(1) Δ lnSales	(2) Δ Profitability
Upstream shocks (Downstream propagation effect)		
Δ IMEER	0.003	-0.051
	[0.020]	[0.051]
Δ IMEER*L.Import share	-0.003	0.120
	[0.050]	[0.126]
Firm import/export exchange rate shocks		
Δ IMEER	-0.016	0.008
	[0.023]	[0.024]
Δ IMEER*L.Import share	0.051	-0.116***
	[0.064]	[0.039]
Δ EXEER	0.080***	0.020
	[0.023]	[0.016]
Δ EXEER*L.Export share	0.386***	0.347***
	[0.106]	[0.134]
Downstream shocks (Upstream propagation effect)		
Δ EXEER	0.158***	0.083
	[0.020]	[0.075]
Δ EXEER*L.Export share	0.727***	0.173***
	[0.069]	[0.029]
Controls	Yes	Yes
Firm FE	Yes	Yes
Industry-year FE	Yes	Yes
Observations	100928	100928
R-squared	0.198	0.015

Direct and indirect exporters: Pure indirect exporters

Dep. Vars.:	(1) Continuous export and import	(2)	(3) Never export and import	(4)
	Δ lnSales	Δ Profitability	Δ lnSales	Δ Profitability
Upstream shocks (Downstream propagation effect)				
Δ IMEER	0.033	-0.002	-0.054**	-0.113
	[0.032]	[0.011]	[0.025]	[0.104]
Δ IMEER*L.Import share	-0.061	-0.017	0.105	0.287
	[0.081]	[0.035]	[0.069]	[0.272]
Firm import/export exchange rate shocks				
Δ IMEER	0.025	-0.014	0	0
	[0.034]	[0.014]	[.]	[.]
Δ IMEER*L.Import share	0.057	-0.092**	0	0
	[0.071]	[0.042]	[.]	[.]
Δ EXEER	0.051	0.002	0	0
	[0.038]	[0.012]	[.]	[.]
Δ EXEER*L.Export share	0.257**	0.196**	0	0
	[0.102]	[0.090]	[.]	[.]
Downstream shocks (Upstream propagation effect)				
Δ EXEER	0.140***	-0.018	0.135***	0.135
	[0.038]	[0.024]	[0.025]	[0.126]
Δ EXEER*L.Export share	0.399***	0.067*	0.703***	0.173***
	[0.098]	[0.036]	[0.100]	[0.047]
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	34501	34501	47603	47603
R-squared	0.214	0.127	0.199	0.014

Direct and indirect exporters: Large firms vs SMEs (employees<300)

Dep. Vars.:	(1)	(2)	(3)	(4)
	Large firms		SMEs	
	Δ lnSales	Δ Profitability	Δ lnSales	Δ Profitability
Upstream shocks (Downstream propagation effect)				
Δ IMEER	0.112*	0.012	- 0.005	- 0.058
	[0.060]	[0.018]	[0.021]	[0.060]
Δ IMEER*L.Import share	0.045	0.008	- 0.006	0.138
	[0.115]	[0.029]	[0.057]	[0.147]
Firm import/export exchange rate shocks				
Δ IMEER	- 0.039	- 0.014	0.000	0.014
	[0.053]	[0.015]	[0.030]	[0.031]
Δ IMEER*L.Import share	- 0.079	0.01	0.068	- 0.149***
	[0.096]	[0.037]	[0.079]	[0.049]
Δ EXEER	0.105**	0.034**	0.113***	0.022
	[0.053]	[0.016]	[0.029]	[0.022]
Δ EXEER*L.Export share	0.849***	0.313***	0.157	0.347*
	[0.141]	[0.053]	[0.154]	[0.196]
Downstream shocks (Upstream propagation effect)				
Δ EXEER	0.193***	- 0.016	0.148***	0.096
	[0.061]	[0.014]	[0.022]	[0.085]
Δ EXEER*L.Export share	0.576***	0.062	0.754***	0.183***
	[0.152]	[0.044]	[0.078]	[0.033]
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	16238	16238	84690	84690
R-squared	0.245	0.124	0.209	0.015

Direct and indirect exporters: Relative firm size

Dep. Vars.:	(1) Large firms	(2)	(3) SMEs	(4)
	Δ lnSales	Δ Profitability	Δ lnSales	Δ Profitability
When upstream suppliers are large				
Δ IMEER*L.Import share	0.073	0.004	-0.017	0.000
	[0.109]	[0.022]	[0.074]	[0.057]
When upstream suppliers are SMEs				
Δ IMEER*L.Import share	-0.249	-0.074	0.026	-0.066
	[0.227]	[0.069]	[0.120]	[0.054]
When downstream customers are large				
Δ EXEER*L.Export share	0.793***	0.125***	0.878***	0.189***
	[0.138]	[0.036]	[0.088]	[0.037]
When downstream customers are SMEs				
Δ EXEER*L.Export share	0.273	-0.113	0.579	0.091
	[0.589]	[0.121]	[0.422]	[0.118]

Note: Upstream and downstream exchange rates changes/ exposure are simple average. Own firm controls include firm TFP growth and trade weighted GDP growth rate. Standard errors are clustered at the firm level in parentheses. ***, ** and * denote significance at the 1, 5 and 10% level, respectively. All specifications include firm and year fixed effects. Observations vary by specification.

Dep. Vars.:	(1)	(2)	(3)	(4)
	full samples		both growth rates are available	
	Δ lnSales	Δ Profitability	Δ lnSales	Δ Profitability
Upstream shocks (Downstream propagation effect)				
Δ IMEER	0.116*	0.027	0.091	0.026
	[0.066]	[0.028]	[0.092]	[0.027]
Δ IMEER*L.Import share	-0.049**	-0.027***	-0.051	-0.029***
	[0.022]	[0.009]	[0.031]	[0.009]
Firm import/export exchange rate shocks				
Δ IMEER	-0.014	-0.021	-0.022	-0.020
	[0.044]	[0.025]	[0.044]	[0.025]
Δ IMEER*L.Import share	0.115	-0.100*	0.123	-0.100*
	[0.098]	[0.060]	[0.100]	[0.061]
Δ EXEER	0.144***	0.021	0.141***	0.023
	[0.041]	[0.026]	[0.042]	[0.028]
Δ EXEER*L.Export share	0.283	0.487*	0.296	0.486*
	[0.214]	[0.262]	[0.218]	[0.263]
Downstream shocks (Upstream propagation effect)				
Δ EXEER	0.430***	0.267***	0.668***	0.265***
	[0.091]	[0.038]	[0.126]	[0.038]
Δ EXEER*L.Export share	0.226***	0.013	0.252***	0.015
	[0.022]	[0.010]	[0.030]	[0.010]
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	838572	540879	537155	537155
R-squared	0.356	0.262	0.373	0.266

Direct and indirect exporters: Including small firms (employees<50) in TSR data (2009-2013)

Dep. Vars.:	(1)	(2)	(3)	(4)
	Large firms		SMEs	
	Δ lnSales	Δ Profitability	Δ lnSales	Δ Profitability
Upstream shocks (Downstream propagation effect)				
Δ IMEER	0.297	-0.187	0.098	0.026
	[1.469]	[0.478]	[0.092]	[0.027]
Δ IMEER*L.Import share	0.469	0.141	-0.049	-0.029***
	[0.482]	[0.142]	[0.031]	[0.009]
Firm import/export exchange rate shocks				
Δ IMEER	0.007	-0.015	-0.011	-0.012
	[0.082]	[0.027]	[0.052]	[0.031]
Δ IMEER*L.Import share	0.154	0.034	0.054	-0.144*
	[0.164]	[0.063]	[0.117]	[0.079]
Δ EXEER	0.264***	0.037	0.147***	0.014
	[0.075]	[0.023]	[0.052]	[0.037]
Δ EXEER*L.Export share	0.266	0.172**	0.457	0.642*
	[0.243]	[0.087]	[0.328]	[0.377]
Downstream shocks (Upstream propagation effect)				
Δ EXEER	0.745***	0.454	0.624***	0.264***
	[1.267]	[0.320]	[0.127]	[0.038]
Δ EXEER*L.Export share	-0.28	0.013	0.261***	0.016
	[0.234]	[0.076]	[0.030]	[0.010]
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	13250	13250	523905	523905
R-squared	0.344	0.231	0.376	0.27

Conclusion

- A depreciation of Yen significantly increased the exports, sales and profitability of Japanese firms.
- The sales and profitability of indirect exporters, especially SMEs, respond to the exchange rate shocks/exposure of downstream customers/exporters (upstream propagation effect)
- The propagation effects of exchange rate shocks are asymmetric by firm size (own, upstream and downstream).
- From the perspective of supply chains, the stabilization of exchange rates is crucial to the SMEs engaging in indirect importing/exporting,