Trade Shocks and U.S. Firms' Global Supply Chains: Evidence from the 2018-2019 U.S. Trade War

Preliminary Results

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"The Rise of Global Supply Chains"

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Motivation

- Global supply chains have risen in importance with the decline in communication and travel barriers
- ...but so have disruptions to those production chains:
  - Restrictive trade policies
  - Localized shutdowns during the COVID-19 pandemic
  - Shipping bottlenecks and port delays

What we do

Study the effects of supply chain shocks on U.S. firms' supplier choices and import decisions.

- Research questions:
  - Are U.S. imports of key products especially vulnerable to shocks?
  - What were the most important U.S. firm responses to the raft of new tariffs imposed in 2018-2019?
  - What does the differential response to the tariffs across products reveal about the resilience of U.S. supply chains?
- New measures and facts about supplier relationships
  - detailed supplier vs country measures of concentration by product
  - new import growth decomposition highlighting supplier relationship churning

Outline

- Data on buyer-supplier matches in US trade transaction
- Concentration of suppliers in US import supplier data
- Margins of adjustment of U.S. import growth during trade war of 2018-2019
- Conclusion

Data

Confidential trade microdata from U.S. Census Bureau:

- Longitudinal Firm Trade Transactions Database (LFTTD), 1992-2019
  - Universe of merchandise import transactions valued $\geq \$2,000$
  - U.S. firm code–foreign supplier code–product(HS6)

Identifying foreign suppliers in U.S. import transactions

Table: Sample Manufacturer identifier

Country	Name	Address	City	Manufid
Bangladesh	Red Fabrics	1234 Curry Road	Dhaka	BDREDFAB1234DHA
France	Green Chemicals	1111 Baguette Lane	Paris	FRGRECHE1111PAR
Korea	Blue Umbrellas	88 Kimchi Street	Seoul	KRBLUUMB88SEO

Source: Kamal and Monarch (2018).

Cleaning

- Remove country code, street address
- Retain unique exporter name and city–supplier(s)
  - e.g. REDFABDHA, GRECHEPAR, BLUUMBSEO
  - Eventually (not today)–use city codes to eval geographic shocks/concentration/risks

Concentration by source country: aggregate trade data

- Public-use country-product imports values M_{cp}
- Herfindahl-Hirschman Index Country-Product Agg Data

$$HHI_p^{ctry} = \sum_c \left[\frac{M_{cp}}{\sum_c M_{cp}} \right]^2 = \sum_c s_c^2$$

  - Sum of squared country-product import shares
  - HHI $= 1 \implies$ all imports come from a single source country
  - Lower index $\implies$ imports more evenly dispersed across source countries

- Data limitation: no sub-aggregation is feasible

Concentration of foreign suppliers: micro trade data

- Import value M_{scp} by supplier(s)-country(c)-product(p) via LFTTD supplier IDs
- Within country HHI over all foreign suppliers

$$HHI_{cp} = \sum_s \left[\frac{M_{scp}}{\sum_s M_{scp}} \right]^2 \text{ for each } c$$

- Overall supplier HHI_p related to country version HHI_p^{ctry}

$$HHI_p = \sum_c \left[s_c^2 \times HHI_{cp} \right]$$

  - Sum of within country supplier HHI_{cp} weighted by aggregate import shares
  - By definition $HHI_p \leq HHI_p^{ctry}$
  - strict only if every country has a single supplier firm

Potential concentration risk for product-level shocks:

- Global sourcing shocks:
  - risk if concentration in small number of total suppliers in world (e.g. pandemic, global demand shocks, freight/shipping delays)
  - Product-level HHI, # of suppliers, # of suppliers per buyer
- Country sourcing shocks:
  - risk if many suppliers in single country/region (e.g. U.S.-China Trade War, earthquake, floods, terrorism, spillovers from non-trade disputes)
  - switching from source country difficult, diversification options low
  - Compare HHI across country groups–China vs. Less Adversarial Country Groups

Foreign Sourcing Concentration in Key Products

We check HHI for potential vulnerability for two sets of products:

- Imports identified as having high national security importance: Batteries, semiconductors, rare earths, pharmaceuticals
- Imports used to help fight pandemic: Masks, gloves, shields, shoe covers, goggles

Supplier concentration: strategic products

Product	Supplier HHI	Supplier Ct (Mean)	Suppliers per Buyer
Batteries	0.11	717	1.3
Semiconductor	0.08	2590	1.7
Rare earths	0.20	56	1.3
Pharmaceuticals	0.31	222	1.6
Average	0.18	714	1.7
Compare to:			
Apparel not knitted	0.04	2603	2.5

Source: Authors' calculations using LFTTD.

- Rare earths and pharmaceuticals more concentrated than average.
- Also have far fewer suppliers than the average product.

Country concentration: strategic products

Product	Country HHI	Sources (Mean)	Friendly Share	China Share
Batteries	0.40	35	0.64	0.26
Semiconductors	0.19	59	0.29	0.11
Rare Earths	0.43	11	0.42	0.50
Pharmaceuticals	0.42	23	0.75	0.02
Average (all products)	0.41	25	0.60	0.18
Compare to:				
Apparel not knitted	0.30	63	0.13	0.35

Source: Authors' calculations using public-use trade data.
Notes: "Friendly": FTA countries, EU, Japan.

- At country-level, batteries, rare earths and pharmaceuticals about as concentrated as the average product.
- Less than half of semiconductors and rare earths imported from friendly countries.

Supplier concentration very dispersed in medical products...

Table: Supplier Shocks: Medical Products

Product	Supplier HHI	Suppliers (Mean)	Suppliers per Buyer
Gloves & shields	0.01	34700	1.9
Goggles	0.02	2164	1.7
Masks	0.00	25910	2.2
Shoe covers	0.01	14810	1.8
Average (all products)	0.18	714	1.7
Compare to:			
Apparel not knitted	0.04	2603	2.5

Source: Authors' calculations using LFTTD.

...but medical products appear more concentrated at country level

Table: Country Shocks- Medical Products

Product	Country HHI	Sources (Mean)	Friendly Share	China Share
Gloves & shields	0.45	115	0.46	0.45
Goggles	0.33	48	0.12	0.54
Masks	0.55	123	0.16	0.73
Shoe covers	0.12	100	0.56	0.28
Average (all products)	0.41	25	0.60	0.18
Compare to:				
Apparel not knitted	0.30	63	0.13	0.35

Source: Authors' calculations using public-use trade data.

Notes: "Friendly": FTA countries, EU, Japan.

Supplier HHI versus Country HHI

- Country level vs supplier level HHI measures on average

	Supplier HHI	Country HHI
Mean	0.18	0.41
SD	0.21	0.25

- Supplier-based smaller by definition
- If highly correlated, then measure similar characteristics and result in similar conclusions
- Unfortunately, the correlation is very low

Product concentration measures poorly correlated

Ranking	Country HHI	Supplier HHI
1	masks	pharmaceutical
2	other textile	chemicals
3	gloves & shields	rare earths
4	chemicals	rubber
5	rare earths	batteries
6	pharmaceutical	plastics
7	batteries	instruments
8	machinery	machinery
9	goggles	semiconductor
10	rubber	other textile
11	apparel not knitted	apparel not knitted
12	plastics	goggles
13	instruments	gloves & shields
14	semiconductor	shoe covers
15	shoe covers	masks

- Rank correlation is only 0.04 (Pearson correlation 0.20)

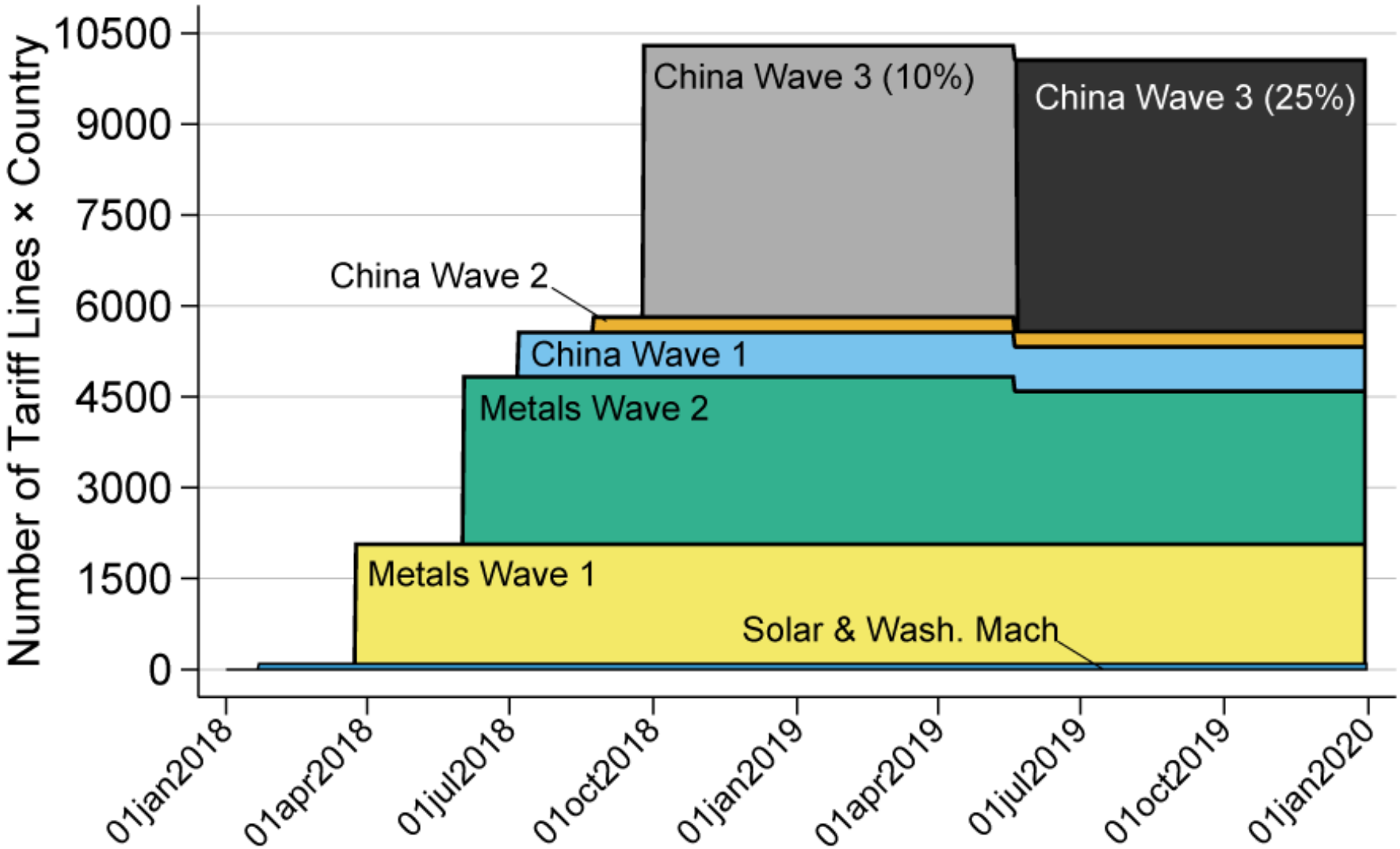
Product concentration takeaways:

- Pronounced concentration in 2 of 4 key strategic products: rare earths and pharmaceuticals highly concentrated among few suppliers/few countries.
- Semiconductor imports much more dispersed, but lower than average share originating from friendly countries.
  - inconsistent with some news/business reporting
  - Quality/contracting and customization may imply relationship specificity not captured by HS codes
- Large numbers of foreign suppliers of medical products (at individual supplier and country level).
  - COVID-19 shortages likely due to common global demand shock that induced hoarding, export controls, etc.
- Country trade share based concentration are *NOT a good proxy* for supplier concentration

Measuring margins of adjustment in firm-level responses to tariffs

- United States imposed a host of new import tariffs in 2018-2019:
  - Tariffs on majority of imports from China, as well as most steel/aluminum imports.
  - Significant tariff retaliation by trading partners.
- How did U.S. firms adjust their imports in response to these tariffs?
  - reduce imports in ongoing relationships?
  - drop existing suppliers?
  - exit import markets altogether?
  - find new sources within/across countries?

Count of U.S. new tariffs by country*product (2018-2019)



Source: Handley, Kamal and Monarch (2020)

Trade-war related literature

- **Tariff Effects on Prices:** Fajgelbaum, Goldberg, Kennedy, Khandelwal (2020); Amiti, Redding, Weinstein (2019, 2020), Carvalho, Gopinath, Neiman, Tang (2019), Flaaen, Hortaçsu, Tintelnot (2019).
- **Tariff Effects on Domestic Activity:** Waugh (2019), Flaaen and Pierce (2019), IMF (2019).
- **Effects on Exports:** Handley, Kamal, Monarch (2020), Benguria & Saffie (2019).
- **Effects on Uncertainty:** Caldara, Iacoviello, Molligo, Prestipino, Raffo (2019), Baker, Bloom, Davis (2019).

Gross trade creation margins

Total country-product import values are sum of continuing U.S. buyer b and supplier s relationships and new relationshps: $M_{cpt} = \sum_{b,s} M_{bscpt}$
Partition positive change in imports:

- $TC^{cont}_{cpt} = \sum_{bs \in cont} \max\{M_{bscpt} - M_{bscp,t-1}, 0\}$
  - trade value creation in continuing buyer(b)-supplier(s) relationships that are expanding
- $ADD_{cpt} = \sum_{bs \in ADD} M_{bspt}$
  - trade from the addition of new buyer-supplier relationships in country c by continuing buyers (b)
- $ENTRY_{cpt} = \sum_{bs \in ENTRY} M_{bspt}$
  - trade from the entry of new buyers from any relationship in country c

Gross trade destruction margins

Partition negative change in imports:

- $TD^{cont}_{cpt} = \sum_{bs \in cont} \min\{M_{bscpt} - M_{bscp,t-1}, 0\}$
  - trade value destroyed in continuing buyer(b)-supplier(s) relationships that are contracting
- $DROP_{cp,t-1} = \sum_{bs \in DROP} M_{bsp,t-1}$
  - trade lost from discontinuation of existing buyer-supplier relationships in country c by continuing buyers (b)
- $EXIT_{cp,t-1} = \sum_{bs \in EXIT} M_{bsp,t-1}$
  - trade lost from the exit of buyers from any relationship in country c

Margins of Trade Creation and Destruction

Total change in imports:

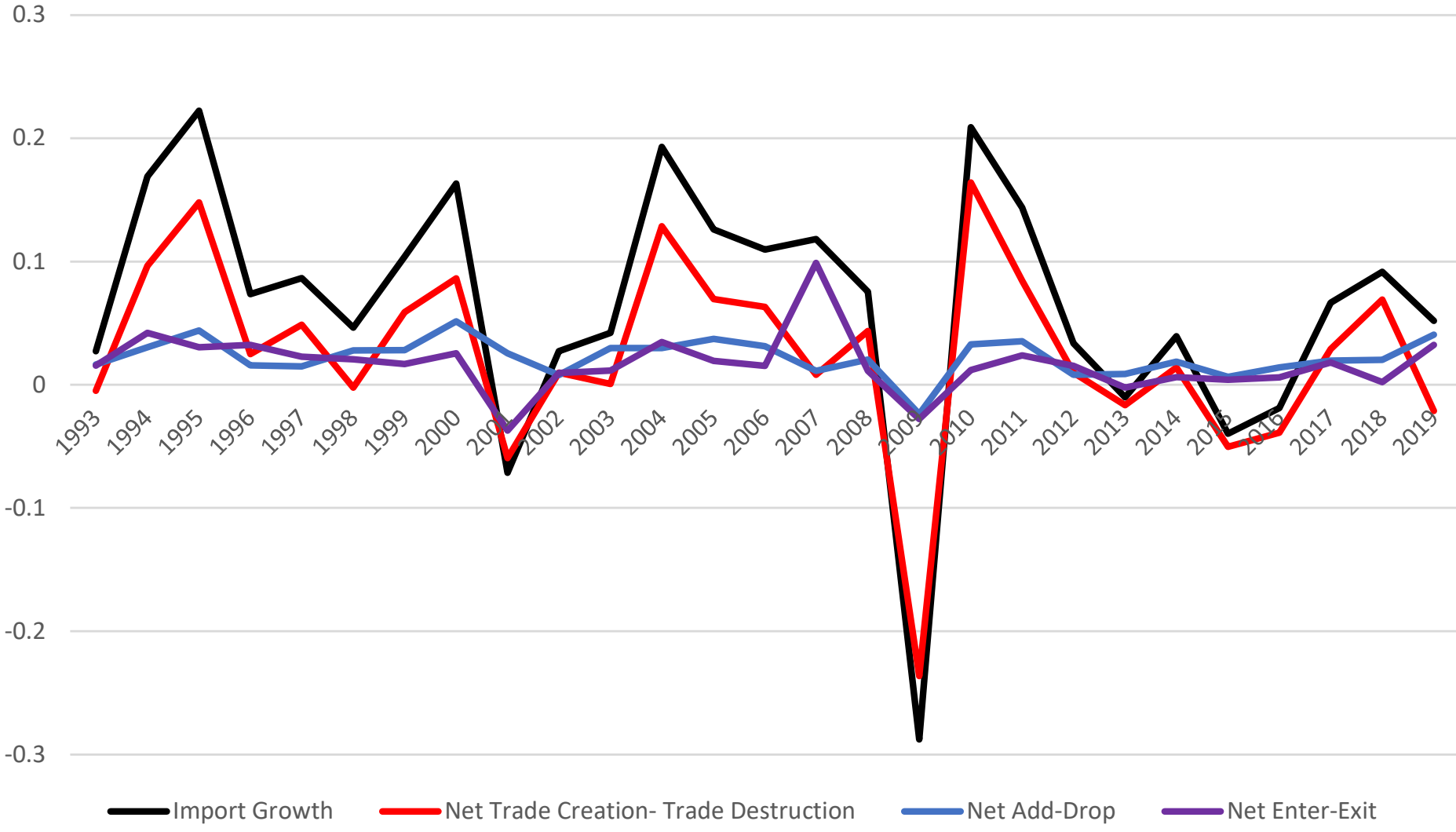
$$M_{cpt} - M_{cp,t-1} = \underbrace{TC^{cont}_{cpt} - TD^{cont}_{cpt}}_{\text{Intensive Margin}} + \underbrace{ADD_{cpt} - DROP_{cp,t-1} + ENTRY_{cpt} - EXIT_{cp,t-1}}_{\text{Extensive Margin}}$$

Total growth rate of imports

$$g_{cpt} = \frac{TC^{cont}_{cpt} - TD^{cont}_{cpt} + ADD_{cpt} - DROP_{cp,t-1} + ENTRY_{cpt} - EXIT_{cp,t-1}}{(M_{cpt} + M_{cp,t-1})/2}$$

- Permits decomposition into intensive and extensive components
- Symmetric and bounded between [-2,2]
- Equivalent to log changes up to 2nd order taylor series but accommodates zero flows

Annual import growth rate margins, 1993-2019



Note: Change in LFTTD matching algorithm in 2007 (Kamal & Ouyang, 2020).

Summary stats: growth rate margins, 1993-2019

Margin	Growth Contribution (mean)	Share
Intensive Margin (Net Trade Creation)	2.7	0.41
Extensive Margin	4	0.59
(a) Net Add-Drop	2.2	0.34
(b) Net Entry-Exit	1.7	0.26
Total Growth	6.6	1.0

Key point: Contribution of relationship churning to aggregate trade growth is very high

2018-2019 Trade war and supplier margins

$$g_{cpt} = \beta_1 I(\tau_{pc}) \times Post + \alpha_{ct} + \alpha_{pt} + \alpha_{cp} + \varepsilon_{cpt}$$

- Growth rates between 2013-2019 difference-in-diffs
  - 1st Diff: indicator $I(\tau_{pc} > 0) = 1$ for country-Products eventually hit by new trade war import tariff τ_{pc}
  - 2nd Diff: $Post = 1$ if $t > 2017$ trade war (2018-19) vs Pre (2013-2017)
- Controls for
  - country*time supplier shocks (α_{ct})
  - product-time global shocks (α_{pt})
  - country*product (α_{cp}) characteristics (distance, productivity, endowments).
- Cluster at country-hs6 level

Analyzing supplier margins

- These measures give the window we need to see how firms responded to the U.S. import tariff shock.
- Combining the effects of a shock on all 6 margins gives the total effect on import growth[1].
- We regress the 2018-2019 tariff shock on country-HS6 import growth rates (overall and by the six margins) for 2013-2019.

[1] Denominator of the growth rate is "average imports"

Tariffed Product Margins of Adjustment

	Total Growth	*Trade Creation*	*Trade Destruction*	*ADD*	*DROP*	*ENTRY*	*EXIT*
$I(\tau_{pc})\times$ *Post*	-0.17***	-0.02***	-0.05***	-0.01***	-0.02***	-0.02*	-0.04***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
F.E.				ct, pt, cp			
Obs.				956,000			

- Tariffed country-products tended to have a change in growth rates about 17pp lower than non-tariffed products.
- Driven by:
  - Shrinking but ongoing relationships had a 5pp more negative change in growth rates compared to non-tariffed products, and
  - Exiting importers had a 4pp more negative change in growth rates compared to non-tariffed products–higher share of total change than average '92-'19.

Response to tariff: heterogeneity by concentration

- How differently did concentrated products react to the tariffs relative to dispersed products?

$$g_{cpt} = \beta_1 I(\tau_{pc}) \times Post + \beta_2 I(\tau_{pc}) \times Post \times HHI_{p,t-1} + \alpha_{ct} + \alpha_{pt} + \alpha_{cp} + \varepsilon_{cpt}$$

- Do products with higher supplier concentration respond more or less to tariff shock?

Differential response across products supplier concentration

	Total Growth	*Trade Creation*	*Trade Destruction*	*ADD*	*DROP*	*ENTRY*	*EXIT*
$I(\tau_{pc})\times$ $Post$	-0.24***	-0.03***	-0.05***	-0.02***	-0.03***	-0.05***	-0.07***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$I(\tau_{pc})\times$ $Post\times$ $HHI_{p,t-1}$	0.50***	0.02	0.05**	0.05**	0.02	0.18***	0.20***
	(0.11)	(0.02)	(0.02)	(0.02)	(0.02)	(0.06)	(0.06)
F.E.				ct, pt, cp			
Obs.				956,000			

- For two products facing new trade war tariffs, more concentrated products had *smaller* decline in growth rates (1 SD of HHI $\approx$ 0.1).
- Stems from smaller negative changes in growth rates among entering and exiting importers.

What do we learn?

- Products facing new import tariffs (in 2018+) had much lower growth rates.
- Extensive margin adjustment is primary driver
  - more than half of negative effect is foregone new entry and new supplier additions AND dropping suppliers or exiting market
- However, in more concentrated products, the negative contribution to the change in growth from these channels is much weaker implying that for concentrated products:
  - much less trade lost from importers exiting or not entering foreign markets
  - harder to break in/get out of products with a higher HHI—fewer short-term alternatives

Concluding remarks

- Strategic product vulnerabilities
  - Imports of key technological products exhibit greater reliance on individual suppliers and/or countries
  - Less localized vulnerability for medical products
- Supplier margin adjustments to import tariff increases
  - In general, and during trade war, buyers supplier relationship churning are large contributors to import growth
    - ★ unknown so far–waiting out tariffs? inventory adjustment? added suppliers in other markets?
    - ★ To be continued with next round of data analysis/disclosures...
  - Disaggregated measures of supplier concentration matter
    - ★ Adjustment attenuated where supplier concentration is higher and affects extensive margin more
    - ★ suggests that alternative foreign/domestic suppliers not available
    - ★ supplier based concentration measures not correlated with country trade share measrues