

Supply Shocks in Supply Chains: Evidence from the early lockdown in China¹

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Motivation

- How do firms in global value chains react to input shortages?
 - 50% of aggregate trade is embodied in GVCs
 - Key channel for the international transmission of shocks
 - Limited quantitative evidence of the reaction of firms in GVCs to input shortages
- Question is particularly topical in the context of the Covid-19 crisis
 - Plenty of **Anecdotal evidence**
 - Question is in the **political agenda** in Europe and in the US

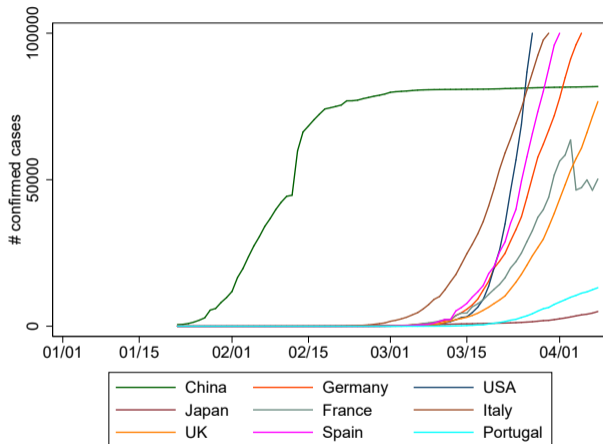
This paper

- Uses the **early lockdown in China** as a natural experiment of a shock to French firms' input purchases
- Estimates the **transmission of the shock** to downstream firms
- Studies the **heterogeneity** across “treated” firms depending on
 - The ex-ante diversification of their input purchases
 - The ex-ante level of their inventories
- What type of risk management strategies can help **weather input disruptions**?

Related literature

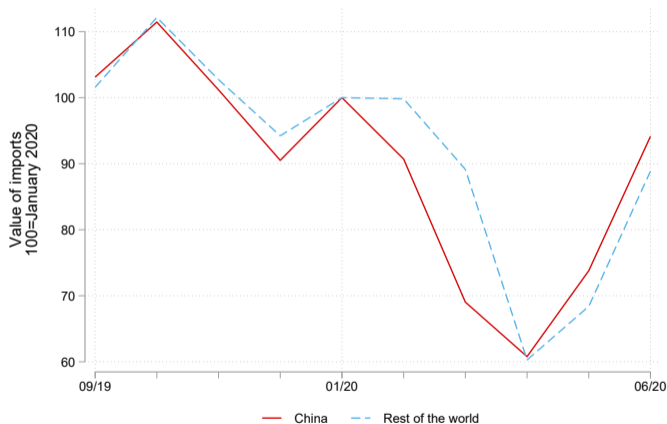
- Transmission of shocks in GVCs
 - Barrot and Sauvagnat (2016), Boehm et al. (2019), Carvalho et al. (2020)
- Trade in the Covid-19 pandemic
 - Bonadio et al. (2020), Heise (2020), Berthou and Stumpner (2021), Bricongne et al. (2021)
- Structure and resilience of GVCs
 - Antràs and Chor (2013), Antràs (2020), Grossman et al. (2021), Elliot et al. (2021), Freund et al. (2021)

Context



Source: Oxford COVID-19 Government Response Tracker. Number of confirmed Covid cases in a selection of countries. [More](#)

Context



Source: French customs. Value of imports, without Covid-related products. In 2019, China represents 9.3% of French imports.

Data & Sample

Data:

- Monthly imports and exports at the Firm \times Product \times Country-level, 2019-2020 (French Customs data)

Sample:

- “Firms in GVCs” before the shock, meaning:
 - Import intermediates *and* export
 - Between Sep. 2019 and Jan. 2020
- Treatment and Control groups:
 - **importing from China** before the shock (N=14,880)
 - **importing from elsewhere** before the shock (N=18,603)
 - Robustness on the treatment and on the control
 - Note: Importing from China = directly or indirectly through a third EU country

Summary Stat

Specification

- Difference-in-Differences

$$Y_{ft} = \beta \mathbb{1}_{\{Treated_f=1\}} \times \mathbb{1}_{\{t>01/2020\}} + \theta_f + \delta_t + \varepsilon_{ft} \quad (1)$$

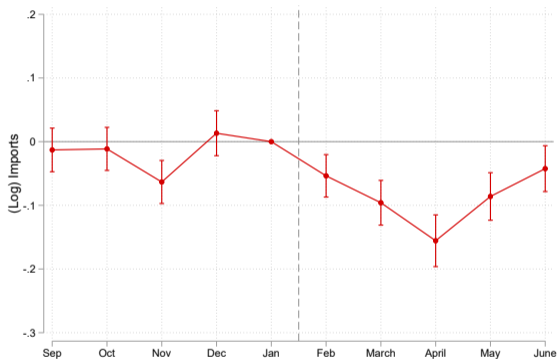
- Y_{ft} : outcome of firm f , period t
- θ_f, δ_t : firm and period fixed effects
- standard errors clustered at the firm-level

- *Implicit assumption*: absent the early Chinese lockdown, firm-level exports would have evolved the same way for treated and control
- Dynamic version:

$$Y_{ft} = \sum_{\substack{l=-4 \\ l \neq 0}}^5 \beta^l \mathbb{1}_{\{Treated_f=1\}} \times \mathbb{1}_{\{t=l\}} + \theta_f + \delta_t + \varepsilon_{ft} \quad (2)$$

Exposed firms imported less

Regression Table

DiD est.: -0.07^{***} 

FP-level

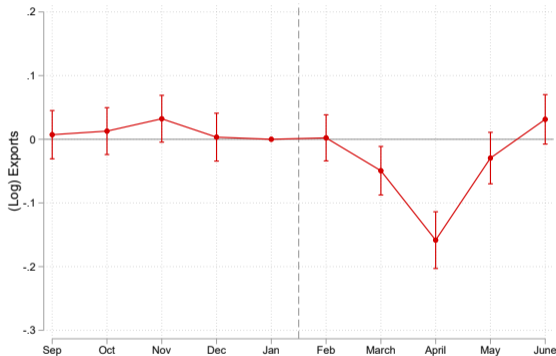
Sector heterogeneity

Heterogeneity due to freight delays

Impact materializes in February (resp. March) for firms relying on air (resp. sea) freight

Transmission to firm-level exports

Regression Table

DiD est.: -0.049^{***} 

Impact is almost entirely driven by the **within-firm extensive margin** (less products / destinations served). No evidence of a significant difference in **exit probabilities**

Robustness

- Definition of the treatment
 - Use a narrower treatment: monthly importers ●
 - Use a narrower treatment: importers from Hubei ●
 - Heterogeneity of the treatment ●
- Impact of seasonality
 - Placebo treatment one year before ●
- Impact of systematic differences in portfolios of destinations/products
 - Identification within a product \times country \times period ●
 - Identification within a sector \times period ●

Robustness (cont'ed)

- Alternative interpretation: Complex supply chains
 - Use a placebo based on exposure to US inputs
- Other differences between treated and control firms:
 - Exclude importers from EU15 only
 - Restrict control group to countries with Chinese-like CA
 - Use matching estimators

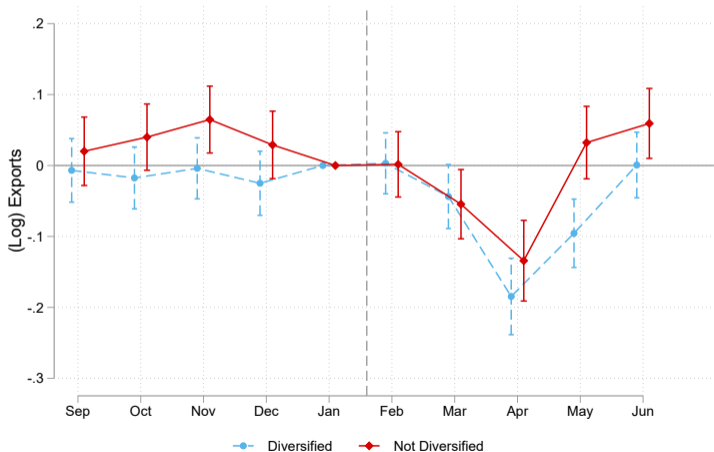


Diversification of supply chain: Measurement

- Does ex-ante diversification help weather supply chain disruptions?
- Difficulty is to measure diversification:
 - **Input** is “Non-diversified” if imported only from China
 - **Firm** is “Non-diversified” if one of its main inputs is “Non-diversified”
 - Main inputs: account for $\geq 1\%$ (5%, 10%) of total imports of inputs
- 40% of treated firms are “diversified”

Ex-ante diversification did not help

DiD est. diff: $-.002(0.016)$



Ex-ante diversification does not help?

1. Mismeasurement

- Assumption is that having purchased the same product from two sources is correlated with potential substitution possibilities
- No clear increase in imports from rest of the world, conditional on being diversified
- Narrow the definition to diversified purchases on homogenous / non-sticky products

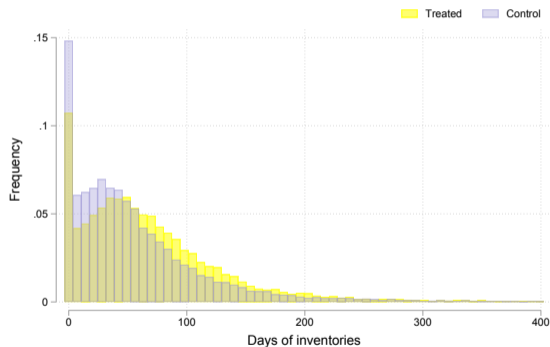
2. Selection into diversification

- Firms that diversify ex-ante may be the ones that are the less likely to be able diversify ex-post
- No formal test but some empirical support

Stockpiling: Measurement

- Is just-in-time production a source of enhanced fragility?
- Balance-sheet information on end-of-year stock of inventories (raw materials + merchandises) (FARE, 2018 data)
- Our measure: “Days of production in inventories”

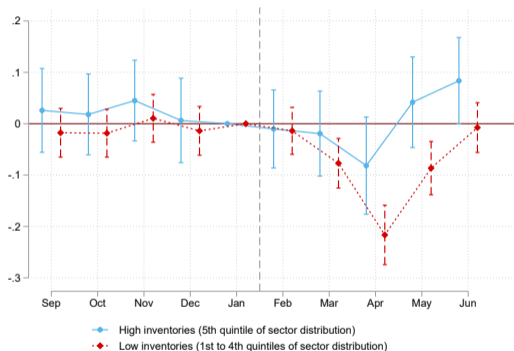
$$IR = \frac{Stocks_M + Stocks_P}{Turnover} \times 365$$



→ High-inventory firm: $IR \in$ fifth quintile of its sector-specific distribution

Stockpiling absorbs supply shocks

DiD est. of diff.: +0.053**



Note that we do not observe any difference in adjustments on the import side, as is expected

Conclusion

1. Evidence of input shortages **pass-through** to the rest of the supply chain
→ Role of (temporary?) extensive margin adjustments
2. Novel evidence on heterogeneity with potentially important policy implications:
 - **Diversification** strategies may be unequally possible / efficient across products
 - **Stockpiling** can be useful for short-lived shocks (by far the most likely) although inventories are now at a **historical low level**
3. Avenue for future research
 - What are the **long-term** impacts of supply-chain disruptions? (c. Freund et al., 2021)
 - **Where** to target interventions in the supply-chain (and who should bear the cost)?

Thank you for your attention!

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Winter storms and crammed ports in the U.S. add to disruptions of production and supplies during the pandemic

20/09/2021

Global bicycle production hit by supply chain delays | Financial Times

Supply chains

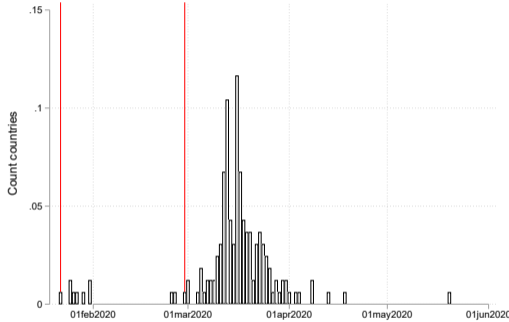
Global bicycle production hit by supply chain delays

Manufacturers heavily reliant for parts on Japan's Shimano struggle to meet demand

Resilience in the political agenda

- Executive Order on America's Supply Chains, 02/24/2021: *"The United States needs resilient, diverse, and secure supply chains to ensure our economic prosperity and national security. Pandemics and other biological threats, cyber-attacks, climate shocks and extreme weather events, terrorist attacks, geopolitical and economic competition, and other conditions can reduce critical manufacturing capacity and the availability and integrity of critical goods, products, and services. Resilient American supply chains will revitalize and rebuild domestic manufacturing capacity, maintain America's competitive edge in research and development, and create well-paying jobs."*
- France Relance: *"The France of 2030 will have to be more independent, more competitive, more attractive. It is about no longer depending on others for essential goods, no longer risking critical supply disruptions."* (600 million euros for "securing critical supplies")

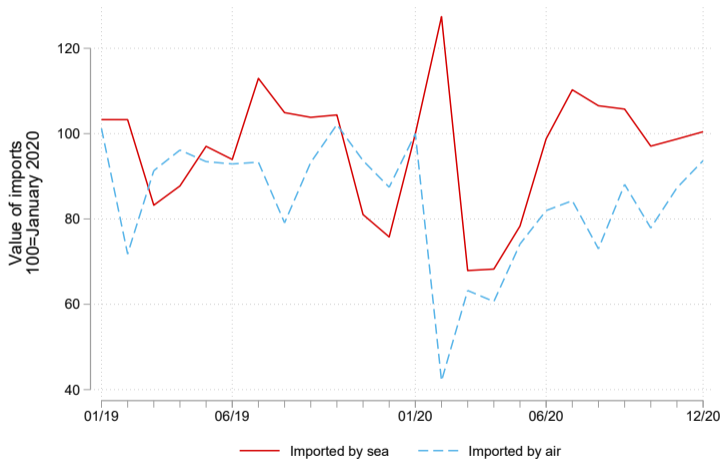
Context: Chinese lockdown



Source: Oxford COVID-19 Government Response Tracker (OxCGRT)

Imports from China fall quickly by air transport

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Source: French customs, import files.

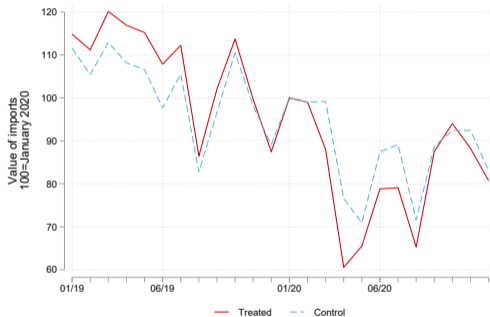
Summary Statistics on the Estimation Sample

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	Nb. of firms	Avg. Imports Exports (M€)		% of aggregate Imports Exports	
All firms	33,483	6.87	13.3	89.5	91.6
Importers from					
China	14,880	10.4	21.7	61.0	66.1
Elsewhere	18,603	3.9	6.7	28.6	25.4
Monthly importers from					
China	4,495	20.3	41.8	36.0	38.6
Elsewhere	10,387	6.7	9.8	27.3	20.9

Source: French customs, import and export files. The summary statistics are computed on firms both importing and exporting between September 2019 and January 2020. Statistics on imports are about intermediate goods.

Evolution of imports: Treated versus control



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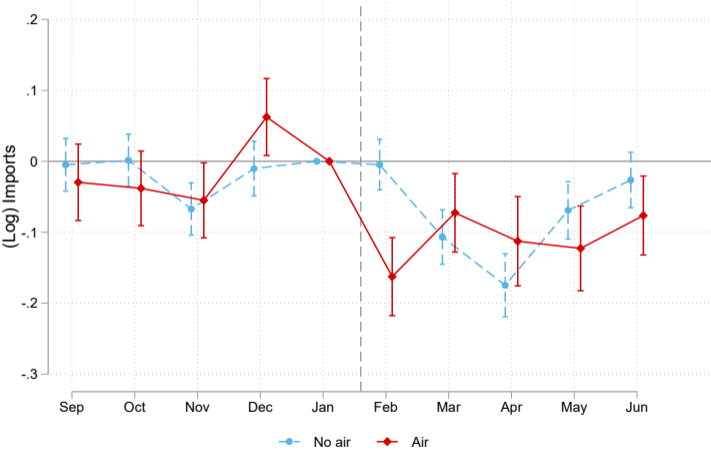
Baseline results on imports

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	Dep. Var: log of imports						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Treated firm	0.286 ^a (0.028)						
Treatment × Post	0.001 (0.013)	-0.070 ^a (0.010)	-0.120 ^a (0.012)	-0.073 ^a (0.010)	-0.075 ^a (0.006)	-0.058 ^a (0.011)	-0.101 ^a (0.014)
Treatment × Post × Air						-0.038 ^b (0.016)	-0.067 ^a (0.022)
Firm FE	N	Y	Y	Y	× Product	Y	Y
Time FE	Y	Y	Y	Y	× Product	Y	Y
# Treated	13,994	13,994	4,495	13,054	11,126	13,994	4,495
# Control	16,543	16,543	10,387	15,202	24,850	16,543	10,387
# Interacted						4,719	1,249
Sample	All	All	All	$\frac{X}{X+M} \geq .1$	All	All	All
Treatment	T1	T1	T2	T1	T1	T1	T2
R ²	0.004	0.861	0.861	0.860	0.869	0.861	0.861
# Obs.	244,896	244,896	144,701	224,010	2,217,183	244,896	144,701

Note: Sample is restricted to exporting firms. "T1" means that control group are firms that import inputs from abroad outside of China whereas treated firms are those exposed to Chinese inputs in the five months before the pandemic. "T2" means that control group is firms that import inputs monthly from a specific country which is not China and treated that import every month from

Heterogeneity in the timing of the transmission



Baseline results on exports

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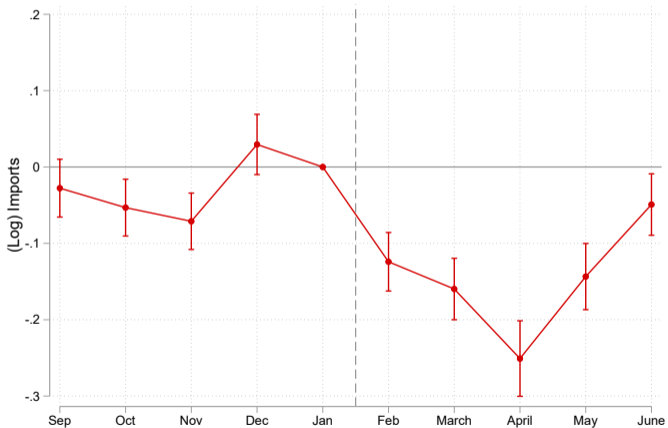
	Dep. Var: log of exports						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Treatment × Post	-0.048 ^a (0.011)	-0.063 ^a (0.015)	-0.049 ^a (0.011)	-0.059 ^a (0.018)	-0.034 ^a (0.005)	-0.035 ^a (0.012)	-0.058 ^a (0.017)
Treatment × Post × Air						-0.041 ^b (0.017)	-0.016 (0.027)
Firm FE	Y	Y	Y	Y	× Product	Y	Y
Time FE	Y	Y	Y	Y	N	Y	Y
Product×Destination×Period	N	N	N	N	Y	N	N
# Treated	13,731	4,322	13,074	7,383	12,025	13,731	4,322
# Control	16,646	9,672	15,820	6,994	14,320	16,646	9,672
# Interacted						4,693	1,215
Sample	All	All	$\frac{X}{X+M} \geq .1$	Final goods	All	All	All
Treatment	T1	T2	T1	T1	T1	T1	T2
R ²	0.857	0.875	0.853	0.865	0.736	0.857	0.875
# Obs.	234,482	116,087	227,901	100,347	6,794,403	234,482	116,087

Note: The table reports estimation results of the difference-in-differences estimation using the log of exports as left-hand side variable. “T1” means that the control group is composed of firms that import inputs from abroad outside of China whereas treated firms are those exposed to Chinese inputs in the five months before the pandemic. “T2” focuses on firms that import inputs monthly from a specific country, China for treated firms and another country for control firms. The date of the treatment is February 2020 and the DiD thus compares the evolution of imports between September 2019 and January 2020 (pre-treatment period) and between February 2020 and June 2020 (post-treatment period). Columns (5) and (8) run estimations at the Firm×Product×Destination×Period level and standard errors are clustered at the Firm×Product level. In Column (6), the “Air” dummy is equal to one if more than 25% of its inputs from China are sent by air. In Column (7), the dummy equals one if the firm receives products by air every month between September 2019 and January 2020. Standard errors are clustered at the firm-level (firm×product in Columns (5) and (8)). ^a, ^b and ^c denote significance at the 1, 5 and 10% level respectively.

Treatment based on monthly importers

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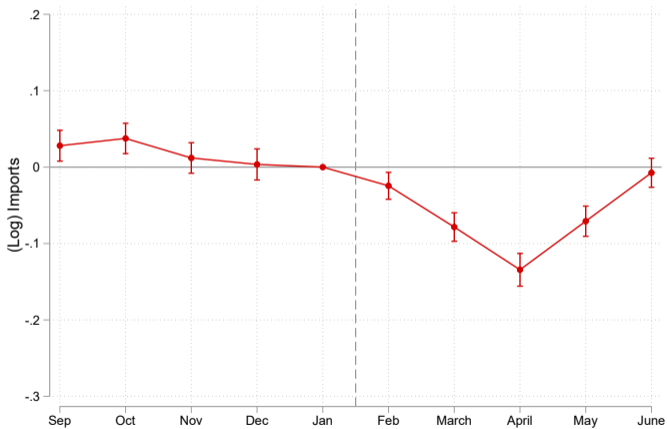
DiD coeff.: $-.120^{***}$



Within a product

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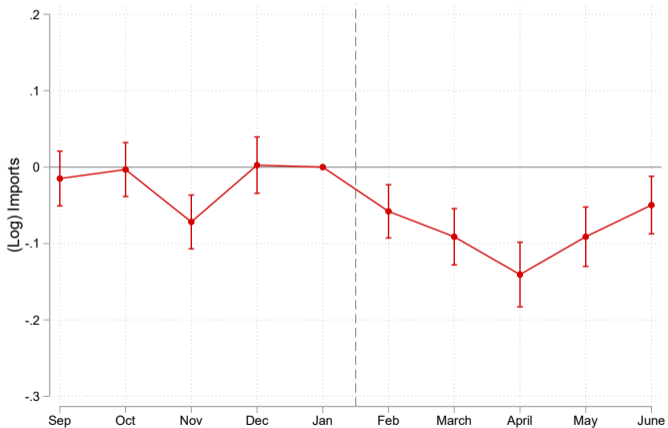
DiD coeff.: $-.075^{***}$



Controlling for sector-specific variations

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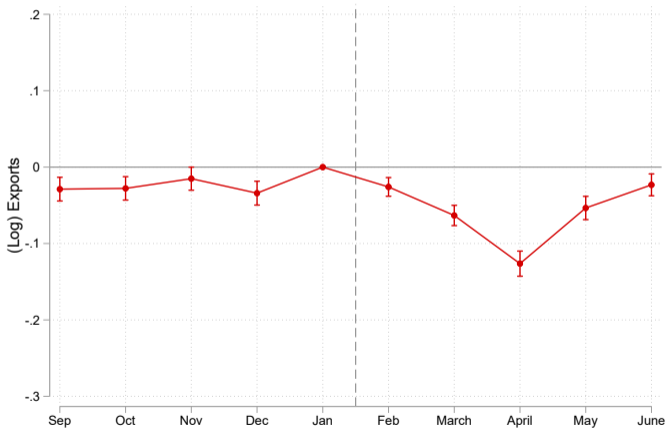
DiD coeff.: $-.085^{***}$



Accounting for country- and product-specific demand shocks

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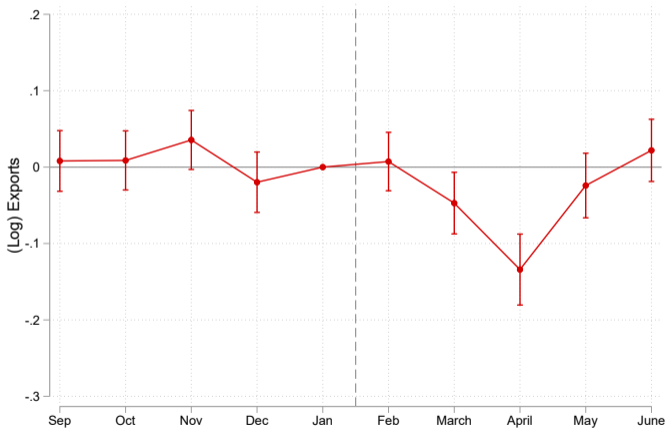
DiD coeff.: $-.035^{***}$



Accounting for sector-specific variation

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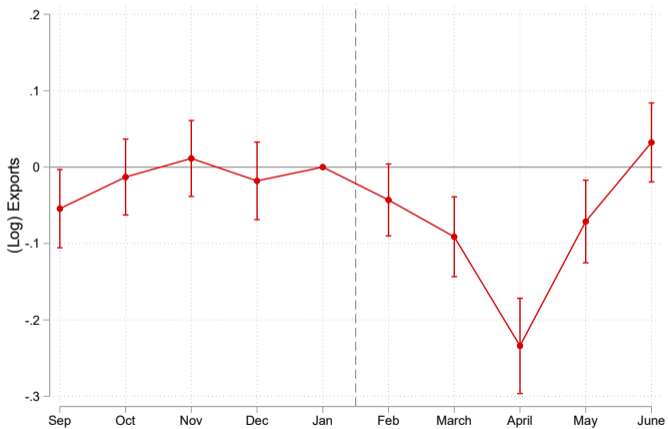
DiD coeff.: $-.075^{***}$



Monthly importers

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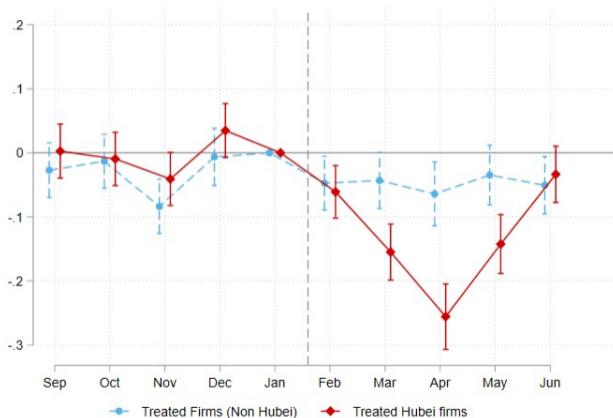
DiD coeff.: $-.063^{***}$



Exposure to Hubei-products

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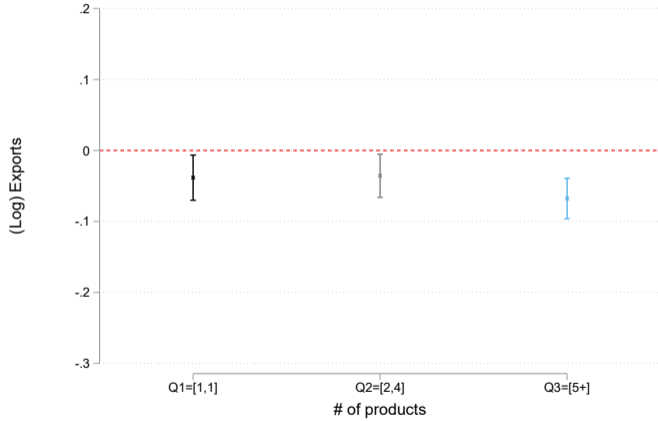
DiD est. of diff.: $-.103^{***}$



Notes: Treated group is now split into two sub-samples. The “Hubei” group is composed of firms that are exposed to Chinese inputs which the Hubei region is specialized into. Hubei’s specialization patterns are measured using data on Chinese exports to France, by region, in 2014. A product is considered a comparative advantage of Hubei if its share in Hubei’s exports is larger than its share in Chinese’s exports (Balassa ratio > than 1).

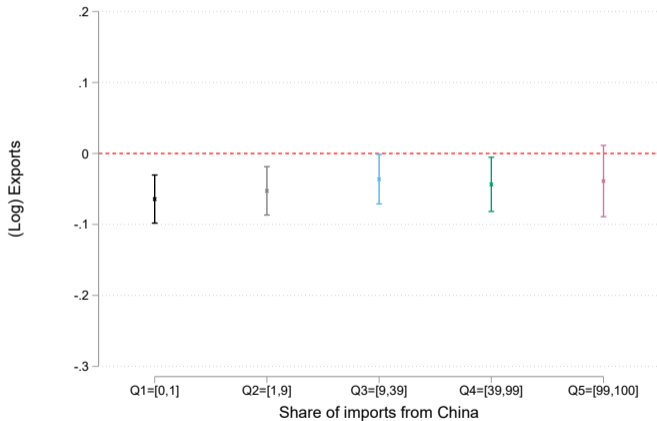
Heterogeneous exposure (# of products)

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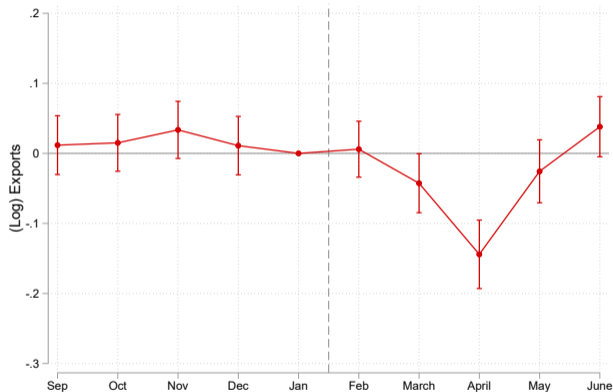
Heterogeneous exposure (import share)

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Excluding firms importing solely from EU15

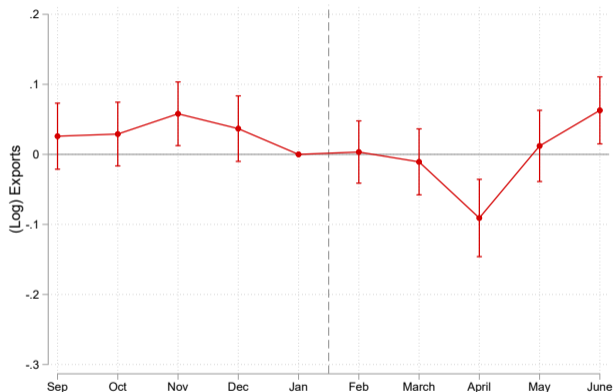
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Notes: Treatment is unchanged. Control group excludes the 4,889 firms that solely imports from the EU15: 13,097 remain

Control firms are importing from countries similar to China

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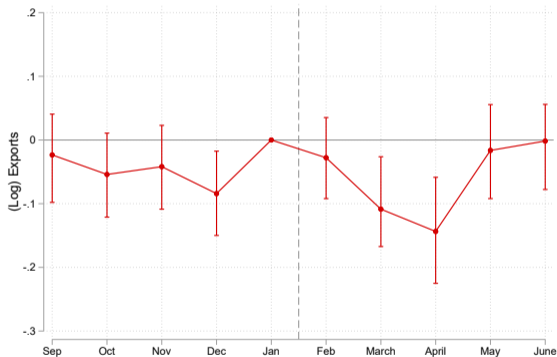


Notes: Treatment is unchanged. Control group is restricted to the 7,276 firms importing from other emerging countries.

Matching estimator

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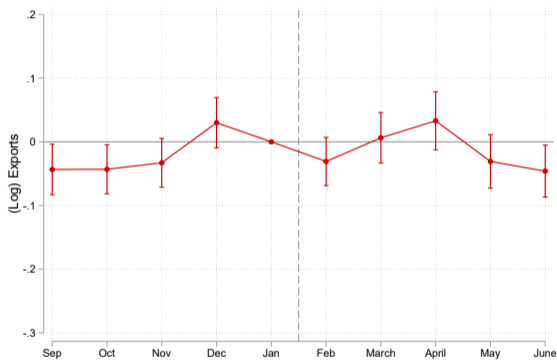
DiD est. of diff.: $-.030^{***}$



Notes: Treatment effect estimation based on propensity score matching.

Placebo based on exposure to US inputs

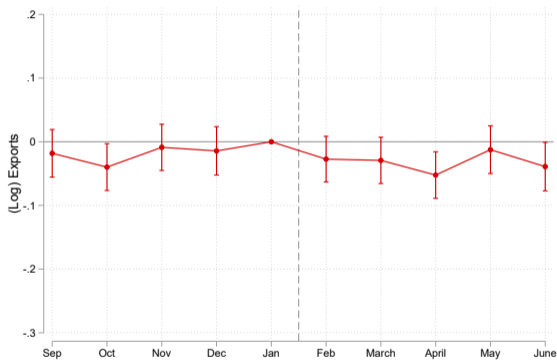
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Notes: Treatment is based on imports from the US between September 2019 and January 2020. There are 10,377 treated and 23,106 control firms.

Same strategy, 12 months earlier

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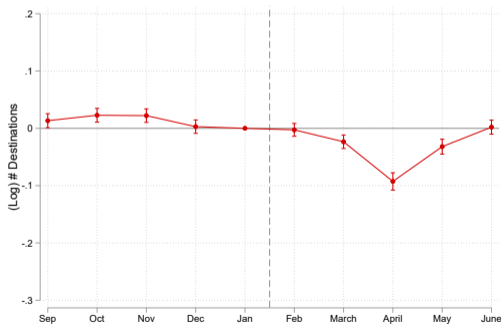


Notes: Treatment, control status, and firm-level exports are based on 2018-2019 data.

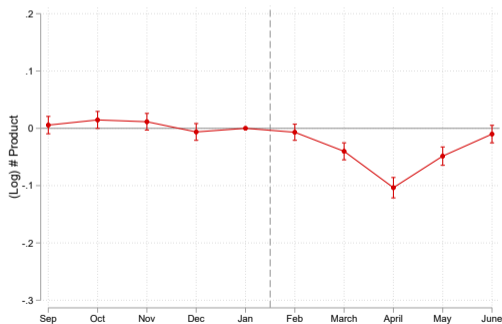
Within-firm adjustments along the extensive margin

$$X_{ft} = N_{ft} \times \bar{X}_{ft} \quad (3)$$

N_{ft} =# Destinations: DiD est.: -0.04^{***}

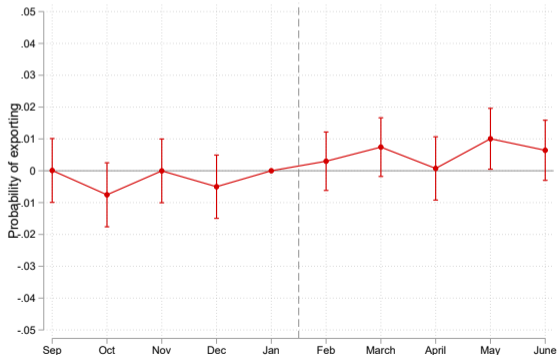


N_{ft} =# Products: DiD est.: -0.04^{***}



Adjustments along the extensive margin: Exit probability

$$\mathbb{1}_{ft} = \sum_{l=-4}^5 \beta^l \text{Treated}_f \times \text{Time}_{lt} + FE_f + FE_t + \varepsilon_{ft}$$



Diversification, Stickiness, Differentiation

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	Dep. Var: log of exports					
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment \times Post	-0.047 ^a (0.014)	-0.057 ^a (0.020)	-0.053 ^a (0.011)	-0.068 ^a (0.015)	-0.042 ^a (0.012)	-0.055 ^a (0.017)
$-\times-\times$ Div	-0.003 (0.016)	-0.013 (0.025)	0.091 ^a (0.034)	0.133 ^b (0.067)	-0.018 (0.016)	-0.026 (0.026)
Firm FE	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y
# Treated	13,731	4,322	13,731	4,322	13,731	4,322
# Control	16,646	9,672	16,646	9,672	16,646	9,672
# Interacted	5,799	1,937	591	146	4,240	1,199
Treatment	T1	T2	T1	T2	T1	T2
R ²	0.857	0.875	0.857	0.875	0.857	0.875
# Obs.	234,482	116,087	234,482	116,087	234,482	116,087

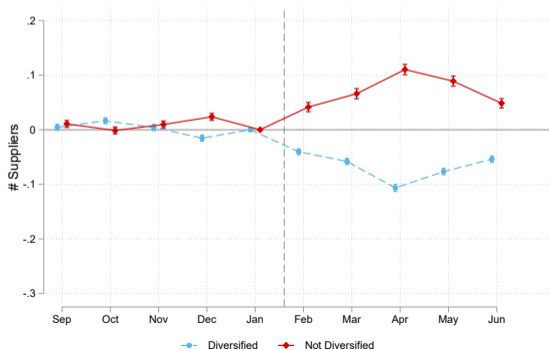
Note: Here the treated firms are split into a group of “diversified” and a group of “non-diversified” firms. In columns (1) and (2), diversified firms are those that import all of their main inputs from at least two countries during the pre-treatment period. In columns (3) and (4), we focus on inputs classified as “non-differentiated” by [Rauch \(1999\)](#) and call a firm “diversified” if all of its main inputs sourced from China are non-differentiated and sourced from at least two countries in the pre-treatment period. In columns (5)-(6), we perform a similar exercise but focus on inputs that are less sticky according to [Martin et al. \(2020\)](#). We call a firm “diversified” if all of its main inputs sourced from China are non-sticky and sourced from at least two countries in the pre-treatment period. Standard errors are clustered at the firm-level. ^a, ^b and ^c denote significance at the 1, 5 and 10% level respectively.

Non-Diversified diversifying ex-post

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Poisson regression:

$$NbSuppliers_{fpt} = \sum_{\substack{l=-4 \\ l \neq 0}}^5 \beta^l \mathbb{1}_{\{Treated_{fp}=1\}} \times \mathbb{1}_{\{t=l\}} + \theta_{fp} + \delta_{pt} + \varepsilon_{fpt} \quad (4)$$

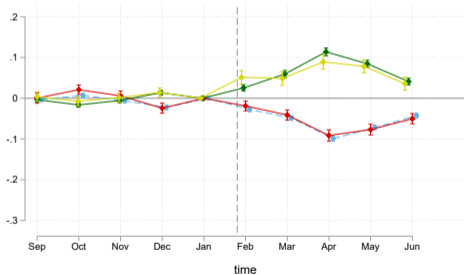


Non-Diversified diversifying ex-post

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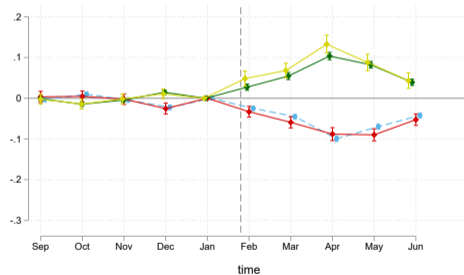
Heterogeneity based on

Differentiation



—○— Diversified Diff —△— Diversified not Diff
—◇— Not Diversified Diff —□— Not Diversified not Diff

Stickiness



—○— Diversified Diff —△— Diversified not Diff
—◇— Not Diversified Diff —□— Not Diversified not Diff

The level of inventories is now extremely low

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Source: Solde d'opinion sur le niveau des stocks, Enquete mensuelle de conjoncture, Industrie Manufacturiere, INSEE

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