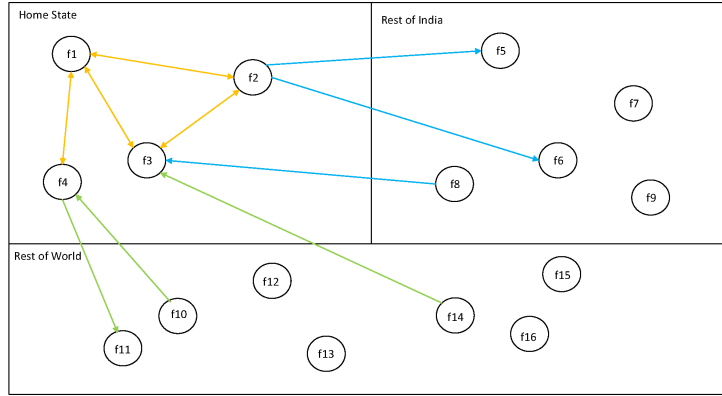


Appendix for online publication only

A Details on the Firm-to-Firm Data

We illustrate a stylized example of our establishment-level networks data in Figure A1. As the diagram shows, we observe all transactions where one node of the transaction is within the state. This includes all transactions between establishments within the state (the yellow lines), any inflows from or outflows to the rest of the country (the blue lines), and all international imports and exports (the green lines).

Figure A1: Stylized Example of Establishment-Level Network



Note. Stylized example of establishment-level data. The upper half represents the country, and the upper left quadrant represents the state in question. The data includes all transactions within the state, and all transactions where one node of the transaction (either buyer or seller) is in the state.

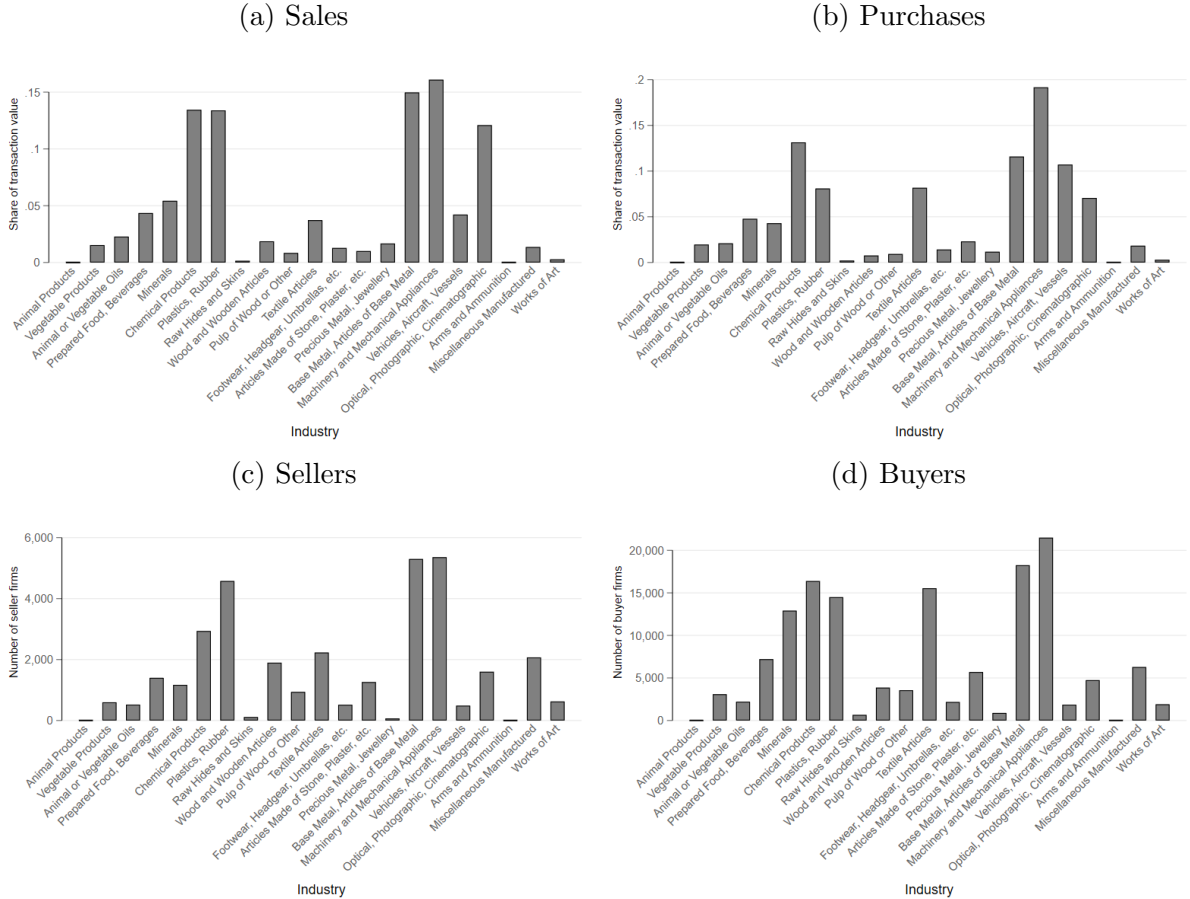
The data report value and quantity of traded items, so we can construct unit values. To do this, we aggregate values and quantities at the four-digit HSN/month/transaction level, and then construct implied unit values. We can then collapse the data at the 4-digit HSN/month level to construct average unit values, the number of transactions between each seller and buyer pair, and total value of the goods transacted. This is the foundation of the firm-to-firm dataset we use in the analysis. Additionally, we can aggregate these data to the buyer level, which we use in our reduced-form section. Table A1 summarizes our primary variables of interest using this dataset.

Table A1: Summary Statistics for Main Variables

Outcome	Mean	p25	p50	p75
Separation Rate (%)	30.9	0.00	16.67	52.63
Entry Rate (%)	74.10	5.13	50.00	107.69
Net Separations (%)	-43.21	-71.43	0.00	0.00
Real Input Purchases (log)	14.91	12.48	14.55	16.95
Real Sales (log)	17.78	15.48	17.66	19.85
Avg. Supplier Size (millions of rupees)	106.55	9.60	34.01	127.89
Avg. Supplier Outdegree	43.00	3.30	10.99	31.96
Share Purch. Lgst. Supplier (%)	52.34	31.04	47.79	71.77
Number Products	12.01	3.00	7.00	14.00
Share Purch. Diff. Prod. (%)	60.08	21.03	72.57	97.78
Supply Chain Depth	32.31	28.14	31.45	36.35
Number Suppliers	12.34	3.00	7.00	14.00
Avg. Distance (km)	436.13	75.99	189.84	541.23
Share Purch. Non-Home State (%)	38.45	0.00	24.19	78.40
Avg. Transactions	29.58	3.50	6.50	15.49
Spatial Concentration	0.38	0.31	0.36	0.44
Downstreamness	0.49	0.39	0.44	0.62
N Suppliers per Firm-Product	3.89	1.00	2.00	4.00
Stickiness	2.83	2.80	3.03	3.17

Note. We calculate summary statistics for key outcomes listed in the first column (as described in Section 3.1), firm characteristics (as described in Section 4), and measures of supplier composition (as described in Section 5). Summary statistics calculated in December 2019-February 2020.

Figure A2: Share of sales/purchases, by product codes



Note. For the left panel we plot the share of total sales of firms located in our large Indian state by 1-digit product code. In the right panel we plot the share of total purchases of firms located in our large Indian state by 1-digit product code. The bottom panels plot the number of sellers and buyers for each 1-digit product code. The time period for this data is the full 2019 year. The time period for this data is the full 2019 year.

B Validating Lockdown Measures

In Table A2, we summarize the differences in Covid-19-related outcomes across the various lockdown zones. We validate our measures of lockdown intensity using Google Mobility data, and satellite nighttime luminosity data in Figure A3.

Table A2: Summary Statistics by District Lockdown Degree

Zone	Avg. Cases/Million	Avg. Deaths/Million	Avg. Population	Total Cases	Total Deaths	Total Population
Green	26.316	0.1865	1,135,294	7,533	50	287,229,399
Orange	69.841	0.9236	1,990,250	24,713	364	469,698,944
Red	369.80	10.901	3,196,090	143,828	4,796	354,766,033

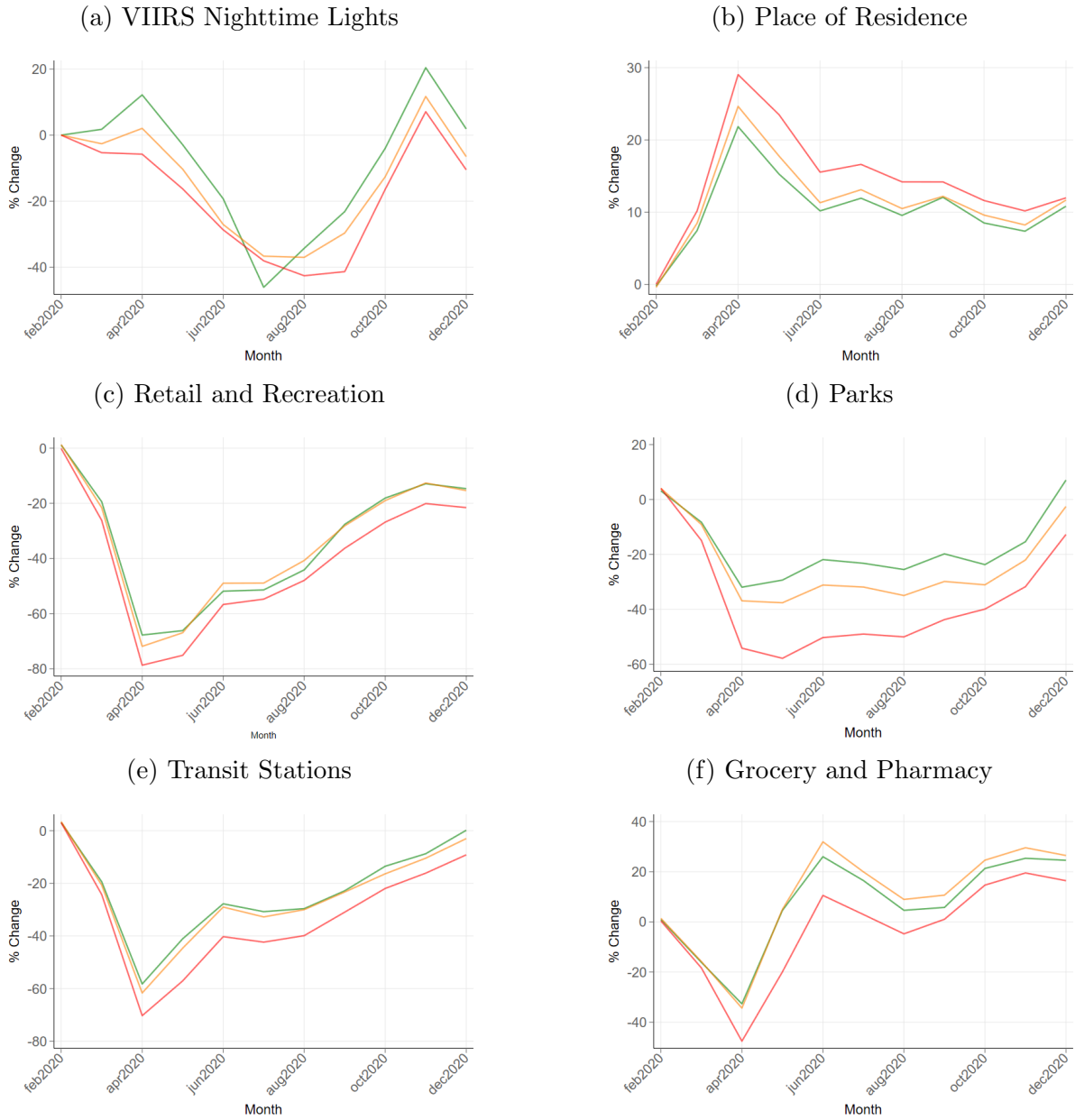
Note. Summary statistics calculated in March-May 2020 by lockdown zone. District-level Covid-19 cases and deaths are collated from official sources by the Development Data Lab <https://www.devdata.org/covid>. Averages/totals taken across districts with the same lockdown risk.

The mobility data show how the number of visitors to (or the time spent in) categorized places change compared to baseline days. The baseline day is the median value from the period Jan 3 to Feb 6, 2020. As is clear from Figure A3b, we see that people in red zones spent more time at home compared to people in either orange or green zones. They also spent less time at retail and recreation establishments, parks, transit stations, grocery stores and pharmacies as shown in Figures A3c to A3e. Such differences also exist between orange and green zones. By December 2020, these differences become smaller.

In Figure A3a, we follow past research in using nighttime lights from the VIIRS system, as a proxy for economic activity (Elvidge et al., 2013; Henderson et al., 2012). More recently, this has been used in India (Chodorow-Reich et al., 2019), where high-frequency, high-spatial resolution economic data is rare. These data have been shown to correlate well with measures of economic activity. The panel shows that the fall in nighttime lights was more pronounced in red zones, than in orange or green zones. Together, these measures validate our use of the geographically varying lockdown zones.

While almost all districts' lockdown zones remained constant in the three months from March 2020, on April 30 2020 one district was reclassified from red to green. We rely on initial lockdown zones as our shock measures throughout.

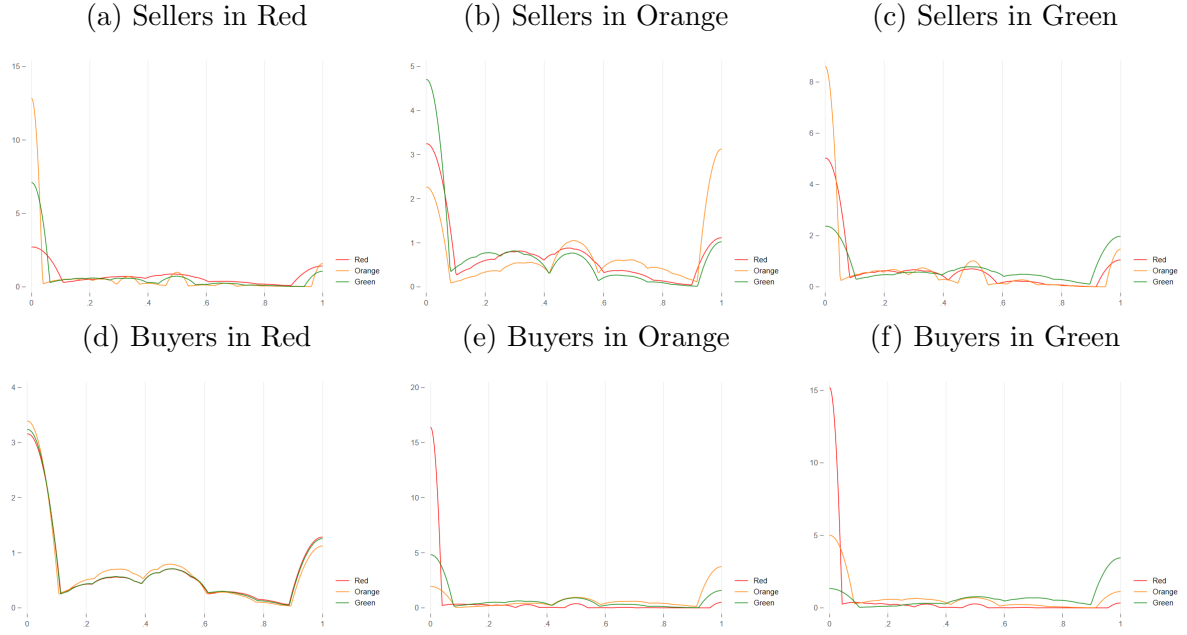
Figure A3: Alternative Lockdown Measures



Note. We validate our lockdown measures using the VIIRS Satellite Nighttime lights data in panel (a) and Google Mobility data in panels (b)-(f). Google mobility data shows how the number of visitors to (or the time spent in) categorized places change compared to the period Jan 3 – Feb 6, 2020. Source:

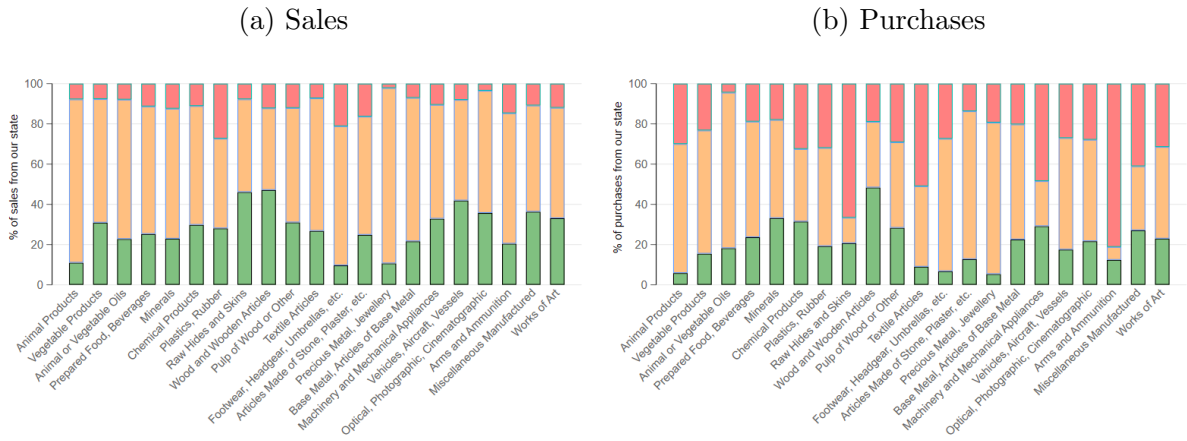
https://support.google.com/covid19-mobility/answer/9824897?hl=en&ref_topic=9822927

Figure A4: Distribution of links and sales across lockdown zones



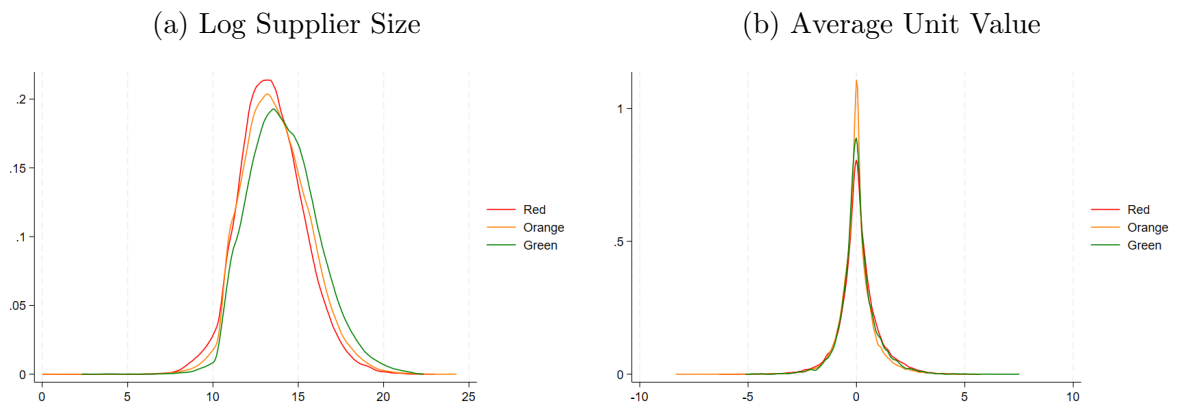
Note. In the three upper figures, each panel plots the distribution of the share of buyers located in *Red*, *Orange*, or *Green* districts. Each figure corresponds to sellers located in their corresponding color district. In the bottom three figures, each figure plots the distribution of the share of sellers located in *Red*, *Orange*, or *Green* districts. Each figure corresponds to buyers located in their corresponding color district. The time period is April 2018 - February 2020.

Figure A5: Share of sales/purchases, by product codes and zone



Note. On the left panel, for each 1 digit product code (HS section, horizontal axis), we plot the share of total sales of firms located in our large Indian state by the color of selling districts. In the right panel, for each HS section (horizontal axis), we plot the share of total purchases of firms located in our large Indian state by the color of buying districts. The time period for this data is the full 2019 year.

Figure A6: Log Supplier Size and Average Unit Value distributions by zone

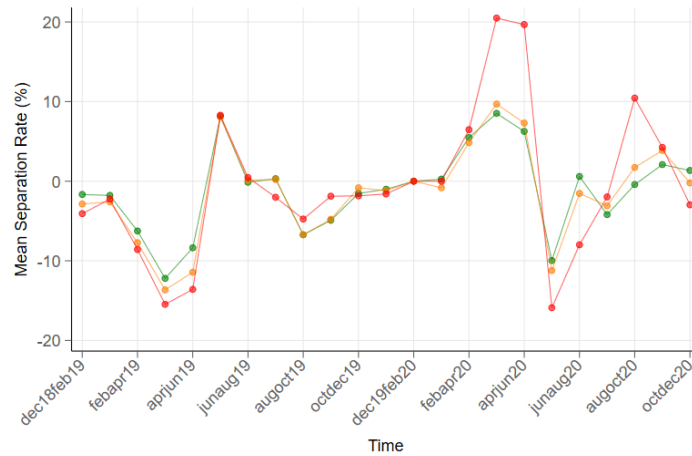


Note. The left panel plots the distributions of supplier size by the color of their district. The right panel plots the average unit value by the color of their district. The time period for this data is the full 2019 year.

To corroborate lockdowns indeed caused supply-chain disruptions, in Figure A7, we plot the mean separation rate over time. For each firm, we compute the separation rates using rolling 3-month periods and calculate a different separation rate for suppliers located in red, orange, and green lockdown zones. We also limit the sample of buyers to firms who are in our state with medium-lockdown districts to avoid differences in firm own-lockdown severity. To control for seasonality in separation rates, we first residualize the separation rates using month-zone fixed effects. We then take the mean of such residuals for each period and normalize to zero the period of December 2019 to February 2020. Hence, the separation rates should be interpreted as relative to this period.

The patterns shown in Figure A7 are striking. The separation rates for suppliers across the three lockdown-severity zones track each other closely until March 2020, when separations from suppliers in red zones more than double the separations from suppliers in green zones. After April 2020, the separation rates for red zones decreases relative to green/orange zones to later increase again towards the end of 2020. We should note that some amount of the separation rates rebounding is mechanical, as it depends on the number of suppliers in the previous period. In subsequent figures we show balance in the characteristics of the network, industry composition, firm size, and prices.

Figure A7: Mean separation rate by supplier location (relative to Dec 2019 - Feb 2020).



Note. We plot the mean separation rate across the firms in our sample, separating their suppliers by their district's lockdown stringency. We restrict the sample of buyers to firms in our state who are located in districts with medium-stringency. Separation rates are defined using three-month periods and computed for every month, such that the plotted rates capture the rolling average across time. To adjust for seasonality, we regress the firm-level separation rates on month-zone dummies and take the residual. Then, we calculate the average residual separation rate across firms in each period relative to the average in December 2019-February 2020.

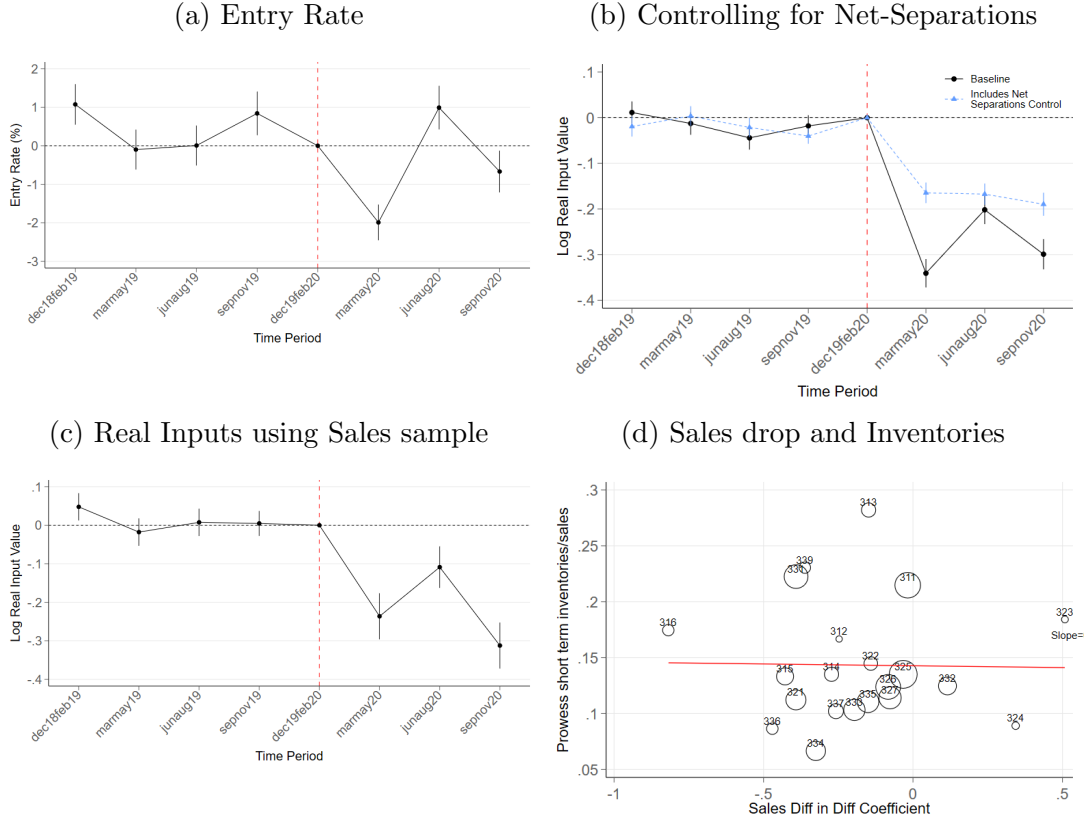
C Alternative Specifications and Robustness

We complement the baseline analysis by running regression 4 with the entry rate as the outcome. As shown in Figure A8a, the overall entry rate of suppliers for firms with one standard deviation above the mean risk was 2pp lower than for firms with average supplier exposure, a 2.7% decrease with respect to baseline. However, the decrease in the entry rate in the post period is not statistically different from zero. To put the separation and entry numbers into context, if we compare a firm with suppliers located in strict-lockdown (red) areas with a firm with suppliers in mild-lockdown (green) areas, the more exposed firm experienced a separation rate 15.4pp higher than the less exposed firm (or a 50% higher separation rate). For the entry rate, the more exposed firm experienced a rate 8.3pp (or 11%) lower than the less exposed firm. To further study the role of the extensive margin, we run our baseline specification with the log real input purchases as the dependent variable, but add the net separations experienced by the firm as a control. Such analysis quantifies the residual response in input purchases after we account for the extensive margin response experienced by the firm. As shown in Figure A8b, the drop in real input purchases for firms with high supplier exposure gets slashed by half once we control for net separations, going from a drop of 34% to a drop of 16%. This finding suggests that the extensive margin is an important channel to measure supply-chain disruptions.

We run two additional checks related to our real sales results. First, in Figure A8c, we run our real input event study for the same sample used for real sales, where we restrict to firms that are observed selling something every period prior to the shock. Real inputs drop in a similar magnitude than the full baseline sample. Second, we investigate whether the milder response in terms of real sales is driven by firms using inventories to mitigate the shock. To do so, we merge our transaction data with the corporate dataset Prowess, which provides for a subgroup of Indian firms, information on sales, short-term inventories and other financial at the firm level. Overall, 1,830 parent firms are matched from Prowess to our transaction dataset. We proceed to run our real sales regression separately by industry in a difference in difference regression, and correlate the drop in sales after the shock with the average short term inventories to sales ratio in the industry. As shown in Figure A8d there is no relationship between the inventory to sales ratio and the post-shock drop in sales. This is suggestive that firms are not using inventories to meet demand, and consistent with the low inventory ratios for this sample of firms in 2019 discussed in [Castro-Vincenzi et al. \(2024\)](#).

In Figure A9, we evaluate if there is a differential separation rate for suppliers of higher importance in a firm's purchases. To do so we compute the separation and net-separation rates by weighting each supplier link by the total input sales of each supplier to firm j . As shown in Figures A9a and A9b, the separation and net-separation rates are slightly higher

Figure A8: Baseline Event Studies



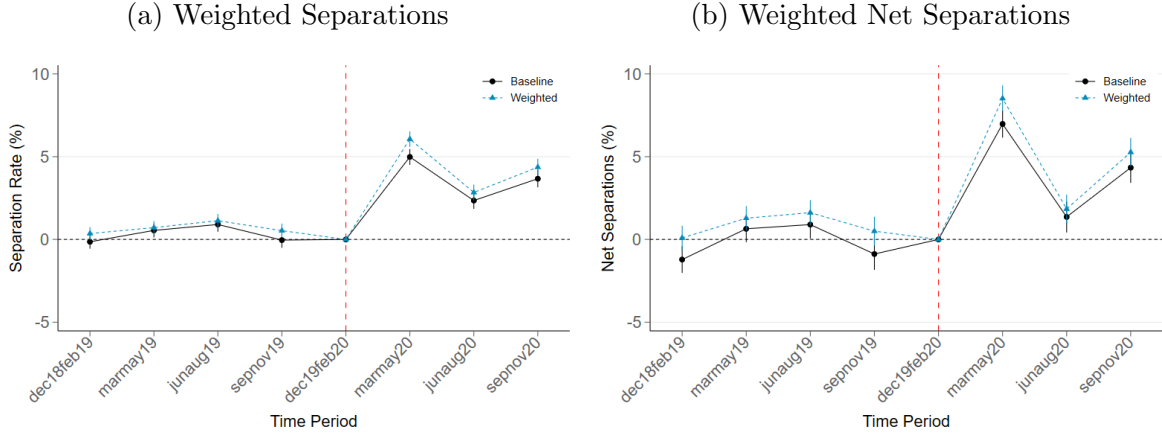
Note. We plot the estimated coefficients γ_x from estimating equation 4 for alternative outcomes (entry rate, panel (a)) and with alternate controls (panel (b)). Confidence intervals are 95%. Omitted period is December 2019 to February 2020. Average entry rate in the omitted period: 74.1%. In panel (b), the purple line captures the input drop when controlling for net separations. Standard errors are clustered at buyer level. Sample size for panels a and b is 930,501. Panel (c) estimates the drop in real inputs once we make the same restriction as in the same sample, keeping only firms that have positive sales every period before the shock. Sample size is 166,906 observations. Finally, panel (d) plots the correlation between the drop in real sales by industry and the mean ratio of short-term inventories to sales by industry taken from the Prowess database.

when using weights, but the estimates are not statistically different from each other.

In Table A3, we present the difference-in-difference estimates for the outcomes in Figure 2. These estimates come from a similar regression as in equation 4, but instead of year dummies, we interact the treatment with a dummy for periods after March 2020. As shown in columns 5 and 6 of Table 2, firms with supplier exposure of one standard deviation above the mean experienced a decrease in inputs of 27% and decrease sales by 16%. We also show in Table A3 how our standard errors change when showing a more conservative clustering at the buyer-district level. In Table A4, we show that our results are robust to only looking at establishments in the manufacturing industry.

We perform a series of robustness checks to ensure that our results are not sensitive to the choice of exposure measure to the lockdowns. In Table A5, we show how our main results change when we define the exposure as a binary variable instead of continuous. To do this, we define dummy variables for exposure larger than median, 75th percentile and

Figure A9: Weighted Separations



Note. We plot the estimated coefficients γ_x from estimating equation 4 with alternate outcomes (weighted separations and weighted net separations). Confidence intervals are 95%. Omitted period is December 2019 to February 2020. Separation rate in the omitted period: mean 30.9%, median: 16.7%. Net-separation rate in the omitted period: mean -43.1%, median 0%. Weighted separation rate in the omitted period: mean 19.5%, median 0.7%. Weighted net separation rate in the omitted period: mean -39.7%, median 0%. The shares of a firm's suppliers in total purchases are used as weights. Standard errors are clustered at buyer-level.

Table A3: Difference-in-Differences Estimates for Key Outcomes.

	Separation Rate	Entry Rate	Net Separations	Real Input Purchases (log)	Real Sales (log)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	3.652***	-1.133***	4.784***	-0.270***	-0.157***
(Firm Clustering)	(0.141)	(0.139)	(0.214)	(0.011)	(0.028)
(District Clustering)	(0.252)	(0.750)	(0.928)	(0.023)	(0.021)
Observations	823,369	823,369	823,369	823,369	143,643
R-squared	0.351	0.318	0.217	0.652	0.740

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table presents results from the difference-in-differences version of equation 4 for key outcomes. Supplier exposure is calculated following equation 3. The post-period includes March 2020 to August 2020. Standard errors clustered at buyer and buyer-district levels in parentheses.

Table A4: Difference-in-Differences Estimates (Manufacturing Only).

	Separation Rate	Entry Rate	Net Separations	Real Input Purchases (log)	Real Sales (log)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	3.703***	-1.085***	4.788***	-0.275***	-0.166***
(Firm Clustering)	(0.144)	(0.142)	(0.218)	(0.011)	(0.029)
Observations	787,631	787,631	787,631	787,631	128,507
R-squared	0.351	0.318	0.217	0.653	0.741

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table presents results from the difference-in-differences version of equation 4 for key outcomes, restricting only to buyers in the manufacturing industry. Supplier exposure is calculated following equation 3. The post-period includes March 2020 to August 2020. Standard errors clustered at buyer and buyer-district levels in parentheses.

90th percentile. As expected, the most exposed firms tend to have larger effects and while the coefficient interpretation changes, the results are qualitatively similar. In Table A6 we define exposure based on the change in the Google mobility index on time spent in place of residence between February 2020 and April 2020. We assign each supplier district the corresponding change in the Google mobility index and aggregate at the buyer level using pre-period purchases as weights. We then standardize the new exposure index. Since the index is quite different, the magnitudes are not directly comparable. However, we can see

that the results are consistent with our baseline results. Finally, we separate the exposure shares of red suppliers and orange suppliers by running equation 8:

$$\begin{aligned}
y_{j,t,r,k} = & \gamma_{red} \mathbb{1}(t > \text{Feb2020}) \times (\text{Share Purchases from Red Zones})_j + \\
& \gamma_{orange} \mathbb{1}(t > \text{Feb2020}) \times (\text{Share Purchases from Orange Zones})_j \\
& + \delta_j + \delta_{r,k,t} + \beta X_{j,t} + \epsilon_{j,t,r,k} ,
\end{aligned} \tag{8}$$

where the specification follows closely the difference-in-difference version of equation 4 with the difference that instead of our standardized exposure measure we separately include the pre-period share of purchases from red zones and orange zones. Perhaps not surprisingly, as shown in Table A7, exposure from red zones have the stronger impact on our resilience outcomes, particularly for separations and net separations. The inputs and sales drop, however, also have a significant impact in response to being exposed to orange zones.

We proceed to investigate whether specific type of firms or transactions drive our results. A novel feature of our data is that it includes establishment level information and it also records transactions within establishments of a same firm. In our pre-period, intra-firm transactions account for 30.1% of the total transaction value recorded. However, the total establishments that engage in intra-firm transactions is small. Throughout our analysis we focus on establishments and include same firm suppliers into the computation of the supplier exposure and the outcomes. However, when excluding intra-firm transactions, the results are quantitatively very similar as shown in Table A8.

As a second step, we want to make sure our results are not driven by retailer or wholesaler firms, who might behave somewhat differently than the manufacturing firms generally focused on by the literature. While we don't directly observe whether firms are retailers or wholesalers, we can use their observed transaction patterns to predict likely-retailers and likely-wholesalers. For retailers we consider two approaches. First, a pure retailer would sell all their goods to consumers so we shouldn't observe them selling to other firms in our data. If a firm is never observed making any sales, we assume it is a likely-retailer. Second, a firm who buys many different products might also be a retailer. We exclude firms above the 90th and 95th percentile in terms of product purchased as additional checks. As shown in Table A9, excluding likely retailers does not change our baseline results significantly, indicating these firms are not providing an important part of the variation.

To understand whether wholesalers drive our results, we predict likely-wholesalers by looking at which products are bought and sold by firms. If a firm buys and sells the

Table A5: Supplier Exposure Using Binary Indicators

Separations				
	Continuous	Median	75th Percentile	90th Percentile
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	3.652*** (0.141)	6.174*** (0.298)	12.005*** (0.406)	16.247*** (0.531)
N	823,369	823,369	823,369	823,369
R-sq	0.351	0.351	0.351	0.351
Net Separations				
	Continuous	Median	75th Percentile	90th Percentile
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	4.784*** (0.214)	5.936*** (0.456)	16.702*** (0.625)	24.501*** (0.822)
N	823,369	823,369	823,369	823,369
R-sq	0.217	0.217	0.217	0.217
Log Real Inputs				
	Continuous	Median	75th Percentile	90th Percentile
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	-0.270*** (0.011)	-0.317*** (0.024)	-1.035*** (0.032)	-1.553*** (0.040)
N	823,369	823,369	823,369	823,369
R-sq	0.652	0.651	0.652	0.653
Log Real Sales				
	Continuous	Median	75th Percentile	90th Percentile
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	-0.157*** (0.028)	-0.134** (0.059)	-0.393*** (0.085)	-1.001*** (0.144)
N	143,653	143,643	143,643	143,643
R-sq	0.740	0.740	0.740	0.740

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table presents results for the equation 4 for key outcomes, but using binary above/below indicators instead of continuous. Standard errors clustered at buyer level in parentheses.

same products, then it is possible that they are a wholesaler who doesn't transform the products they buy. We run our results for the sample excluding firms who buy and sell identical 4-digit products and also evaluate excluding firms whose products bought and sold overlap by more than 90%. As shown in Table A10, our results don't significantly change when excluding these firms.

We also evaluate the robustness of our results if we exclude suppliers with high outdegrees. Given the highly skewed distribution of supplier outdegree presented in Table A11, we want to understand if these nodal suppliers are driving our separation results. When constructing our exposure measure, we exclude suppliers that are above the 90th percentile in the outdegree distribution. Results are quite consistent when excluding these particular suppliers.

Table A6: Difference-in-Differences Estimates with Google Mobility Measure of High Risk

	Separation Rate	Net Separations	Log Real Input Purchases	Log Real Sales
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Google Mobility Supplier Exposure})_j$	0.955*** (0.117)	1.868*** (0.178)	-0.129*** (0.009)	-0.093*** (0.020)
N	820,031	820,031	820,031	143,085
R-sq	0.351	0.217	0.652	0.740

	Separation Rate	Net Separations	Log Real Input Purchases	Log Real Sales
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	3.652*** (0.141)	4.784*** (0.214)	-0.270*** (0.011)	-0.157*** (0.028)
N	823,369	823,369	823,369	143,643
R-sq	0.351	0.217	0.652	0.740

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table presents results from the difference in difference version of equation 4. The top panel uses the change in the Google Mobility Place of Residence trend from February-April 2020 as the supplier exposure. The bottom panel presents the baseline results. The post-period includes March 2020 to August 2020. Standard errors clustered at buyer level in parentheses.

Table A7: Categorical Risk Measurement

	Separation Rate	Net Separations	Log Real Input Purchases	Log Real Sales
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Share of Purchases from Orange Zones})_j$	0.668* (0.389)	1.516*** (0.582)	-0.158*** (0.031)	-0.344*** (0.089)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Share of Purchases from Red Zones})_j$	11.974*** (0.477)	14.280*** (0.727)	-0.919*** (0.037)	-0.482*** (0.101)
N	842,635	842,635	823,369	143,643
R-sq	0.351	0.216	0.652	0.740

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table presents results for impact in orange and red zones. Standard errors clustered at buyer level in parentheses.

Table A8: Excluding Intra-Firm Transactions

	Baseline Separations	Remove Intra-Firm Separations	Baseline Net Separations	Remove Intra-Firm Net Separations
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	3.652*** (0.141)	4.030*** (0.149)	4.784*** (0.214)	5.020*** (0.220)
N	823,369	809,627	823,369	809,627
R-sq	0.351	0.375	0.217	0.259

	Baseline Log Real Inputs	Remove Intra-Firm Log Real Inputs	Baseline Log Real Sales	Remove Intra-Firm Log Real Sales
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	-0.270*** (0.011)	-0.274*** (0.011)	-0.157*** (0.028)	-0.167*** (0.028)
N	823,369	809,627	143,643	137,176
R-sq	0.652	0.652	0.740	0.735

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Columns 1 and 3 present our baseline results while columns 2 and 4 present results after we remove intra-firm transactions. In our pre-period, 30.1% of transaction value comes from intra-firm shipments. Standard errors clustered at buyer level in parentheses.

Table A9: Excluding Likely Retailers

Separations					
	Baseline	Excluding 0 Sales	Excluding 95th Percentile	Excluding 90th Percentile	Excluding 0 Sales and 90th Percentile
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	3.652*** (0.141)	2.876*** (0.190)	3.668*** (0.145)	3.703*** (0.150)	2.919*** (0.208)
N	823,369	346,023	780,005	733,688	288,029
R-sq	0.351	0.350	0.348	0.346	0.339
Net Separations					
	Baseline	Excluding 0 Sales	Excluding 95th Percentile	Excluding 90th Percentile	Excluding 0 Sales and 90th Percentile
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	4.784*** (0.214)	3.749*** (0.280)	4.751*** (0.220)	4.731*** (0.227)	3.744*** (0.307)
N	823,369	346,023	780,005	733,688	288,029
R-sq	0.217	0.198	0.217	0.216	0.194
Log Real Inputs					
	Baseline	Excluding 0 Sales	Excluding 95th Percentile	Excluding 90th Percentile	Excluding 0 Sales and 90th Percentile
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	-0.270*** (0.011)	-0.233*** (0.016)	-0.272*** (0.011)	-0.272*** (0.012)	-0.232*** (0.017)
N	823,369	346,023	780,005	733,688	288,029
R-sq	0.652	0.683	0.630	0.617	0.639
Log Real Sales					
	Baseline	Excluding 0 Sales	Excluding 95th Percentile	Excluding 90th Percentile	Excluding 0 Sales and 90th Percentile
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	-0.157*** (0.028)	-0.157*** (0.028)	-0.147*** (0.029)	-0.132*** (0.030)	-0.132*** (0.030)
N	143,643	143,643	126,905	114,118	114,118
R-sq	0.740	0.740	0.713	0.708	0.708

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table presents results for equation 4 for key outcome variables but excluding various definitions of likely retailers. Column 1 presents the baseline results, column 2 excludes firms with no recorded sales, columns 3 and 4 exclude firms in the 95th and 90th percentile of products purchased, respectively. Column 5 includes only firms that sell their goods and are below the 90th percentile in terms of products purchased. Standard errors clustered at buyer level in parentheses.

As a final check to our baseline specification, we want to understand whether firms break their links with suppliers in a permanent or transitory way. In Figure A10, we compute separation rates, net-separation rates, and total input purchases in periods of 4-months (left panels) or periods of 6-months (right panels). The finding that the separations and net-separations keep the same pattern, even with longer time periods, indicates that the separation rates in Figure 2, are not a product of firms changing the frequency of their purchases, and maintaining their previous suppliers. In Figure A11, we define the entry rate of specific suppliers: suppliers who never transacted with the firm before time t (New supplier), suppliers who transacted with the firm in the six months prior to period t , and suppliers who transacted with the firm in the nine months prior to period t . Overall, we don't find a statistically different entry rate responses across measures, indicating that

Table A10: Excluding Likely Wholesalers

	Separations			Net Separations		
	Baseline	Wholesalers, 90%	Wholesalers, 100%	Baseline	Wholesalers, 90%	Wholesalers, 100%
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	3.652*** (0.141)	3.697*** (0.145)	3.695*** (0.145)	4.784*** (0.214)	4.784*** (0.220)	4.785*** (0.220)
N	823,369	790,377	790,731	823,369	790,377	790,731
R-sq	0.351	0.351	0.351	0.217	0.218	0.218

	Log Real Inputs			Log Real Sales		
	Baseline	Wholesalers, 90%	Wholesalers, 100%	Baseline	Wholesalers, 90%	Wholesalers, 100%
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	-0.270*** (0.011)	-0.270*** (0.011)	-0.270*** (0.011)	-0.157*** (0.028)	-0.167*** (0.030)	-0.166*** (0.030)
N	823,369	790,377	790,731	143,643	124,494	124,760
R-sq	0.652	0.652	0.652	0.740	0.745	0.745

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table presents results for equation 4 for key outcome variables but excluding various definitions of wholesalers. “Wholesalers 90%” excludes firms whose input and output product codes overlap by more than 90%. “Wholesalers 100%” removes firms whose input and output codes overlaps completely. Standard errors clustered at buyer level in parentheses.

Table A11: Excluding Suppliers with Outdegree > 90th Percentile

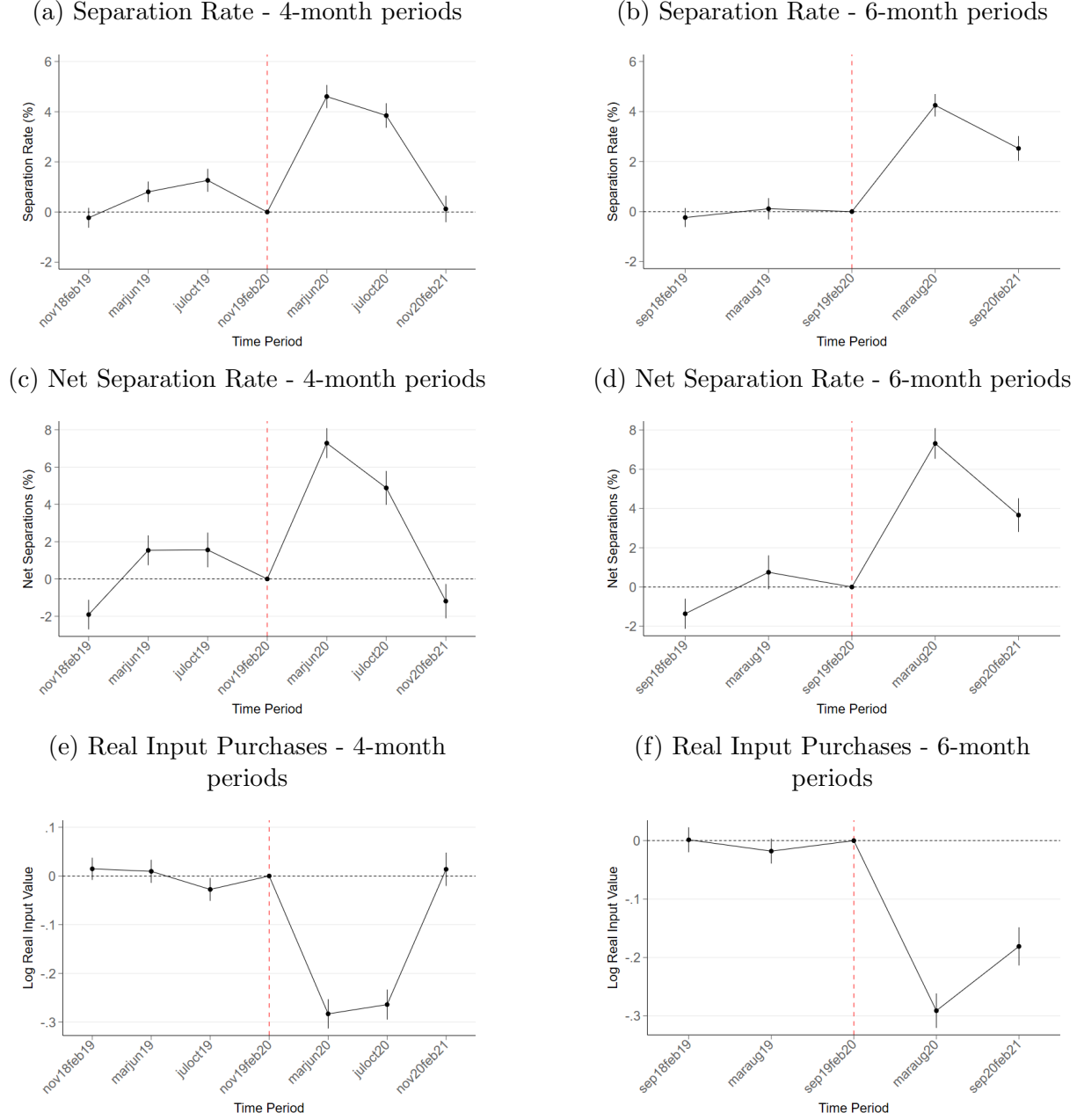
Excluding > 90 th percentile	Separation Rate	Entry Rate	Net Separations	Real Input Purchases (log)	Real Sales (log)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	4.570*** (0.137)	-2.298*** (0.135)	6.868*** (0.209)	-0.354*** (0.011)	-0.162*** (0.029)
Observations	781,190	781,190	781,190	781,190	143,082
R-squared	0.350	0.316	0.216	0.653	0.740

Full Sample	Separation Rate	Entry Rate	Net Separations	Real Input Purchases (log)	Real Sales (log)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	3.652*** (0.141)	-1.133*** (0.139)	4.784*** (0.214)	-0.270*** (0.011)	-0.157*** (0.028)
Observations	823,369	823,369	823,369	823,369	143,643
R-squared	0.351	0.318	0.217	0.652	0.740

Note. Table presents results from the difference-in-differences version of equation 4 for key outcomes, but excluding all suppliers with outdegree above the 90th percentile, in comparison with the full sample results. Supplier exposure is calculated following equation 3. The post-period includes March 2020 to August 2020. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ Standard errors clustered at buyer level in parentheses.

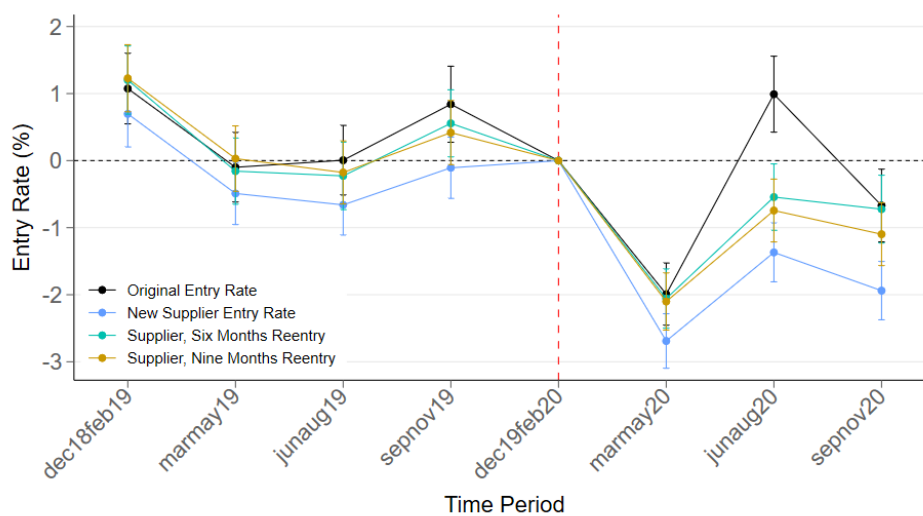
while there might be some return to old suppliers, the net effects also include entry of new suppliers.

Figure A10: Baseline Event Studies with Alternative Time Periods



Note. Panels (a) and (b) extend the baseline event-study estimation in equation 4 to separation rates, panels (c) and (d) for net-separation rates, and panels (e) and (f) for real input purchases, where the time period over which the measures are computed is alternatively four months or six months. For the four-month analysis, the number of observations is 879,376, the mean net-separation rate in the omitted period is -39.9% and the mean separation rate in the omitted period is 33.7%. For the six-month analysis, the number of observations is 702,379, the mean net-separation rate in the omitted period is -32.4% and the mean separation rate in the omitted period is 39.0%. Confidence intervals are at the 95 percent level. Standard errors are clustered at the buyer level.

Figure A11: Comparison of Entry Rate Definitions



Note. We plot our event study results for alternative definitions of the entry rate. “Original Entry Rate” refers to the baseline. “New supplier” is the entry rate for suppliers who never transacted with the firm up to that point. Six and nine month re-entry is the entry rate for suppliers that transacted with the firm six or nine months before the current period. 95% confidence intervals reported. Standard errors clustered at the buyer level.

D Characterizing resilience - additional results

We run our triple difference estimation from equation 6 for two additional outcomes: entry rates and log real output. The estimates on entry rates, presented in the left panels of Figure A12, have the expected opposite direction as the estimates on separations presented in Figure 3. The point estimates for output, shown in the right panel of Figure A12, follow a similar direction as inputs, but given the more stringent sample used for firm output the point estimates tend to be imprecise. In Tables A12 - A14, we present the full triple difference estimates for our main outcomes: separations, net-separations, and log inputs.

Table A12: Triple Difference Results for Separation Rate

	Indegree	Number of Products Purchased	Share Differentiated	Supply Chain Depth 1st Degree	Supply Chain Depth 2nd Degree
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	3.668*** (0.141)	3.460*** (0.140)	3.614*** (0.144)	1.894*** (0.152)	1.876*** (0.152)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Characteristic})_j$	-0.271*** (0.081)	-2.922*** (0.152)	2.696*** (0.163)	2.504*** (0.182)	2.521*** (0.193)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j \times (\text{Characteristic})_j$	0.718*** (0.133)	-0.583*** (0.149)	-0.069 (0.143)	-0.195 (0.157)	0.037 (0.158)
Observations	823,369	823,317	789,622	744,814	744,814
R-squared	0.351	0.351	0.353	0.346	0.346
	Stickiness	Downstreamness	Outdegree	Share Largest Supplier	HHI of Value of Different Products
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	1.846*** (0.165)	3.675*** (0.142)	2.852*** (0.144)	3.572*** (0.137)	3.298*** (0.140)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Characteristic})_j$	-0.635*** (0.151)	0.542*** (0.206)	-4.703*** (0.191)	3.452*** (0.127)	4.180*** (0.133)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j \times (\text{Characteristic})_j$	-0.773*** (0.147)	-0.175 (0.142)	-4.025*** (0.194)	-0.464*** (0.138)	0.596*** (0.138)
Observations	694,949	823,369	823,369	823,369	823,317
R-squared	0.348	0.351	0.351	0.351	0.352
	Average Number of Suppliers	HHI of Sales of Suppliers for Each Product	Average Number of Suppliers per Firm and Product	Product Spatial Concentration	Number of Transactions
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	3.646*** (0.141)	3.677*** (0.139)	3.509*** (0.143)	3.764*** (0.143)	3.645*** (0.141)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Characteristic})_j$	0.287* (0.150)	3.407*** (0.117)	-2.801*** (0.113)	-0.378** (0.160)	-0.708*** (0.198)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j \times (\text{Characteristic})_j$	0.580*** (0.128)	-1.109*** (0.130)	1.307*** (0.133)	0.774*** (0.151)	0.115 (0.120)
Observations	823,317	823,317	823,369	823,317	823,369
R-squared	0.351	0.351	0.351	0.351	0.351

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table presents difference-in-difference results from equation 6 for the separation rate outcome. Supplier exposure is calculated following equation 3. Standard errors clustered at buyer level in parentheses.

Table A13: Triple Difference Results for Net Separations

	Indegree	Number of Products Purchased	Share Differentiated	Supply Chain Depth 1st Degree	Supply Chain Depth 2nd Degree
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	4.829*** (0.214)	4.492*** (0.213)	5.063*** (0.213)	2.013*** (0.229)	1.947*** (0.230)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Characteristic})_j$	-0.940*** (0.188)	-5.096*** (0.257)	5.353*** (0.246)	3.745*** (0.273)	3.296*** (0.287)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j \times (\text{Characteristic})_j$	1.379*** (0.272)	-0.427* (0.254)	-0.560*** (0.213)	-0.908*** (0.232)	-0.171 (0.232)
Observations	823,369	823,317	789,622	744,814	744,814
R-squared	0.217	0.217	0.219	0.209	0.209
	Stickiness	Downstreamness	Outdegree	Share Largest Supplier	HHI of Value of Different Products
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	2.776*** (0.248)	4.822*** (0.216)	3.441*** (0.216)	4.563*** (0.211)	4.122*** (0.212)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Characteristic})_j$	-1.701*** (0.226)	1.350*** (0.321)	-6.997*** (0.256)	8.417*** (0.194)	8.111*** (0.203)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j \times (\text{Characteristic})_j$	-1.313*** (0.217)	-0.251 (0.218)	-8.476*** (0.277)	-0.968*** (0.216)	0.955*** (0.211)
Observations	694,949	823,369	823,369	823,369	823,317
R-squared	0.212	0.217	0.218	0.218	0.218
	Average Number of Suppliers	HHI of Sales of Suppliers for Each Product	Average Number of Suppliers per Firm and Product	Product Spatial Concentration	Number of Transactions
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	4.774*** (0.214)	4.796*** (0.213)	4.480*** (0.217)	4.889*** (0.218)	4.770*** (0.214)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Characteristic})_j$	0.500** (0.226)	7.959*** (0.179)	-6.462*** (0.229)	0.849*** (0.247)	-1.075*** (0.283)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j \times (\text{Characteristic})_j$	1.284*** (0.194)	-2.097*** (0.205)	2.732*** (0.260)	0.942*** (0.239)	0.255 (0.182)
Observations	823,317	823,317	823,369	823,317	823,369
R-squared	0.217	0.218	0.218	0.217	0.217

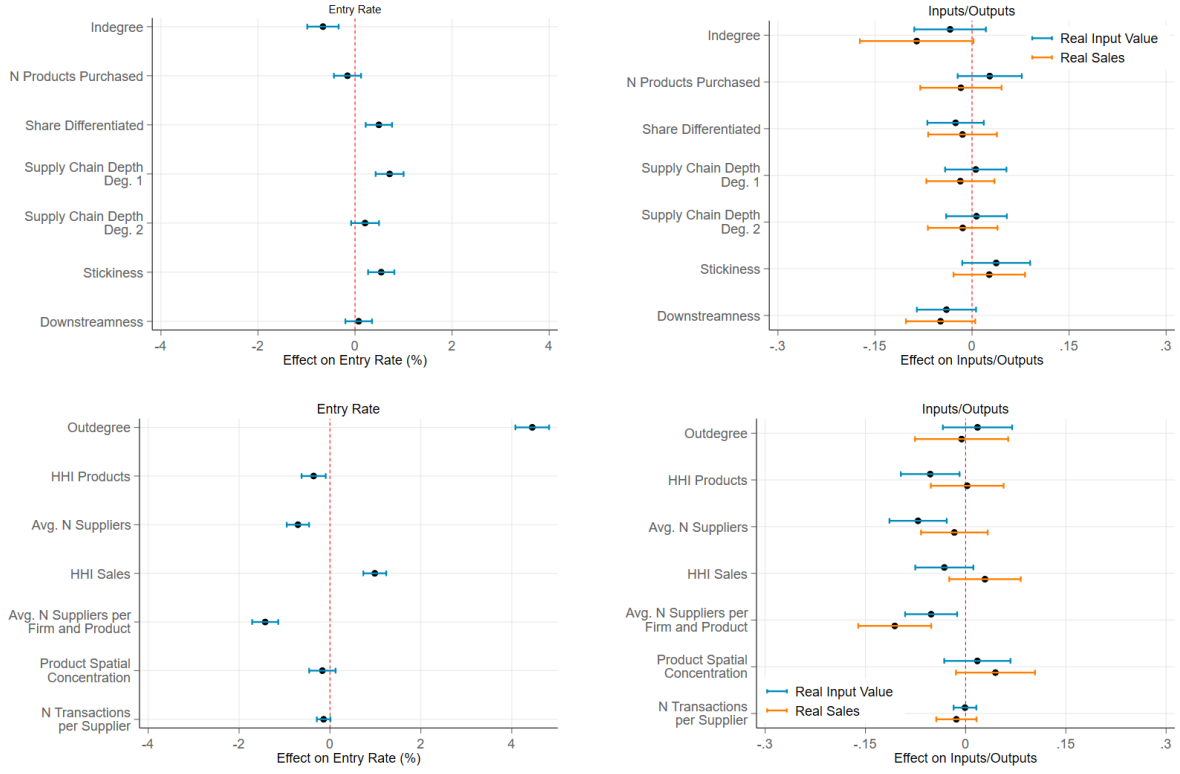
Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table presents difference-in-difference results from equation 6 for the net-separations outcome. Supplier exposure is calculated following equation 3. Standard errors are clustered at buyer level in parentheses.

Table A14: Triple difference results for Input Purchases

	Indegree	Number of Products Purchased	Share Differentiated	Supply Chain Depth 1st Degree	Supply Chain Depth 2nd Degree
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	-0.274*** (0.011)	-0.246*** (0.011)	-0.265*** (0.011)	-0.154*** (0.012)	-0.152*** (0.012)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Characteristic})_j$	0.116*** (0.020)	0.358*** (0.015)	-0.170*** (0.013)	-0.231*** (0.014)	-0.227*** (0.015)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j \times (\text{Characteristic})_j$	-0.031* (0.018)	0.079*** (0.014)	-0.010 (0.011)	0.027** (0.012)	0.006 (0.012)
Observations	823,369	823,317	789,622	744,814	744,814
R-squared	0.652	0.653	0.655	0.657	0.657
	Stickiness	Downstreamness	Outdegree	Share Largest Supplier	HHI of Value of Different Products
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	-0.057*** (0.013)	-0.271*** (0.011)	-0.238*** (0.011)	-0.246*** (0.011)	-0.226*** (0.011)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Characteristic})_j$	-0.103*** (0.012)	-0.092*** (0.017)	0.159*** (0.014)	-0.662*** (0.010)	-0.549*** (0.010)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j \times (\text{Characteristic})_j$	0.080*** (0.012)	0.005 (0.011)	0.216*** (0.014)	0.036*** (0.011)	-0.057*** (0.011)
Observations	694,949	823,369	823,369	823,369	823,317
R-squared	0.663	0.652	0.652	0.654	0.654
	Average Number of Suppliers	HHI of Sales of Suppliers for Each Product	Average Number of Suppliers per Firm and Product	Product Spatial Concentration	Number of Transactions
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j$	-0.271*** (0.011)	-0.264*** (0.011)	-0.259*** (0.011)	-0.277*** (0.011)	-0.270*** (0.011)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Characteristic})_j$	0.125*** (0.012)	-0.500*** (0.009)	0.210*** (0.008)	-0.009 (0.012)	0.031*** (0.008)
$\mathbb{1}(t > \text{Feb2020}) \times (\text{Supplier Exposure})_j \times (\text{Characteristic})_j$	-0.072*** (0.010)	0.067*** (0.011)	-0.100*** (0.010)	-0.054*** (0.012)	-0.002 (0.005)
Observations	823,317	823,317	823,369	823,317	823,369
R-squared	0.652	0.653	0.652	0.652	0.652

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table presents difference-in-difference results from equation 6 for the log real input purchases outcome. Supplier exposure is calculated following equation 3. Standard errors are clustered at buyer level in parentheses.

Figure A12: Effect of Firm Characteristics on Entry/Output



Note. We plot the triple-interaction coefficients β from estimating equation 6 with alternative outcome variables for each of the characteristics described in Section 4. The left panels present the results for the entry rate and the right panels for output. 95% confidence intervals reported. Standard errors are clustered at buyer level.

Next, we investigate whether supply chain characteristics might be correlated with each other, which might explain the pattern of results. Further, supply chains might typically be characterized by several of these metrics at once in the data. Running a horse-race between all of these metrics is computationally challenging, but we take multiple steps to address this issue. We begin by looking at firm size, which is measured as the total value of inputs the firm purchases in the period before the shock. It is well known that firm size tends to be correlated with multiple characteristics such as input complexity, length of the supply chain, likelihood to engage in international trade among many other supply chain features. Hence, we begin by running the regression in equation 6 for each characteristic and add as controls the interaction coefficients between firm size, supplier exposure, and the post period, as well as the triple interaction coefficient among the three.

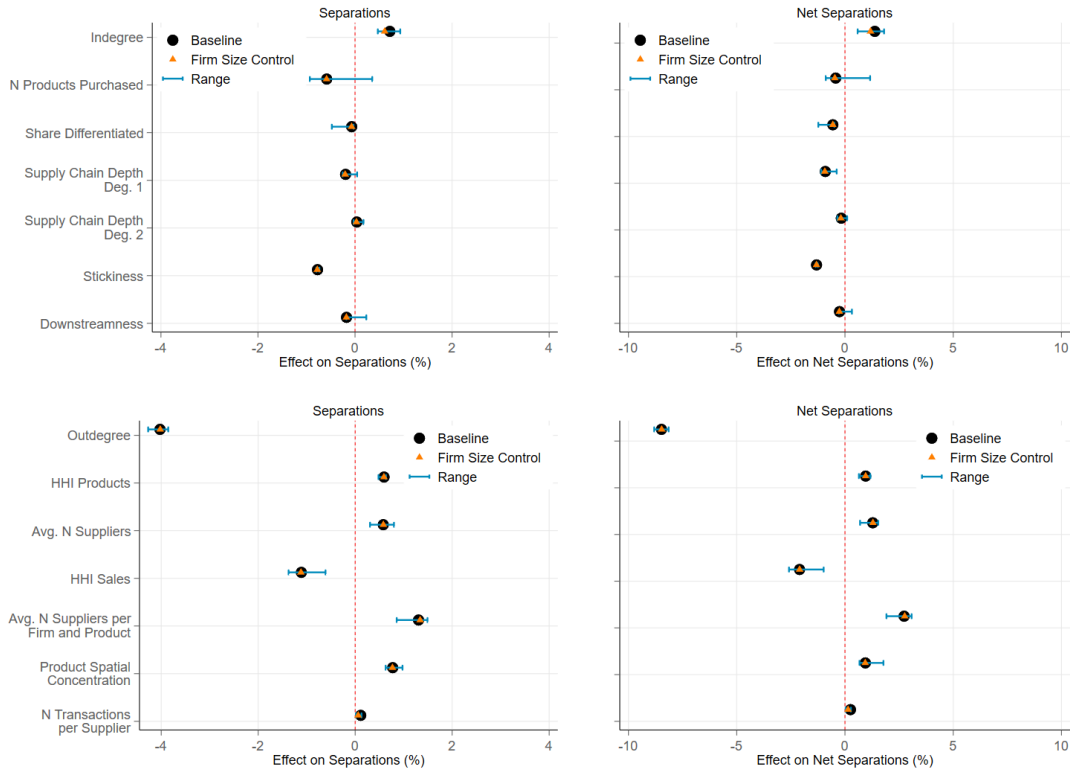
We also run the triple-difference regression for each characteristic and control for the interaction terms with each of the other characteristics. If two characteristics are significantly correlated, we would expect the point estimates to change when adding both characteristics in the same regression.

In Figure A13, we plot the baseline triple difference estimates for separations and net-

separations together with the point estimates of the triple interaction when controlling for firm size. We also plot the maximum and minimum of estimates of the triple interaction when controlling for each of the other characteristics in the regression. It is reassuring to see that none of the estimated coefficients of the triple interaction change significantly when controlling for firm size and other characteristics. For the case of supply-chain depth 1 and 2, we do not include them as a control for each other since, by construction, they are significantly correlated. Figure A14, presents the results for log inputs which also shows results are robust.

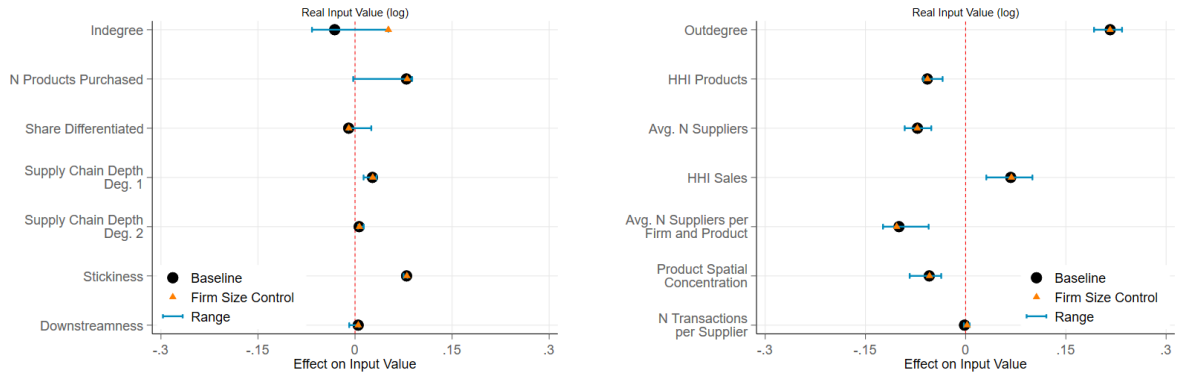
To further asses the degree of correlation among the supply-chain characteristics, Table A15 correlates some of our key metrics. Overall, barring a few obvious correlations such as a high positive correlation between buyer size and buyer indegree, or between product concentration and the share of the largest supplier in total purchases, we do not find much correlation across characteristics, suggesting most of the Z_j considered above are useful metrics of resilience in themselves.

Figure A13: Separation/Net-Separation Results Controlling for Other Characteristics



Note. We plot the triple-interaction coefficients β from estimating equation 6 for each of the characteristics described in Section 4 with additional controls. The baseline point estimate is plotted in black. The point estimate when controlling for firm size is plotted in orange. The additional controls are each possible firm characteristic— that is not the coefficient of interest — individually. We plot the minimum and maximum values of β in blue. Standard errors are clustered at buyer level.

Figure A14: Log Input Purchases Results Controlling for Other Characteristics



Note. We plot the triple-interaction coefficients β for each of the characteristics described in Section 4. The left panels present the input-purchases results for firm characteristics, and the right panels for supplier characteristics when estimating equation 6 with additional controls. The baseline point estimate is plotted in black. The point estimate when controlling for firm size is plotted in orange. The additional controls are each possible firm characteristic— that is not the coefficient of interest — individually. We plot the minimum and maximum values of β in blue. Standard errors are clustered at buyer level.

Table A15: Pairwise Correlation Between Supply-Chain Characteristics

	Buyer Size	Buyer Indegree	Number of Products Purchased	Share of Purchases - Differentiated Prod.
Buyer size	1.00	-	-	-
Buyer indegree	0.47	1.00	-	-
Number of products purchased	0.36	0.51	1.00	-
Share of purchases - differentiated prod.	-0.02	-0.01	0.00	1.00
1st degree supply chain depth	0.01	0.01	0.16	0.11
2nd degree supply chain depth	0.02	0.02	0.16	0.03
Average Supplier outdegree	-0.02	-0.06	-0.08	0.13
Concentration on suppliers (HHI)	-0.11	-0.20	-0.20	0.05
Concentration of products purchased (HHI)	-0.03	-0.13	-0.50	0.01
Number of suppliers in market	-0.01	0.03	-0.03	0.18
Number of suppliers per product	0.25	0.48	0.26	-0.03
Product spatial concentration	0.01	0.00	-0.05	-0.31
Stickiness	-0.04	-0.04	-0.07	0.07
Downstreamness	0.00	0.00	0.07	0.28
N transactions per Supplier	0.26	0.12	0.23	0.02
	1st Degree Supply Chain Depth	2nd Degree Supply Chain Depth	Average Supplier Outdegree	Concentration on Suppliers (HHI)
1st degree supply chain depth	1.00	-	-	-
2nd degree supply chain depth	0.96	1.00	-	-
Number of products purchased	0.11	0.03	1.00	-
Average supplier outdegree	0.18	0.15	0.14	1.00
Concentration on suppliers (HHI)	-0.20	-0.19	0.08	0.08
Concentration of products purchased (HHI)	-0.41	-0.37	-0.18	-0.15
Number of suppliers in market	-0.15	-0.11	-0.10	-0.60
Number of suppliers per product	-0.03	0.00	0.24	-0.01
Product Spatial Concentration	-0.02	-0.13	0.10	0.06
Stickiness	0.36	0.39	-0.10	0.09
Downstreamness	0.03	0.03	0.00	-0.02
N transactions per Supplier				
	Concentration of Products Purchased (HHI)	Number of Suppliers in Market	Number of suppliers per Product	Product Spatial Concentration
Concentration of products purchased (HHI)	1.00	-	-	-
Number of suppliers in market	0.05	1.00	-	-
Number of suppliers per product	-0.06	0.18	1.00	-
Product spatial concentration	0.08	-0.31	0.02	1.00
Stickiness	0.03	-0.13	-0.13	0.04
Downstreamness	-0.06	-0.06	-0.07	-0.23
N transactions per Supplier	-0.03	-0.01	0.04	-0.01
	Stickiness (HHI)	Downstreamness in Market	N transactions per supplier	
Stickiness	1.00	-	-	
Downstreamness	0.05	1.00	-	
N transactions per Supplier	-0.01	0.04	1.00	

Note. We compute pairwise correlations among the different characteristics described in Section 4. All characteristics and correlations are computed for the period December 2019 to February 2020.

E New Buyer-Supplier Links

To explore the new-link formation in more detail, we use an event-study approach as in equation 9 to compare the supplier composition of high- and low-supplier-exposure firms over time.

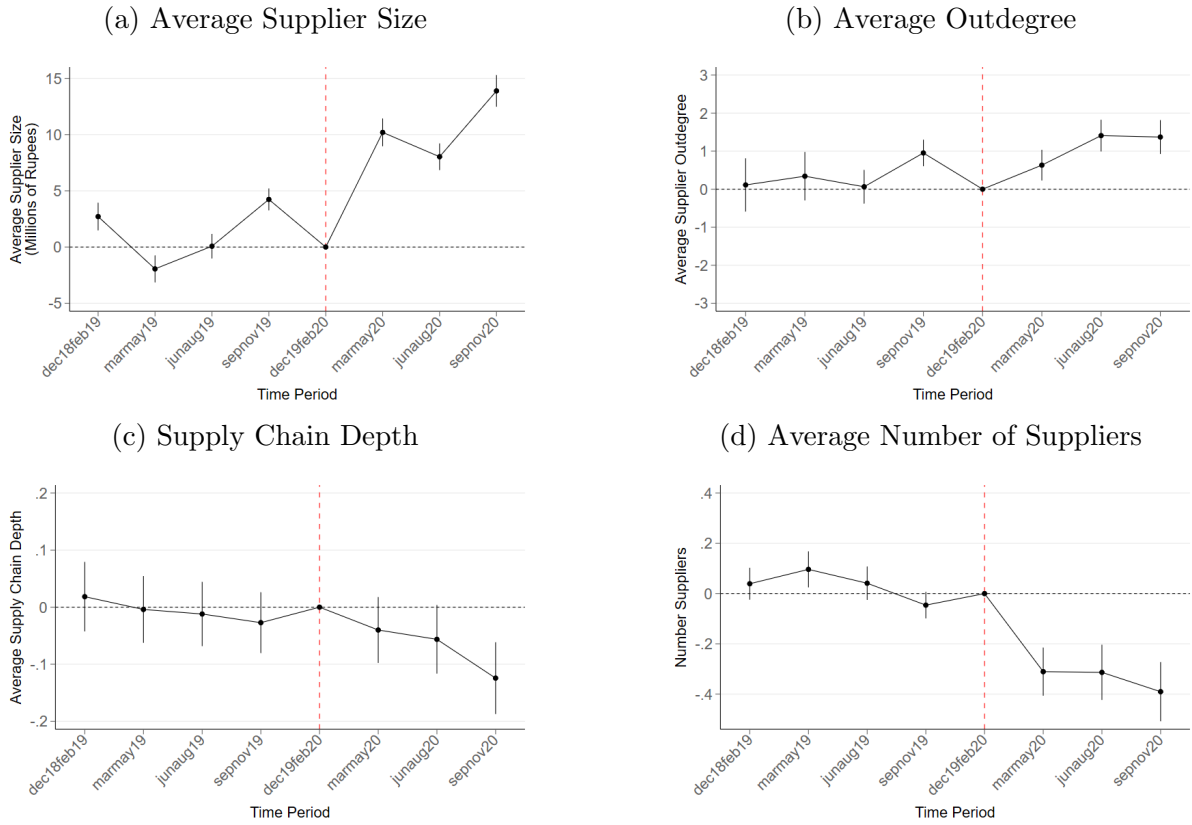
$$\bar{y}_{j,t,r,k} = \sum_{x=t_0-4, \neq t_0}^{t_0+3} \gamma_x (\text{Supplier Exposure})_j + \delta_j + \delta_{r,k,t} + \zeta X_{j,t} + \epsilon_{j,t,r,k} \quad (9)$$

In Figure A15, we plot the event studies for four selected outcomes: average supplier size, average outdegree, supply chain depth of products purchased and the number of suppliers. As shown in Figure A15a, firms seem to significantly concentrate into larger suppliers after the shock. By May 2020, firms with supplier exposure one standard deviation above the mean buy from suppliers that are 10% larger than firms with an average supply-chain risk. Similarly, the average outdegree of suppliers increases after the shock meaning that firms not only transact more with bigger suppliers but also more central ones to the network.

Figure A15c measures how the average supply-chain depth changes over time. As mentioned in Section 4.2, the supply-chain depth measure captures how many products are needed to produce a given product. We compute the average supply-chain depth across products bought by the firm in each time period. The event-study plot in Figure A15c shows that firms with higher supplier exposure decrease their average supply-chain depth, buying products that are, on average, slightly less complex. Finally, firms also reduce the number of suppliers they transact with after the shock.

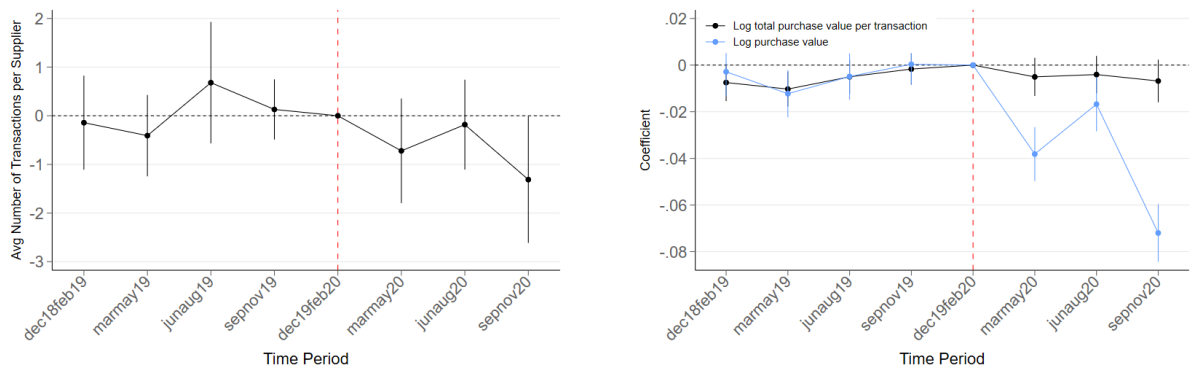
As additional checks, we explore whether the frequency of transactions changes after the shock. We count, for each supplier, the total number of shipments recorded in each time period and calculate the simple average across all suppliers. As shown in Figure A16, firms make on average, 1 fewer shipment from their suppliers per period. However, as shown in Figure A16, the total value per transaction does not change while total inputs purchased does decrease. This suggests that part of the observed input decrease is driven by having fewer transactions with suppliers.

Figure A15: Changes in Composition of New Suppliers



Note. We plot the interactions between time dummies and our supplier-risk measure estimated in equation 9. Average supplier size in omitted period: 112.38 (millions of rupees). Average supply-chain depth in omitted period: 32.31. Average number of suppliers: 12.20. Average outdegree of firms in our sample in pre-period: 42.37. Standard errors are clustered at buyer level. Confidence intervals shown are 95%

Figure A16: Event study: Transaction frequency



Note. We plot the interactions between time dummies and our supplier-exposure measure estimated in equation 9. Confidence intervals shown are 95%. Standard errors are clustered at the buyer level.