

# Global supply chain interdependence and shock amplification – evidence from Covid lockdowns

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*The views expressed in this presentation are those of the discussant and do not necessarily represent the position of the BIS, the IMF or HKMA*

# Main questions

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- **Questions:**
  - How has the pandemic affected GVC interconnections?
    - ✦ Can big data visualisations of granular firm interlinkages give us new insight into GVCs?
  - Does GVC participation amplify shocks to GVC-linked firms?
  
- **Literature:**
  - GVC-dependent firms are more vulnerable: Exports of goods that are more dependent on global value chains are more volatile than other goods
  - GVC networks acted as an important propagation mechanism of China's early lockdowns in 2020 to the rest of the world

# Data and methodology – Network maps

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- Data for network maps:
  - Firm-level supply-chain data from S&P's Capital IQ database
  - Two snapshots: February 2020; December 2021
    - ✦ (Feb. 2020): ~34,000 companies; 170 economies; 8 Global Industry Classification
    - ✦ (Dec. 2021): ~27,000 companies; 161 economies; 8 Global Industry Classification
  - *Locational* data; Direct and indirect linkages mapped
- Data cross check
  - Shipping manifest from US Census - 456,453 shipments to US consignees in 2020
    - ✦ 80% overlap between the two data sets for US-based firms that have business relationships with China and/or Germany

# How has the Covid pandemic affected inter-firm linkages? Stylised facts

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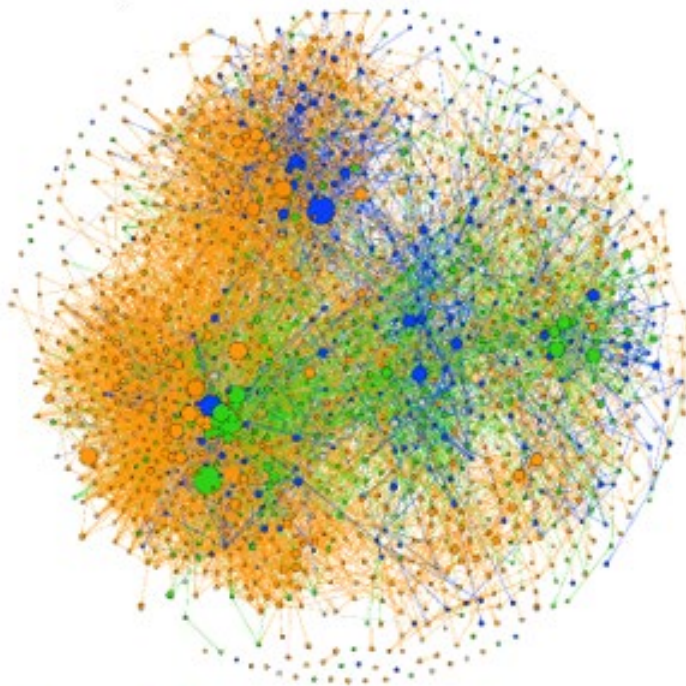
- Mapping linkages:
  - Measuring a firm's position, and the length of the supply chain, relative to a firm in China or Germany in the same production network
- Networks slow to recover
- The number of linkages **30% lower** over the 2-year period
  - Pre-Covid: February 2020
  - Post-Covid: December 2021
- And, GVCs as a patchwork:
  - Networks are hardly uniform or comprehensive;
  - No all-with-all trade or financial flows;
  - Sectors differ from each other in their logics.

# How has the Covid pandemic affected inter-firm linkages? Stylised facts

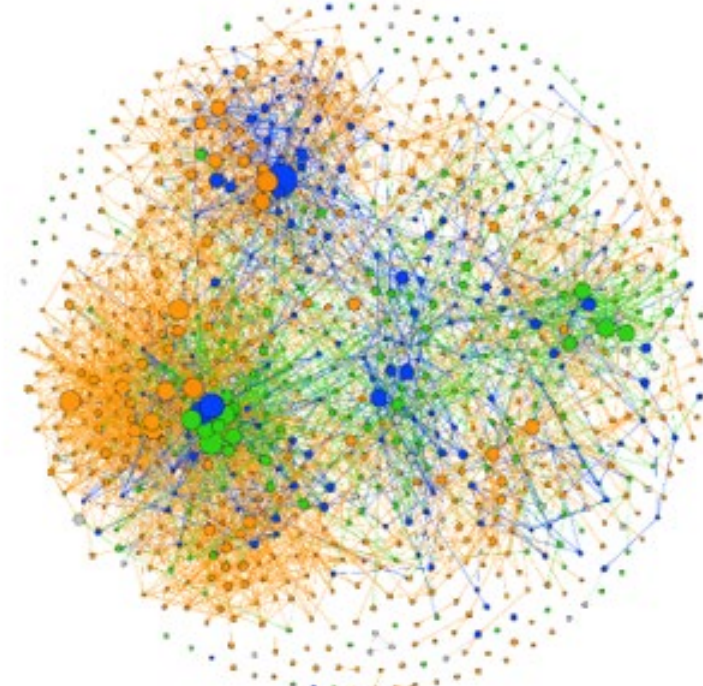
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## Customer-supplier connections suffered after the onset of Covid-19

GVC linkages in Feb 2020 ...



... were far fewer in Dec 2021



■ US   ■ Europe   ■ Asia-Pacific

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# Global GVC as a patchwork - Auto networks

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- **Complex, multi-polar structure**
  - US and European firms are at the center
- **Extensive regional and national networks:**
  - Firms from the same country / region tend to gather in bunches
  - Regional and country “subnetworks” nested within the global auto supply chain
    - ✦ Japan with Japan
    - ✦ US / Europe with more cross-national connections
- ... potentially more resilient to GVC shifts

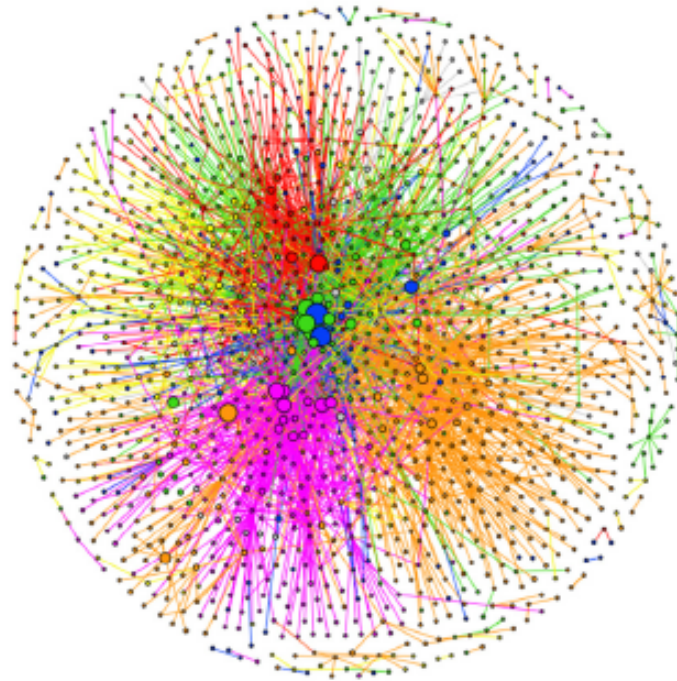
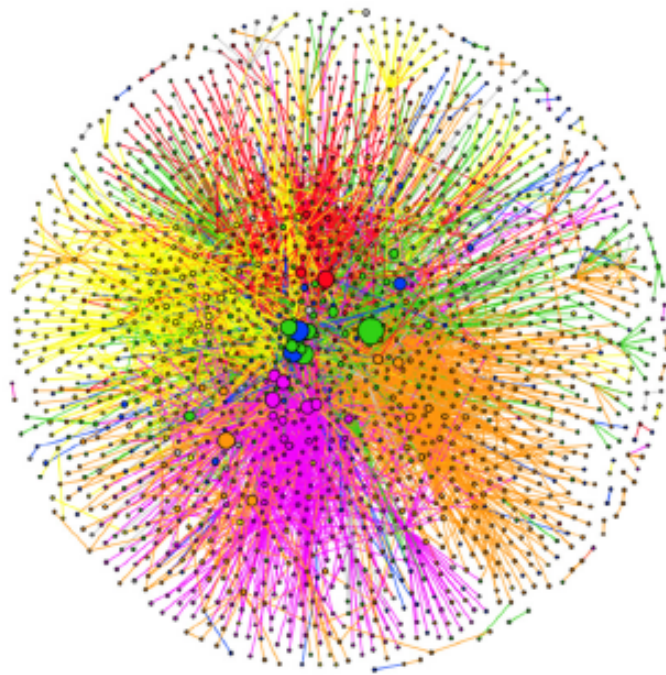
# Global GVC as a patchwork - Auto networks

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**Chart 6: Global supply chain networks – Automobiles & Components industry**

**A: February 2020**

**B: December 2021**



■ US      ■ Asia Pacific ex. CN, KR, JP      ■ China      ■ South Korea  
■ Europe      ■ Japan

Sources: CIO and authors' calculations.

# Global GVC as a patchwork - IT networks

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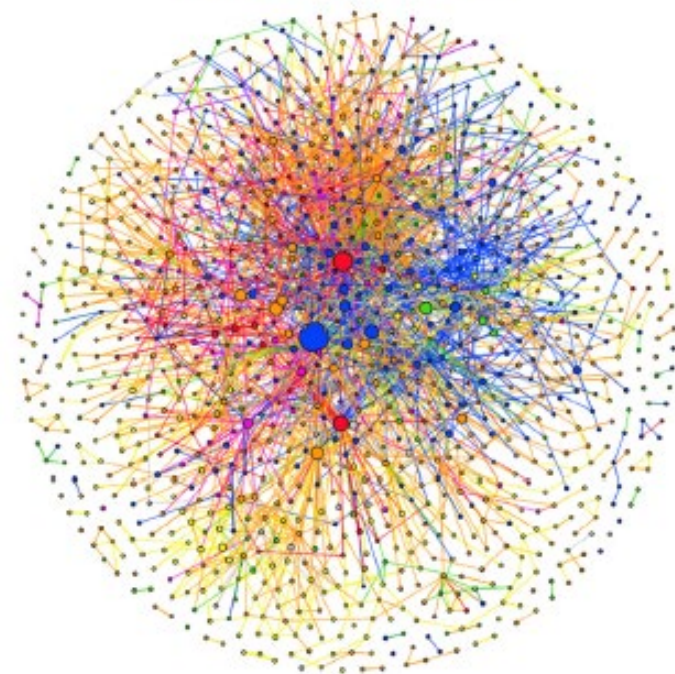
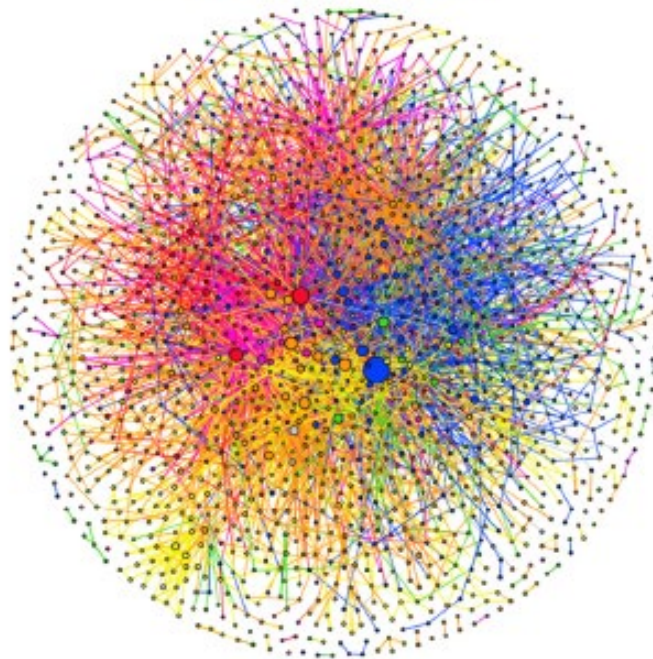
# Global GVC as a patchwork - IT networks

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## Chart 7: Global supply chain networks – Information Technology industry

**A: February 2020**

**B: December 2021**



■ US      ■ Asia pacific ex. CN, KR, JP      ■ China      ■ South Korea  
■ Europe      ■ Japan

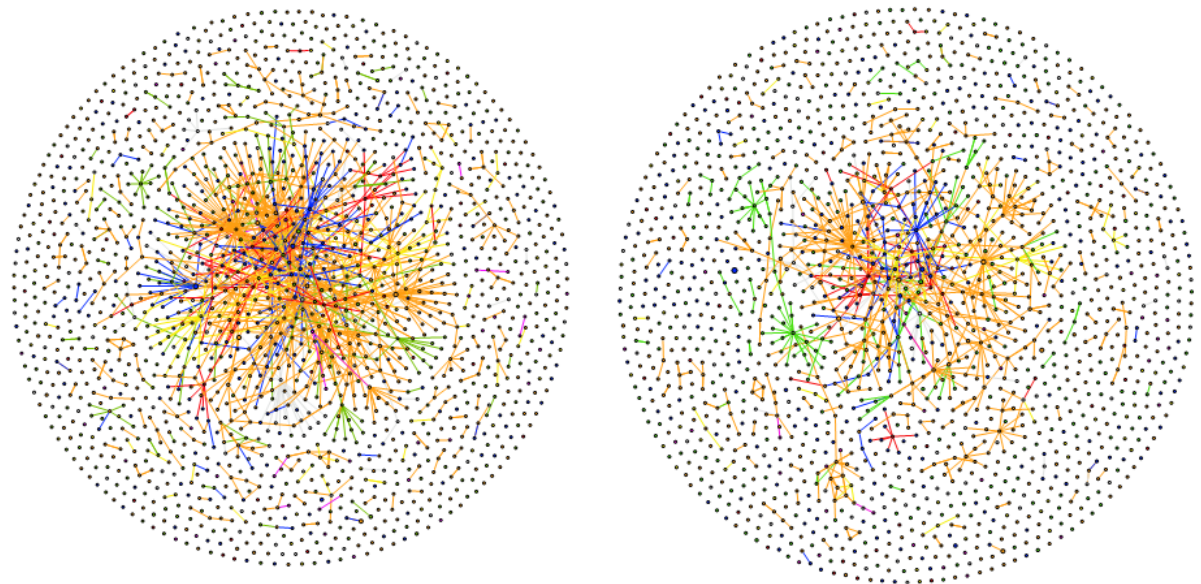
Sources: CIQ and authors' calculations.

# Global GVC as a patchwork - Textile networks

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**Chart: Global supply chain networks – Textiles industry**  
**A: February 2020**                      **B: December 2021**

- Relatively simple China-Asia networks
- Reconfiguration of supply chain easier



<span style="color: blue;">■</span> US	<span style="color: orange;">■</span> Asia pacific ex. CN, KR, JP	<span style="color: yellow;">■</span> China	<span style="color: red;">■</span> South Korea
<span style="color: green;">■</span> Europe		<span style="color: magenta;">■</span> Japan	

Sources: CIQ and authors' calculations.

# Data and methodology – Regression analysis

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- Data for regression analysis – a subset of data for network maps:
  - Publicly listed: 21,340 worldwide; 32% are customers of and/or suppliers to Chinese firms; 29% are customers of and/or suppliers to German firms
- Methodology
  - Event study to assess impact of lockdowns on firms' equity prices
    - ✦ Lockdowns in early 2020 offer exogenous shocks to firms in the GVCs;
    - ✦ China: 23 January 2020; 27 January 2020
    - ✦ Germany: 16 March 2020
  - Robustness checks: Replace the dependent variable with “abnormal return” – ie deviation from the market return.

# How have equity market investors reacted to firms with GVC linkages in locked down economies?

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$$Return_{i,t} = \alpha_i + \mu_t + \sum_{j=CN,DE} \beta_j Lockdown_j \times GVC_{ij} + \delta MarketReturn_t + e_{i,t}$$

- **Event study of lockdown announcements in China/Germany**
  - *Dependent variable*: Daily changes of share prices of firms with GVC linkages (exclude those headquartered in China and Germany)
  - *Key variable* -  $\beta_{CN}$  and  $\beta_{DE}$  : difference in share price adjustment between firms connected and unconnected to China/Germany after announcement
- **Evidence of amplification**
  - Share prices of firms with GVC links fell more by **1.5 ppt** from lockdown announcements than unlinked

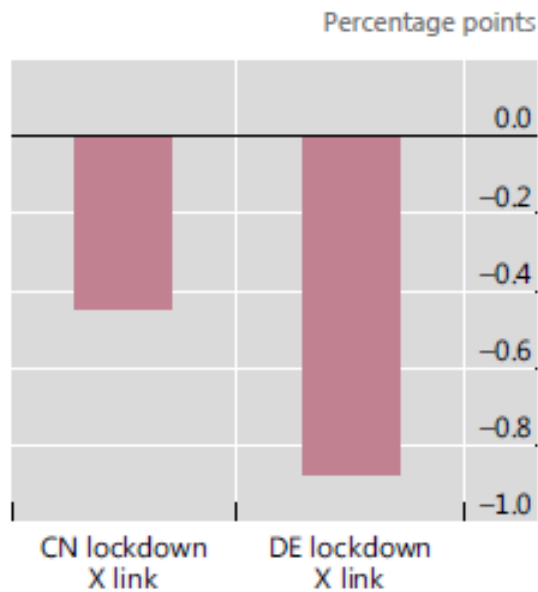
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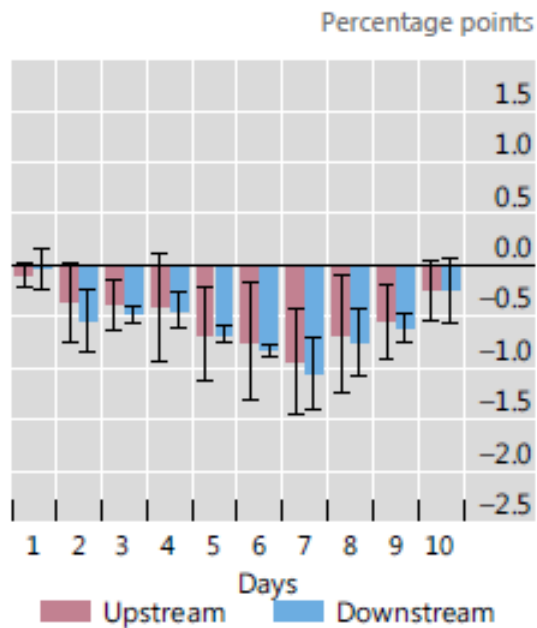
## Lockdown announcements affect GVC-linked firms more negatively

Graph 9

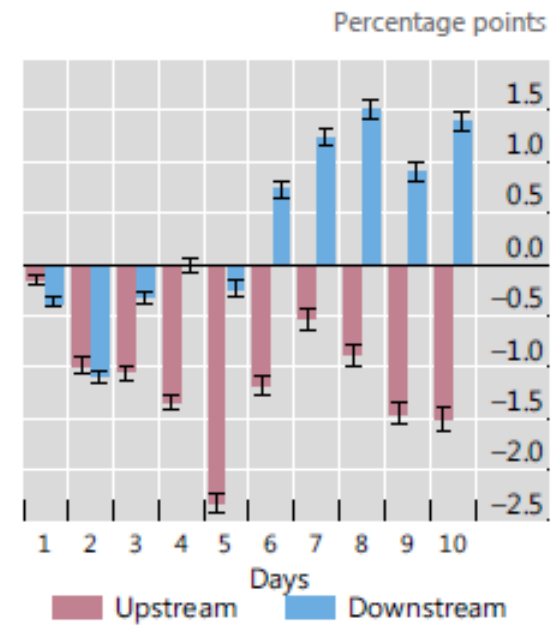
### Impact of lockdown announcement



### Impact from January China lockdown



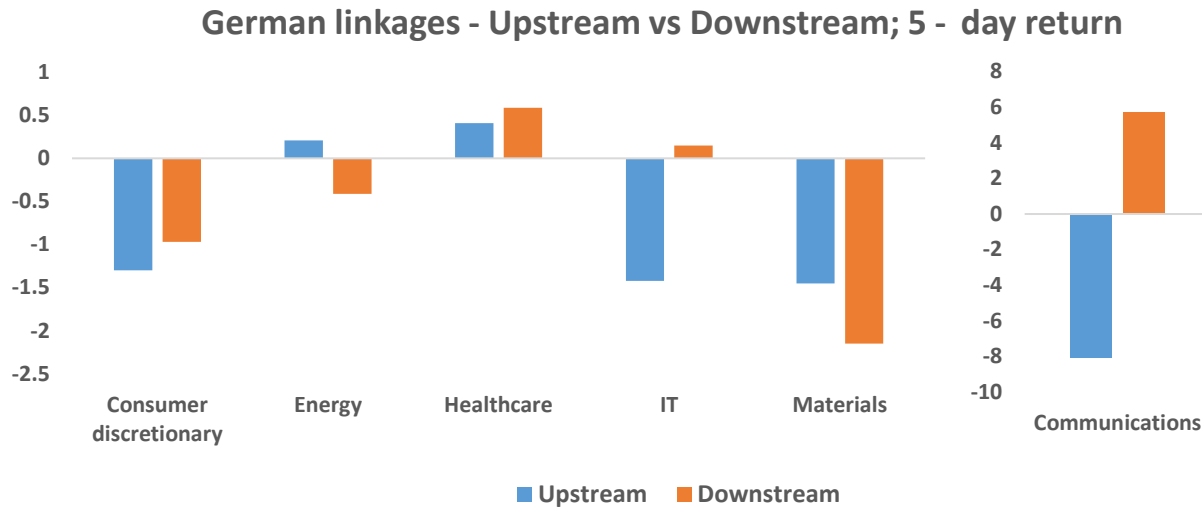
### Impact from March German lockdown



Source: Capital IQ, authors' calculations

# Sectors matter

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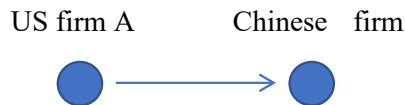
- Those with disruptions to inputs underperformed:
  - Eg, consumer discretionary, energy and industrial materials;
- Those with strong demand outperformed:
  - Eg, healthcare, information technology and communication services
  - ... boosted by investor optimism on stronger demand for medical and work-from-home-related IT products using German inputs

# Network distance matters -

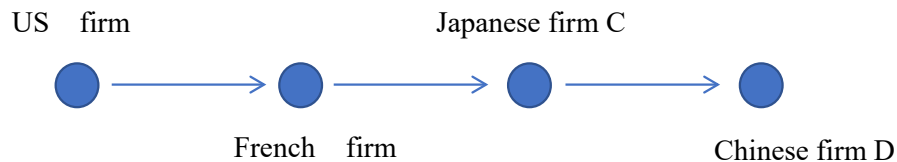
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## Illustrative example - direct and indirect upstream exposure of a US firm to a Chinese firm

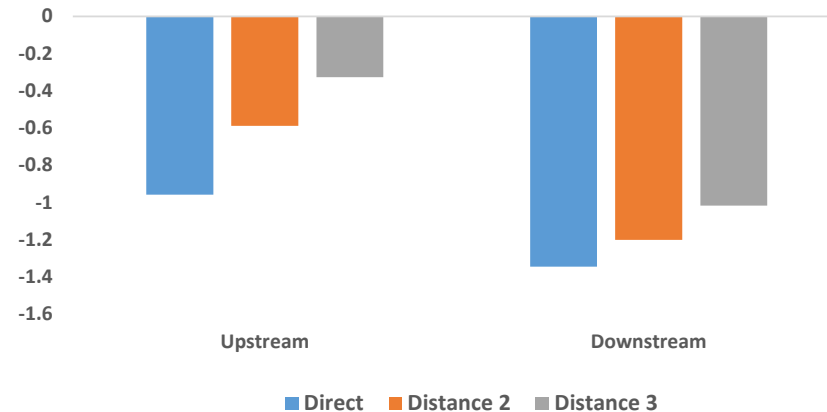
### Direct upstream linkage:



### Indirect upstream linkage:



## German linkages - Network distance



- Both direct and indirect supply chain linkages matter
- Propagation effects tend to weaken as the shock travels along the supply chain:
  - Negative equity price responses diminishes with the distance to affected firms in the production network

# Conclusion

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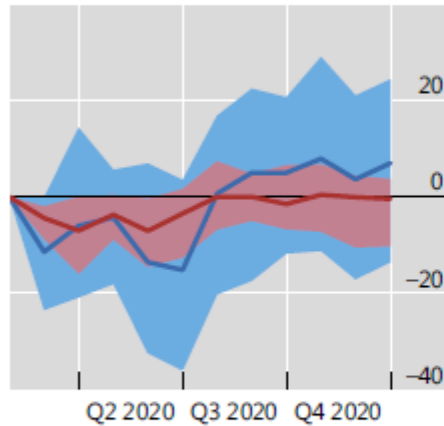
- **GVC networks are complex; necessary to go granular:**
  - Firm-level interlinkages have the potential to drive aggregate GVC trends
  - Decouple vs deglobalize:
    - ✦ Companies in capital intensive sectors – eg, auto and IT – remain complex and highly interconnected; difficult to “decouple” entirely in the short term
- **GVC links can amplify the effect of supply shocks on company share prices**
  - The nature of shock matters
- **Sectors matter**
  - Sectoral response differs even amongst those with similar linkages (eg, downstream firms)
  - The impact fades with greater network distance



# Annex

# Recovery from the Covid pandemic varied across sectors

Number of shippers and shipment quantity per shipper<sup>1</sup>



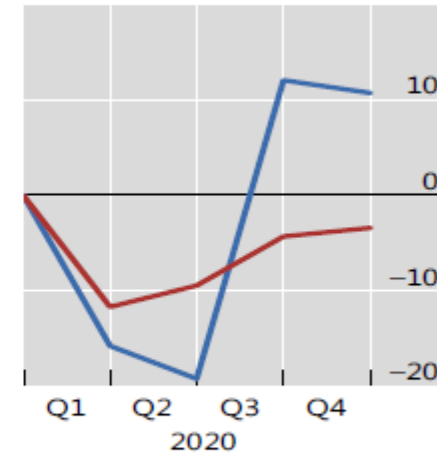
Median: Number of firms (red line), TEU quantity (blue line)  
 Interquartile range: Number of firms (red shaded area), TEU quantity (blue shaded area)

Energy extraction



2020  
 Number of shippers (red line), TEU quantity (blue line)

Consumer discretion



2020  
 Number of shippers (red line), Volume per recipient (blue line)

Footnote<sup>1</sup> Average of twenty-foot equivalent units (TEU) per consignee across respective industries. TEUs measure shipment cargo capacity.

Sources: US Census Bureau; Datamyne; authors' calculations.

- Different pace of recovery:
  - The number of shippers: **38%** of sectors returned to or exceeded pre-pandemic levels
- Expanded production cushioned disruptions:
  - The volume of shipment: **50%** of sectors returned to or exceeded pre-pandemic levels

# Sectors matter -

(b) Firm equity returns and Germany supply chain linkages – industry interactions, local projections.

Dependent variable: Firm equity return (%)	(t + 1)	(t + 5)		
Market return (%)	0.621*** (0.016)	0.746*** (0.016)		
<b>Virus lockdown dummy * the following GICS sub-sectors</b>				
Communication services	0.492*** (0.040)	1.69*** (0.058)		
Consumer discretionary	-1.66*** (0.029)	-2.30*** (0.054)		
Consumer staples	2.80*** (0.035)	6.08*** (0.069)		
Energy	-2.56*** (0.085)	-2.14*** (0.151)		
Healthcare	0.134*** (0.046)	3.48*** (0.076)		
Industrials		(baseline)		
Information technology	-0.788*** (0.034)	-0.934*** (0.051)		
Materials	2.54*** (-0.036)	3.57*** (0.079)		
<b>Virus lockdown dummy * the following linkage dummies (in columns) * the following GICS sectors (in rows):</b>				
	<b>Upstream</b>	<b>Downstream</b>	<b>Upstream</b>	<b>Downstream</b>
Communication services	-2.95*** (0.124)	0.674*** (0.144)	-8.04*** (0.219)	5.68*** (0.221)
Consumer discretionary	1.92*** (0.0431)	-0.585*** (0.0448)	-1.33*** (0.0745)	-0.967*** (0.0730)
Consumer staples	-1.51*** (0.0625)	-0.307*** (0.0499)	-3.60*** (0.101)	-2.28*** (0.0749)
Energy	-0.293*** (0.0900)	-1.87*** (0.0919)	0.207* (0.121)	-0.407*** (0.129)
Healthcare	1.45*** (0.0658)	-0.535*** (0.0721)	0.408*** (0.0967)	0.588*** (0.102)
Industrials	-0.0986** (0.0394)	-0.0105 (0.0478)	-2.46*** (0.0643)	-0.867*** (0.0763)
Information technology	0.174*** (0.0422)	-0.628*** (0.0459)	-1.42*** (0.0709)	0.152** (0.0730)
Materials	-0.333*** (0.0383)	-0.829*** (0.0421)	-1.45*** (0.0652)	-2.15*** (0.0725)
Observations	6,885,940		6,802,809	
Number of firms	20,773		20,773	
Adj. R-squared	0.042		0.102	

# Network distance matters

Firm equity returns and China / Germany supply chain linkages – network distance.

Dependent variable: Firm equity return (%)	(1)	(2)
Market return (%)	0.634*** (0.025)	0.634*** (0.025)
<b>Virus lockdown dummy * the following linkage dummies</b>		
<i>China</i>		
Direct upstream linkage	-0.813*** (0.129)	-0.815*** (0.132)
Indirect upstream linkage	-0.270*** (0.047)	
Distance 2		-0.435*** (0.107)
Distance 3		-0.194*** (0.058)
Direct downstream linkage	-0.508*** (0.137)	-0.493*** (0.138)
Indirect downstream linkage	-0.283*** (0.057)	
Distance 2		-0.471*** (0.073)
Distance 3		-0.280* (0.149)
<i>Germany</i>		
Direct upstream linkage	-0.983*** (0.029)	-0.957*** (0.030)
Indirect upstream linkage	-0.354*** (0.027)	
Distance 2		-0.588*** (0.032)
Distance 3		-0.327*** (0.041)
Direct downstream linkage	-1.323*** (0.038)	-1.345*** (0.041)
Indirect downstream linkage	-0.825*** (0.022)	
Distance 2		-1.200*** (0.030)
Distance 3		-1.016*** (0.036)
Observations	6,313,588	6,313,588
Number of firms	19,048	19,048
Adj. R-squared	0.093	0.093

THANK YOU