Industrial Clusters, Networks and Resilience to the Covid-19 Shock in China

Ruochen Dai, China Central University of Finance and Economics
Dilip Mookherjee, Boston University
Yingyue Quan, Peking University
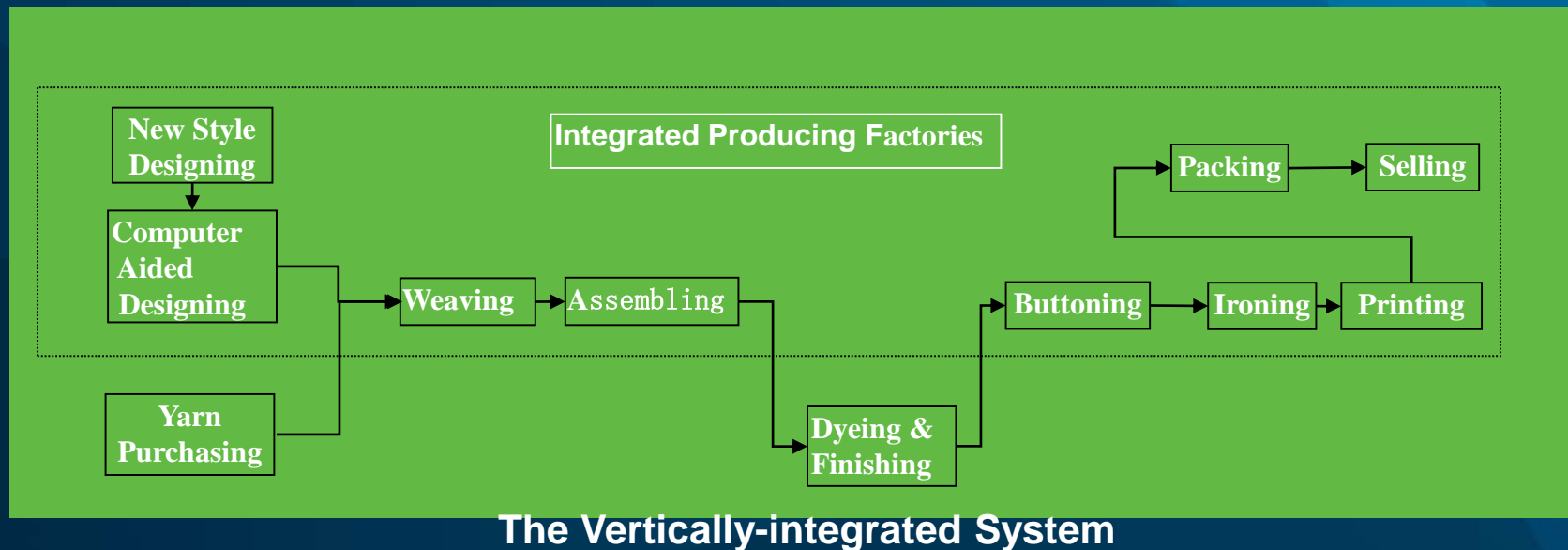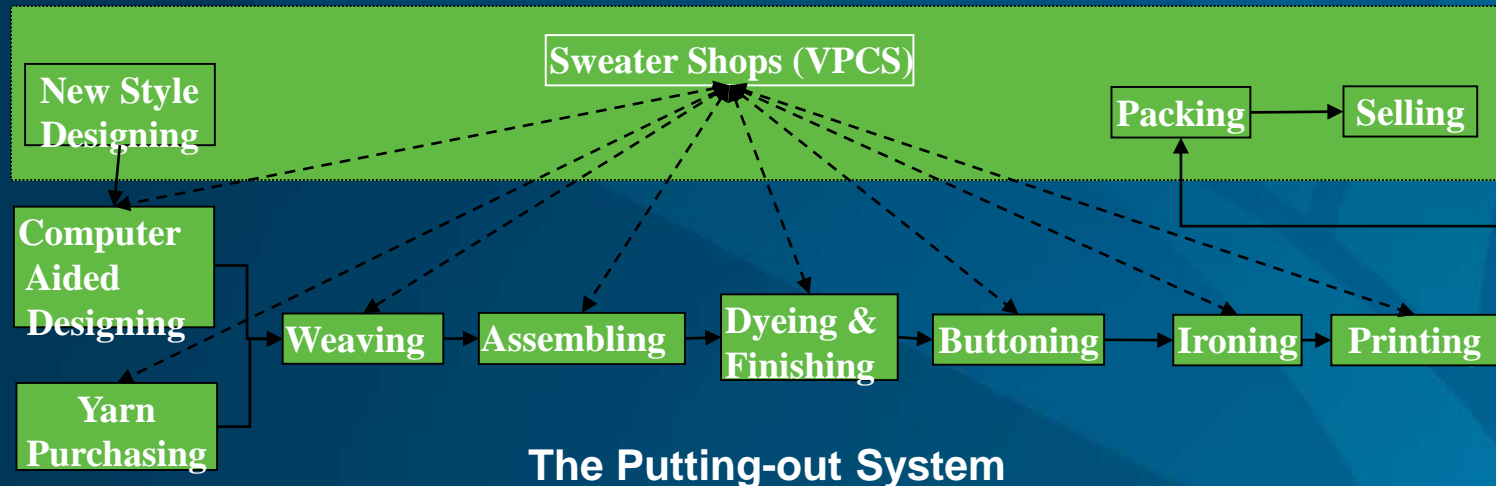Xiaobo Zhang, IFPRI and Peking University

Clusters in China and other LDCs

- Production clusters play a particularly important role in LDC industries, but have some distinct characteristics from their DC counterparts:
  - vertically disintegrated, high specialization in different stages of production
  - small capital size, low inventories
  - proximity to suppliers and customers
  - strong buyer-seller networks
  - sharing of orders, extensive subcontracting, trade credit, local market infrastructure
  - informal agreements rather than formal contracts

- Prevalent in China, Bangladesh, India, and many African countries; Were prevalent in the early stage of development in developed countries, such as UK and US.

- Firms in DC tend to be larger, more vertically integrated, located far from suppliers and markets, using formal contracts

Large manufacturing factory

Two business models in Puyuan Cashmere Sweater Cluster

Sweater Shops (VPCS)

New Style Designing

Computer Aided Designing

Yarn Purchasing

Weaving → Assembling → Dyeing & Finishing → Buttoning → Ironing → Printing

Packing → Selling

The Putting-out System

Integrated Producing Factories

New Style Designing

Computer Aided Designing

Yarn Purchasing

Weaving → Assembling → Dyeing & Finishing → Buttoning → Ironing → Printing

Packing → Selling

The Vertically-integrated System

Ruan and Zhang, EDCC(2009)

Markets in Puyuan

Marketplaces for inputs and final products are a defining feature of clusters

Production organizers

Buyers

Shop owners
Most from Puyuan and Anhui

More than 3,000 such shops

Family workshops

Weaving

Printing

Workers/entrepreneurs

Sewing
From Sichuan

Transpiration, from Henan

Local population: 30,000
Migrants: >100,000

Cutting extra threads

Suitable Cluster Measures for LDC contd.

- Puyuan cashmere cluster in Tongxiang county contains seven different 3-digit industries (with county employment share in the country exceeding 1%) corresponding to different stages of making sweaters
  - silk spinning/printing/dyeing (174)
  - wool spinning/printing/dyeing (172)
  - manufacturing of knitted fabrics (176)
  - leather tanning/processing (191)
  - fur tanning/processing (193)
  - synthetic fiber manufacturing (282)financial information services (694)

- In a more vertically integrated firm, these would have been within the same firm, resulting in lower measure of diversity

Suitable Cluster Measures for LDC

- As shown in the Puyuan case: LDC clusters often involve co-existence of firms in different (but related) industries (e.g., upstream-downstream linkages, diverse products sharing common inputs), which end up with lower measures of regional specialization

- **One consequence of these differences**: Regional specialization indices (HHI, CR3, Krugman) do not adequately measure presence of LDC clusters (Ruan and Zhang 2015)

Ruan-Zhang Cluster Index

- Ruan-Zhang develop a cluster index better suited to LDC context, based on inter-industry proximity measure (`related industries', based on similarity of `revealed comparative advantage' (RCA))

- Measure of **proximity** of industries *i* & *j* (based on employment E_{ri} & E_{rj} across regions *r*):

$$\emptyset_{ij}^e = \min\{P(LQ_{ri} > 1 | LQ_{rj} > 1), P(LQ_{rj} > 1 | LQ_{ri} > 1)\}$$

Where

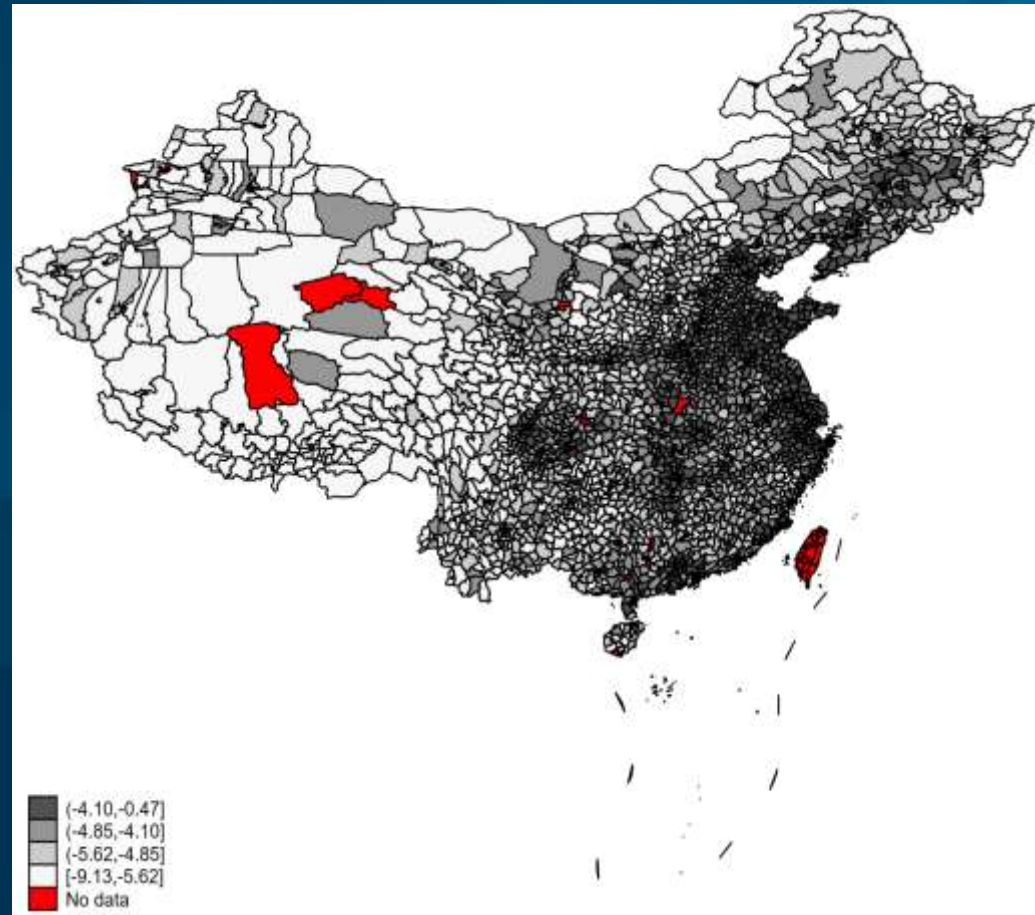$$LQ_{rj} = \frac{E_{rj}/E_r}{E_{cj}/E_c}$$

$P(LQ_{ri} > 1 | LQ_{rj} > 1)$ is the conditional probability that industry *i* in region *r* also reveals a comparative advantage if industry *j* in region *r* reveals a comparative advantage, i.e. Location quotient $(LQ_{rj}) > 1$.

- Region cluster index (employment-based): $\emptyset_r^e$ weighted average of $\emptyset_{ij}^e$ using employment weights

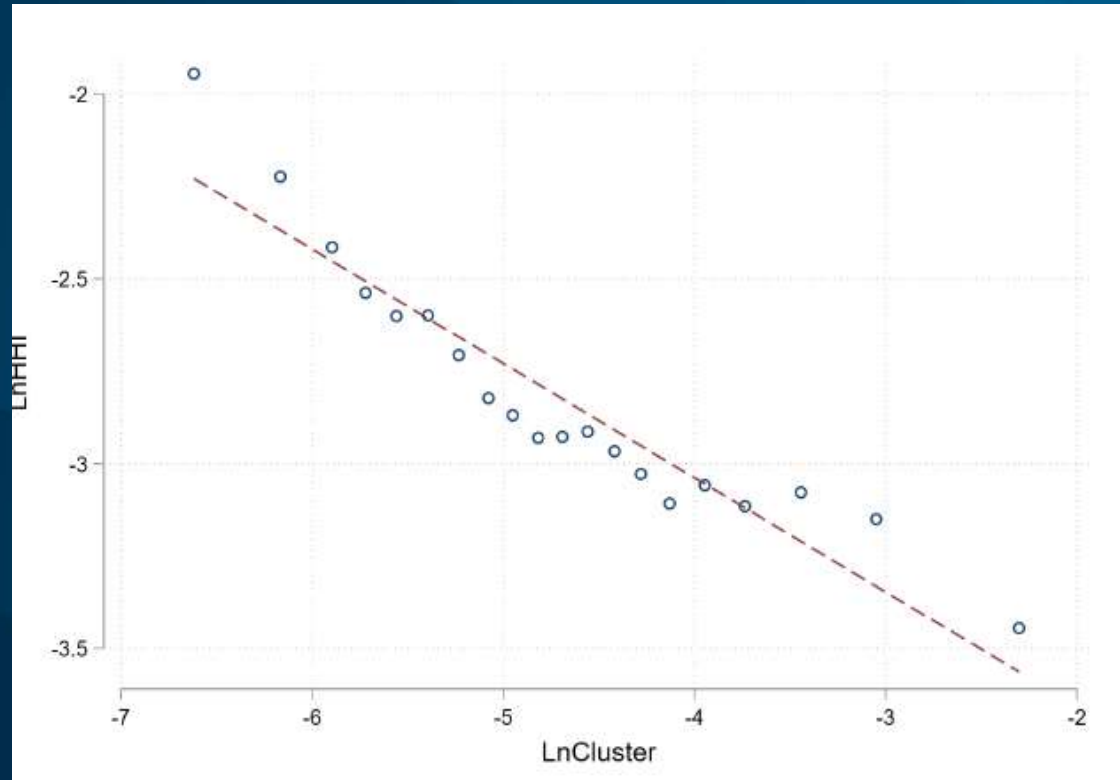- Finally average across employment, output, capital-based cluster indices

Ruan-Zhang Cluster Measure

- Calculated by Ruan-Zhang using SIC3 classification at county level based on 2008 China Economic Census

- Successfully predicts 53 out of top 100 clusters identified by Chinese industry and government experts, compared with maximum of 3 predicted by various regional specialization indices (CR3, Gini, HHI, Krugman, Ellison-Glaeser)

- Regional specialization tends to be highest in areas with fewer firms and fewer industries located inland; while RZ cluster measure highest in SE China coast (Guangdong, Shanghai, Zhejian, Jiangsu)

Prevalence of Clusters (Using RZ measure)

■	(-4.10,-0.47]
■	(-4.85,-4.10]
■	(-5.62,-4.85]
□	[-9.13,-5.62]
■	No data

Cluster-HHI correlation is negative!

Possible interpretation: think of Chinese clusters as diverse ecosystems composed of many different kinds of small plants belonging to related symbiotic species (rather than a collection of large trees)

Features of Clusters

- Proximity to the market (buyers and suppliers) (Marshall, 1920)

- Low capital intensity and prevalence of trade credit

- A large share of non-local workers

- Informal cooperation among social networks of entrepreneurs

Role of Hometown Community Networks

- High vertical disintegration accompanied by high volume of trades and sharing of inputs/technology/customers across firms within the cluster, based on informal agreements rather than formal contracts

- Informal agreements can be thought of as `relational' contracts, sustained by long-term relationships and social sanctions

- Community networks consequently play an important role (e.g., third-party community enforcement a la Greif (1994))

Most transactions are based on oral contracts or just a receipt

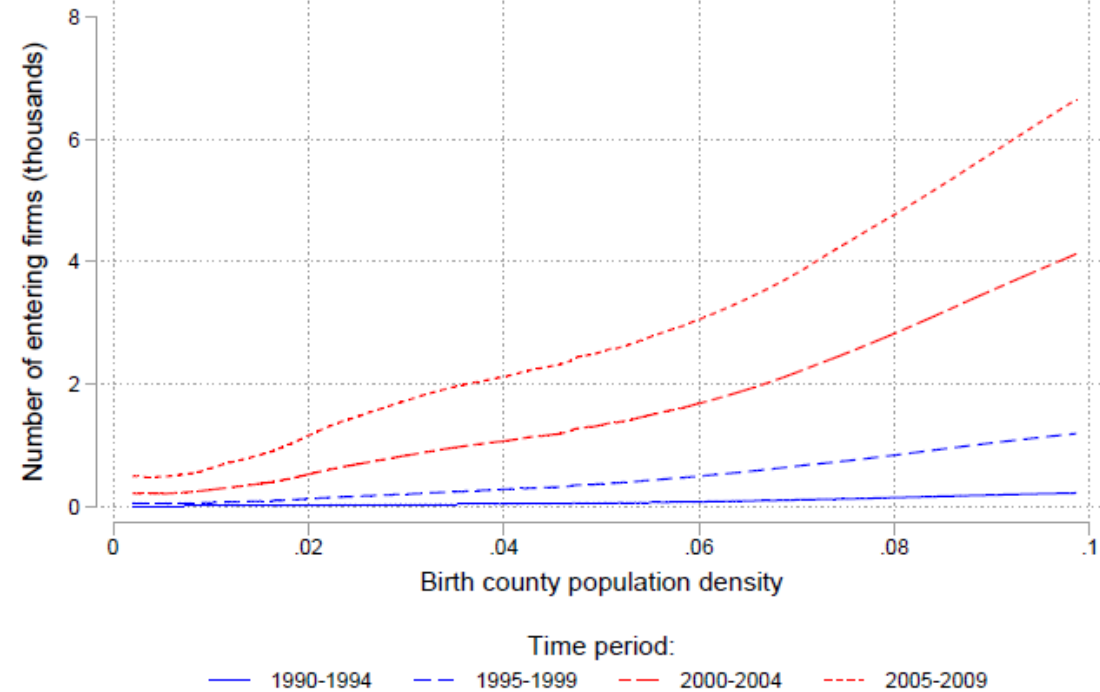# Examples of Hometown-Network Economy (老乡经济)

- Copy shops at PKU: all but one are from Xinhua county of Hunan province

- Nannies: Wuwei of Anhui province

- Private hospitals: Putian of Fujian province

- Gold mining in Ghana: Shanglin county of Guangxi

- Shaxian fast food

  (沙县小吃)

- Harvesting cluster in Peixian, Jiangsu

Role of Hometown Community Networks, Dai *et al* (2018) Results

- Our earlier work with Kaivan Munshi (Dai *et al* 2018) examined the role of networks of Chinese entrepreneurs from the same hometown (birthplace) in entry and growth of private firms over 1990-2009 period, also using firm registration data

- `Quality' of hometown network is proxied by historical (1982) population density of hometown origin (controlling for population, occupation structure and education) — because pop density for county (but not city) origins are strongly positively correlated with measures of local trust, social interactions, cross-ownership and network connectedness of firms

- Data confirmed predictions of a network-based model of firm dynamics: high pop density (county hometown) networks achieved higher and faster growing entry rates, smaller entering firm size, followed by faster size growth

Hometown Pop Density and Firm Entry Rates, 1990-2009

Source: SAIC registration database and 1982 population census.

Covid-19 Restrictions

- Timing of Covid19 lockdown: right before the Chinese New Year

- 26 provinces allowed businesses to reopen on February 10 (two weeks after the lockdown). However, there were still restrictions on labor mobility and logistics disruptions across provinces

- Restrictions on Hubei Province were lifted on April 8.

Now for the Main Question

- Facing restrictions on labor mobility and logistics disruptions, were high cluster regions better able to cope with the Covid-19 shock?

- If so, to what extent did this owe to stronger entrepreneur networks, measured by hometown pop density and HHI? (e.g., owing to better enforced relational contracts that sustain more risk-sharing)

Empirical Research

- Examine fluctuations in monthly (or weekly) entry rates in the first half of 2020, comparing these to monthly (or weekly) rates during 2015-2019, controlling for year, county, and industry dummies, using firm registration data

- Estimate differences between 2020 monthly (weekly) entry rates and previous years, 4 month after Chinese New Year (the starting time of the lockdown) and 6 months before

- Estimate separately for high (above median) vs low (below median) cluster regions, or interact 2020 month (week) dummies with cluster index of the region

- Later corroborate with responses to entrepreneur phone surveys in Feb and May 2020

Preliminary Regression Specification

For each (High/Low Cluster) sub-sample (2017-2020):

$$Perfirm_{ijtm} = \alpha + \Sigma_m \xi_m D_m \times D_{2020} + \lambda_i + \eta_j + D_m + D_{2020} + \epsilon_{ijtm},$$

where

$Perfirm_{ijtm}$: log(per capita entry + 0.001)

D_m: dummy = 1 if month = m;

D_{2020}: dummy = 1 if year = 2020;

λ_i: county fixed effect;

η_j: industry fixed effect;

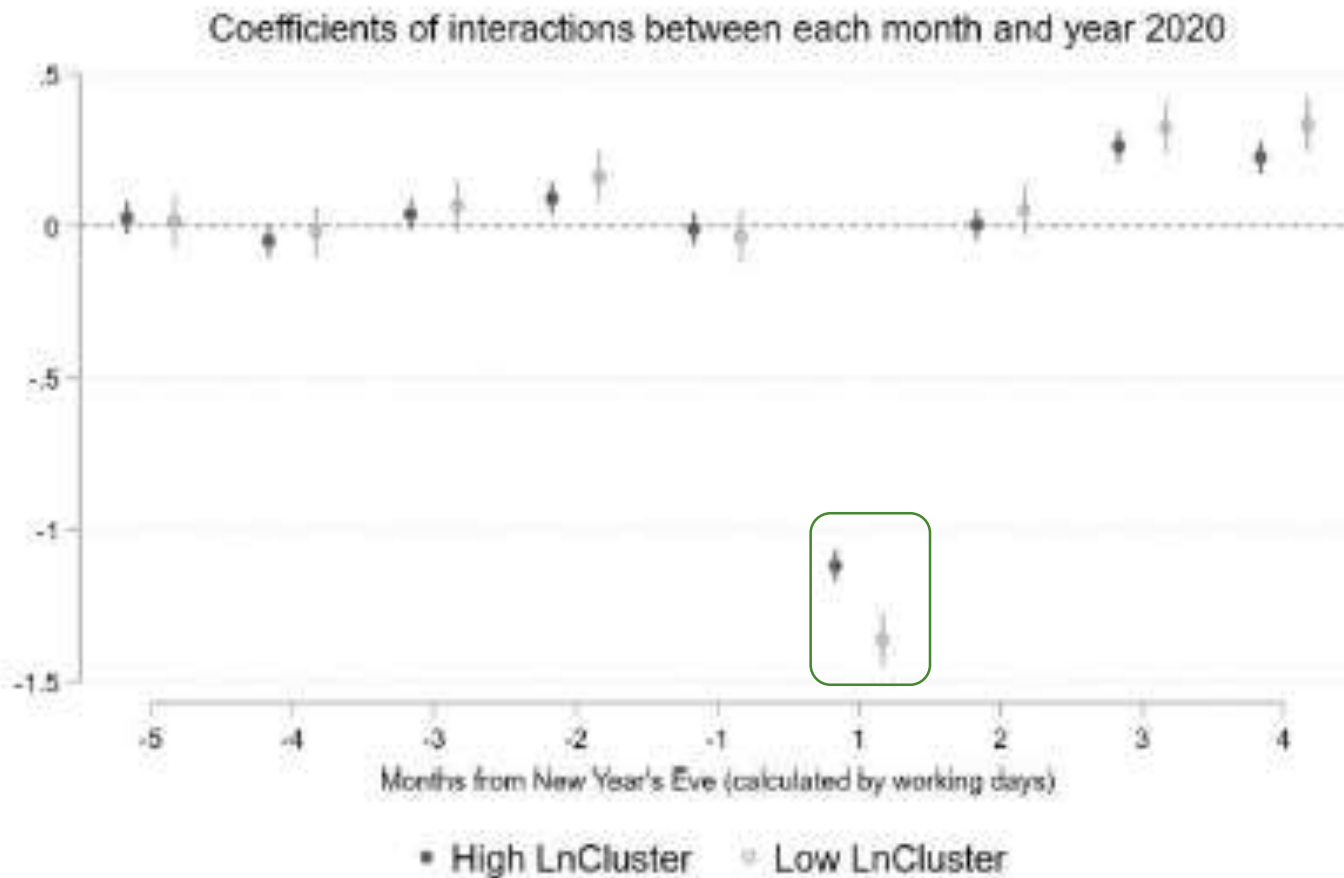i, j, t, m denote county, industry, year and month separately.

Hubei, Xinjiang, Qinghai, Tibet, and Inner Mongolia are excluded from the sample

Three follow-up phone interviews on SMEs

- In the early February, we launched a rapid follow-up interview with a representative sample of private entrepreneurs from a database (Enterprise Survey for Innovation and Entrepreneurship in China, ESIEC) we gathered in 2017-2019: 2,335 SMEs.

- In the mid-May, we conducted the second-wave phone survey and successfully interviewed 2,452 SMEs.

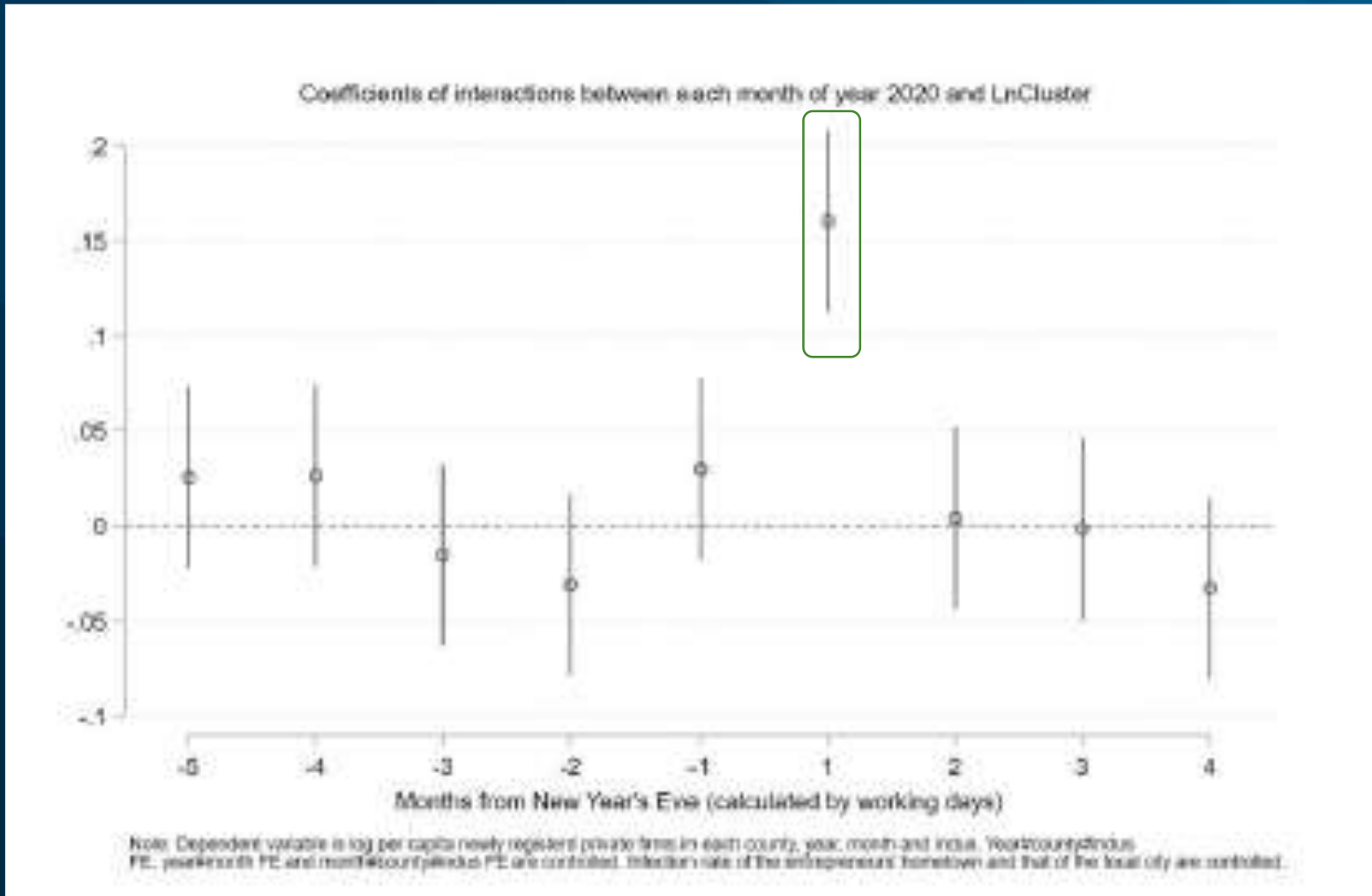- In the mid-August, the third round of phone survey was conducted.

By High and Low Cluster Regions

Coefficients of interactions between each month and year 2020

Months from New Year's Eve (calculated by working days)

• High LnCluster   ○ Low LnCluster

V-shaped recovery

Firm entries in high-cluster and low-cluster areas dropped by 67% and 74%

Interaction of Covid Shock with Cluster Index

Coefficients of interactions between each month of year 2020 and LnCluster

Months from New Year's Eve (calculated by working days)

Note: Dependent variable is log per capita newly registered private firms in each county, year, month and indus. Year#county#indus. FE, year#month FE and month#county#indus FE are controlled. Infection rate of the entrepreneurs' hometown and that of the local city are controlled.
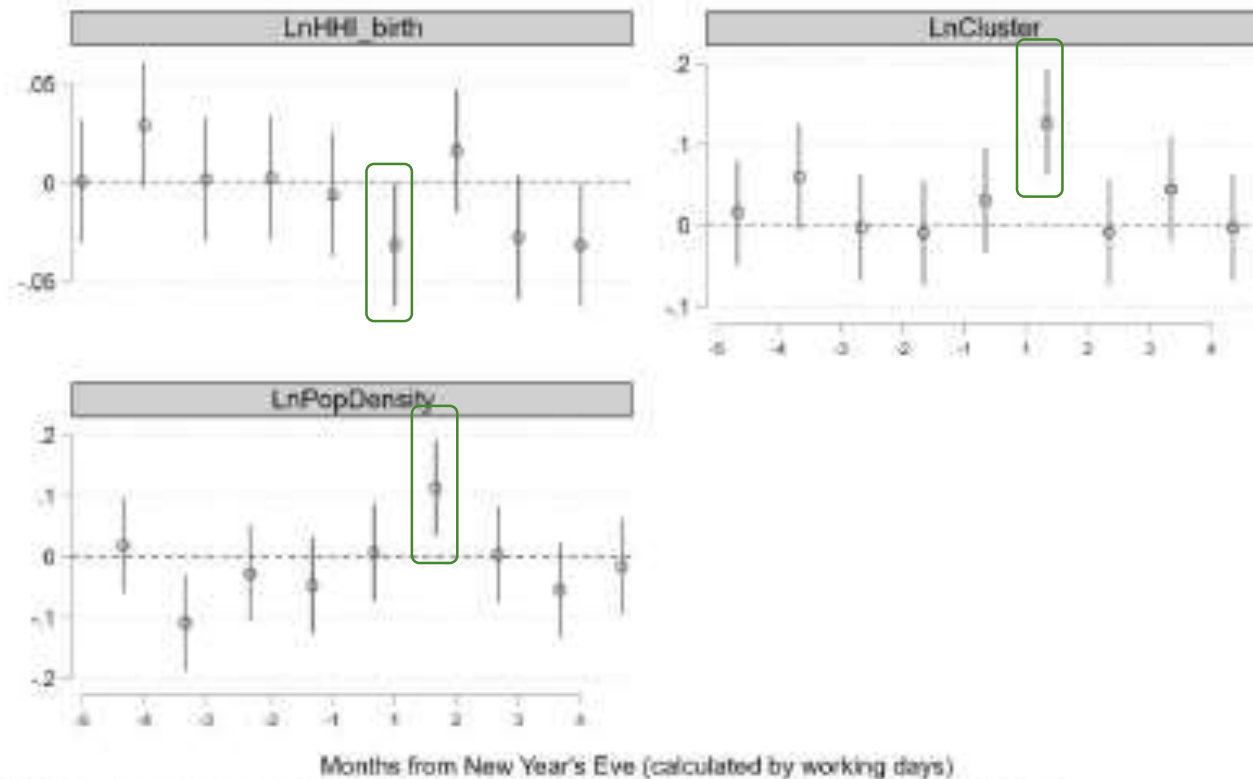
A one s.d. increase in the cluster index was associated with a 12% rise in the entry rate.

Role of Hometown Networks in Resilience

- Now we assess the extent to which greater resilience of high cluster regions can be accounted for by their reliance on higher quality hometown entrepreneur networks

- Use two measures of hometown networks:
  - average pop density of hometowns of entrepreneurs with firms located in a given county
  - spatial HHI of hometown origins

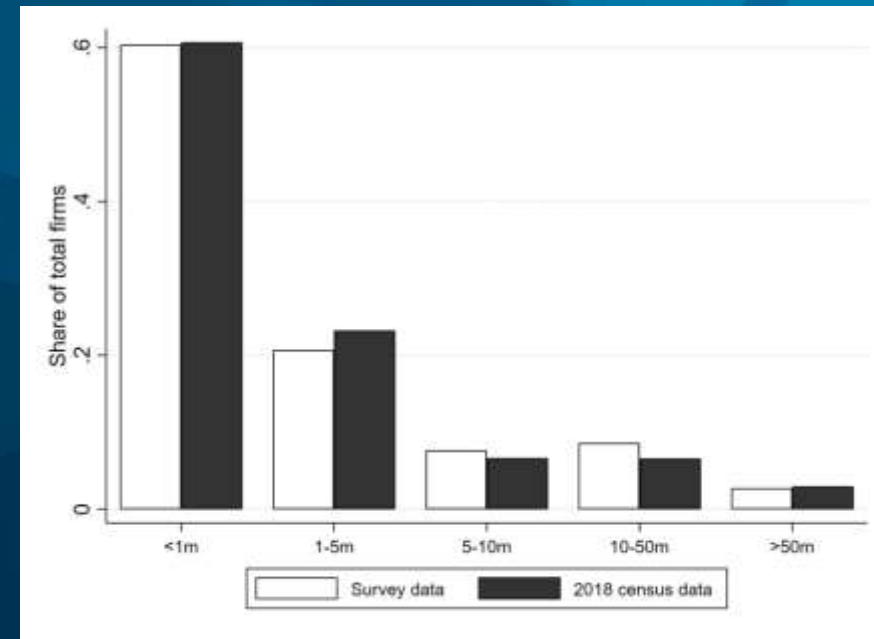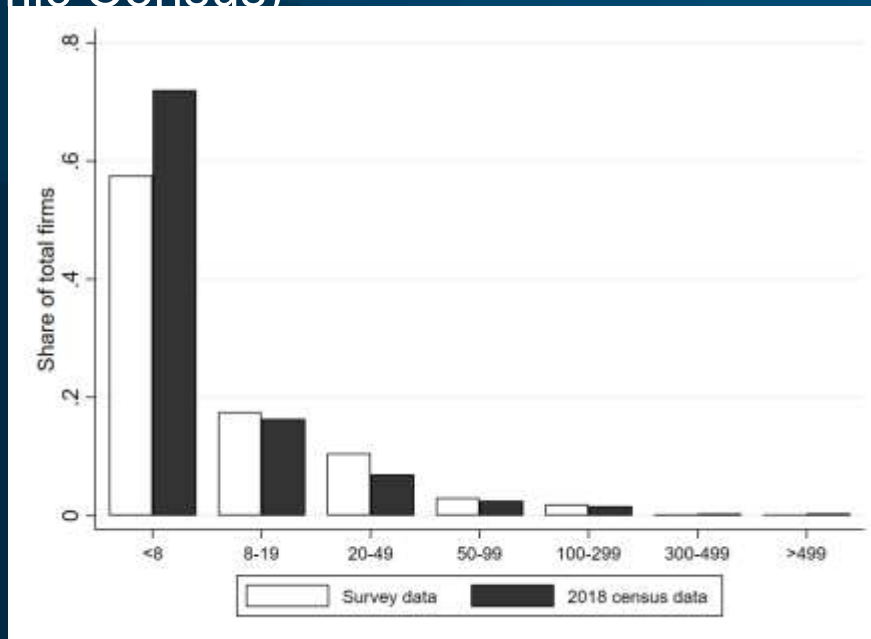# Interactions of Covid Shock with Cluster Index, Population Density Origins, and Hometown HHI

Spatial concentration of hometowns has a negative effect

Hometown pop density has a positive effect in the 1st month

Role of clustering *per se* remains robust: indicating other benefits of clusters beyond related hometown network effects
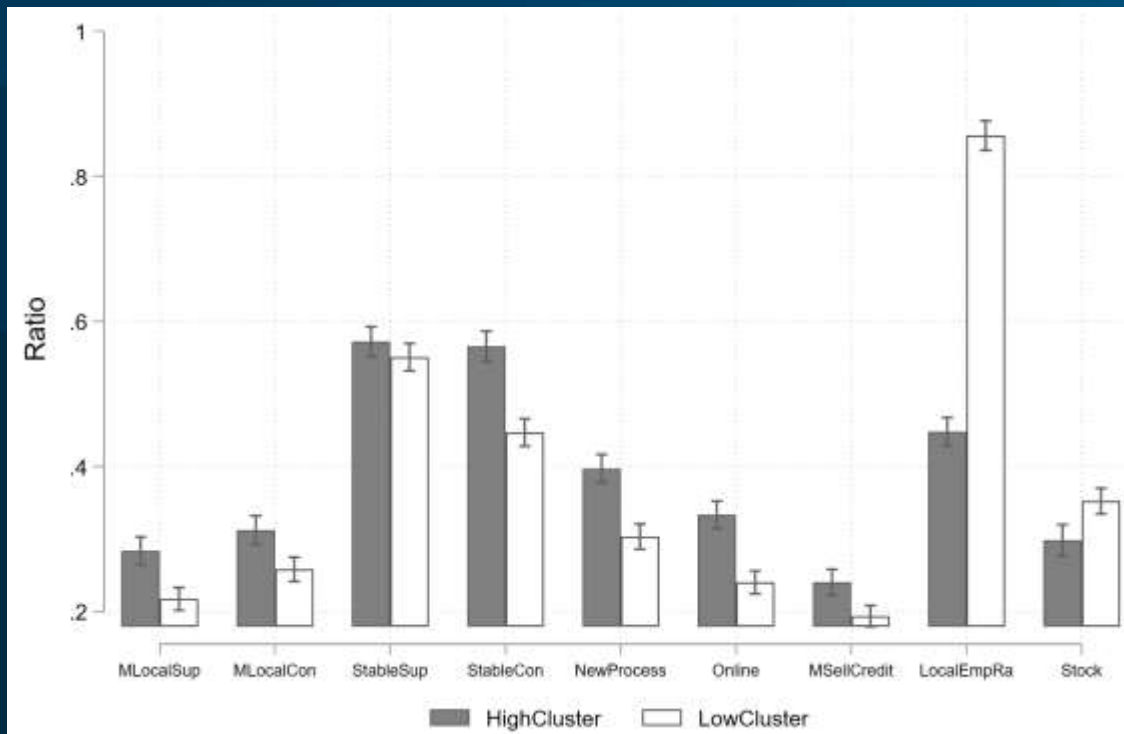
Entrepreneur Survey Data

- We corroborate these results regarding superior resilience of clusters using two waves of phone surveys with previously interviewed entrepreneurs in the baseline survey (Enterprise Survey for Innovation and Entrepreneurship in China (ESIEC), 2017-2019) in Feb and May 2020.

- About 2,400 entrepreneurs each wave. Response rate about 50%. Although the sample is representative only at the province level, it resembles the national distribution (2018 Economic Census)
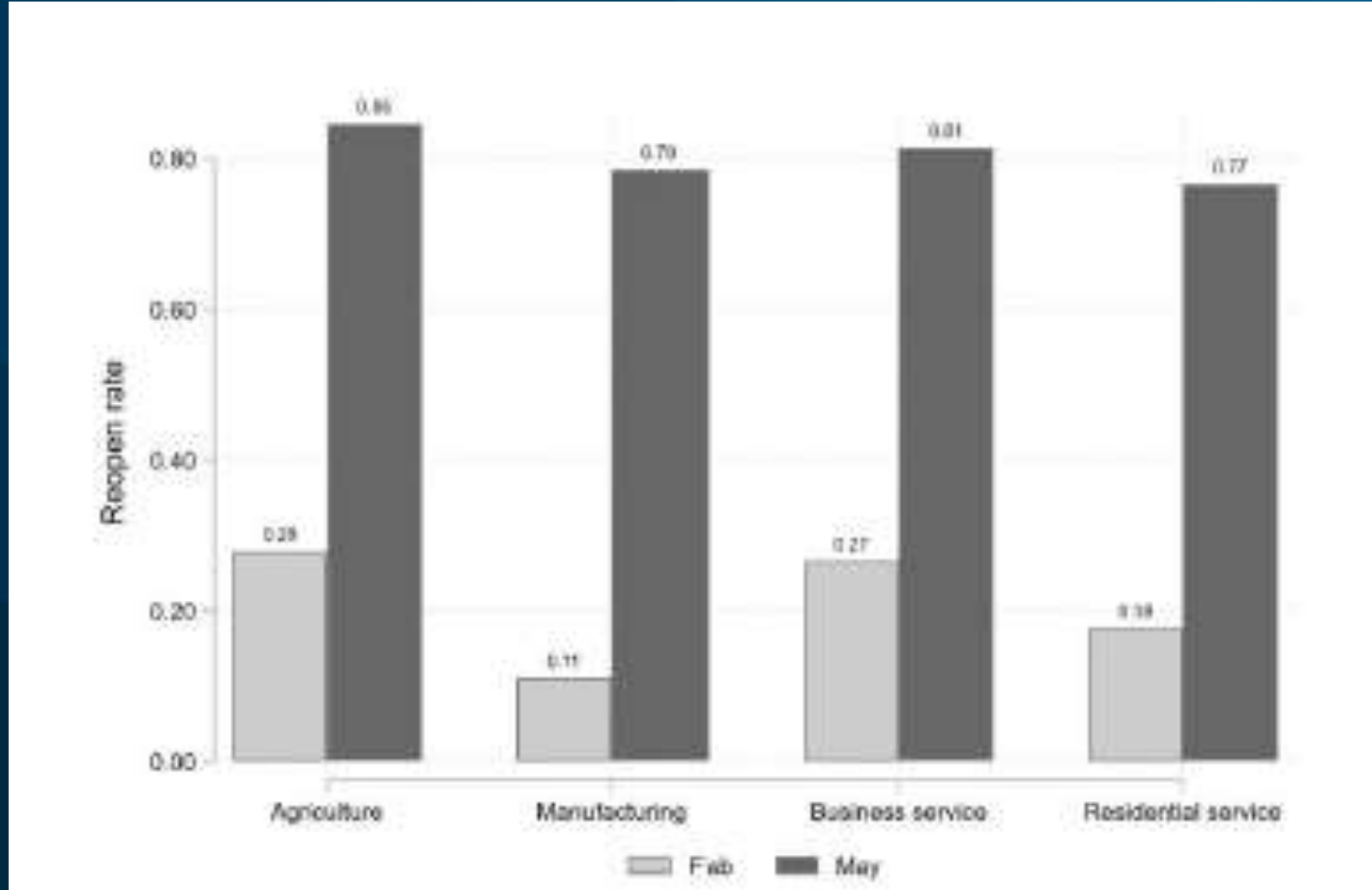
Clusters and Related Attributes

- Questions in the surveys include whether enterprise is operating normally, whether it has local/stable suppliers/customers, trade credit, online sales, innovation, reliance on local workers, and inventories.

Firms in clusters have

- **More local (stable) suppliers/costumers**
- **More innovations**
- **More online sales**
- **More widespread use of trade credit**
- **Lower percentage of local workers**
- **Lower level of inventory**

Reopening Rate in Feb and May by Sector

Also a V-shaped recovery

Variation of Normal Operation with Cluster Index, Pop Density, and HHI of Hometown Origins in Feb & May

VARIABLES	(1) RunWell2	(2) RunWell2	(3) RunWell2	(4) RunWell2	(5) RunWell5	(6) RunWell5	(7) RunWell5	(8) RunWell5
LnCluster		0.072		0.065		0.044		0.047
		(0.013)		(0.013)		(0.010)		(0.010)
LnPopDensity	0.005	-0.040	0.002	-0.038	-0.063	-0.091	-0.067	-0.096
	(0.016)	(0.018)	(0.016)	(0.017)	(0.017)	(0.016)	(0.017)	(0.016)
LnHHI_birth	0.010	-0.007	0.007	-0.007	0.013	0.000	0.013	0.000
	(0.010)	(0.012)	(0.010)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)
PerInfect	-0.017	-0.210	-0.024	-0.192				
	(0.054)	(0.068)	(0.051)	(0.067)				
OffSeason	-0.101	-0.094	-0.083	-0.080	-0.015	-0.008	-0.026	-0.021
	(0.026)	(0.026)	(0.025)	(0.025)	(0.024)	(0.025)	(0.024)	(0.025)
Constant	0.222	0.407	0.219	0.383	0.563	0.662	0.553	0.657
	(0.076)	(0.090)	(0.074)	(0.089)	(0.069)	(0.070)	(0.069)	(0.069)
Observations	1,699	1,699	1,699	1,699	1,816	1,816	1,816	1,816
Adjusted R-squared	0.026	0.046	0.039	0.055	0.010	0.024	0.041	0.055
Indus FE	YES	YES			YES	YES		
SIC-1 indus FE			YES	YES			YES	YES

Robust standard errors in parentheses

Infection rate

Low season

Dependent variable=1 if the business opened at the time of survey

Summary

- Counties with greater presence of clustering were less adversely affected by the covid shock in terms of both entry of new firms and performance of incumbents.

- It provides evidence of and insight into possible reasons for the superior capacity of production clusters to withstand external shocks in a volatile environment with underdeveloped formal markets and institutions — resulting from a combination of informal network-based cooperation, risk-sharing and spatial proximity among buyers and sellers.