Firm Production Network and the Propagation of Firm Exits: Evidence from Japanese Firms

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Motivation

- Firm exits have been at the center of policy debate during the COVID-19 pandemic.
- The scale of government supports to save firms has been unprecedented and the measures have taken various forms (grants, direct loans, guarantees, debt moratoria, corporate bond purchases, equity injection, etc).
- As the measures to support firms are wound back, concerns for potential waves of corporate bankruptcies have been raised (Gourinchas et al. (2020, 2021), IMF (2021)).
- Need to better understand how firm exits affect other firms in the supply network

- *Theoretical contributions - Baqaee, 2018; Lim, 2018; Acemoglu and Tahbaz-Salehi, 2020*
- *Empirical quantification limited*

In this project,

- Using the exogenous and regional nature of the Great East Japan Earthquake of 2011, we quantify the propagation of firm exits through firm supply network to *intensive margin* (sales growth), *extensive margin* (firm exits) and *new network formation*.

- Data: Tokyo Shoko Research Ltd. (TSR), covering more than 950,000 firms each year - more than half of all registered firms in Japan

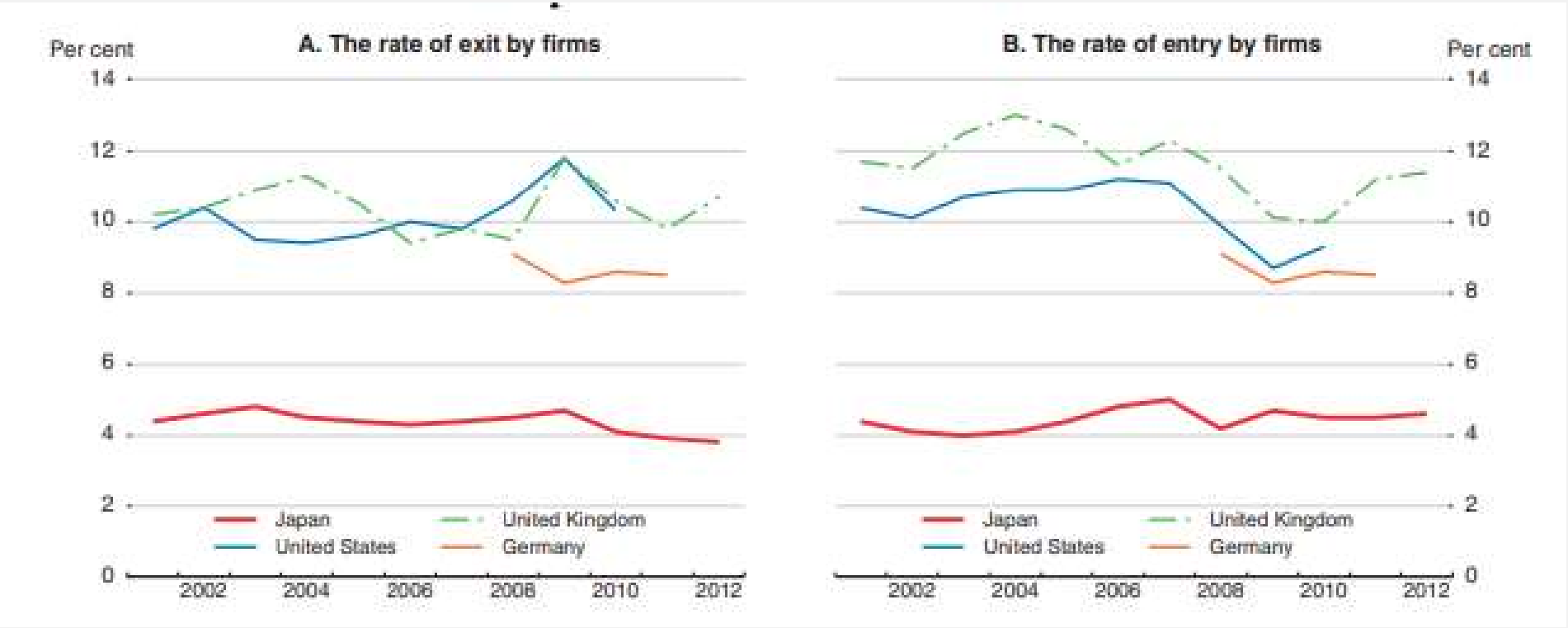
  - ***Firm-Network*:** Up to 24 suppliers and consumers (Bernard et al. 2019; Carvalo et al. 2021)

  - ***Firm-level characteristics***: employment, number of establishments, profits, sales for the past two years, the resulting credit score (assessed by the TSR), a physical address for the firm's headquarters.

  - ***Firm exit***: exit types (bankruptcy, voluntary closures, merger)

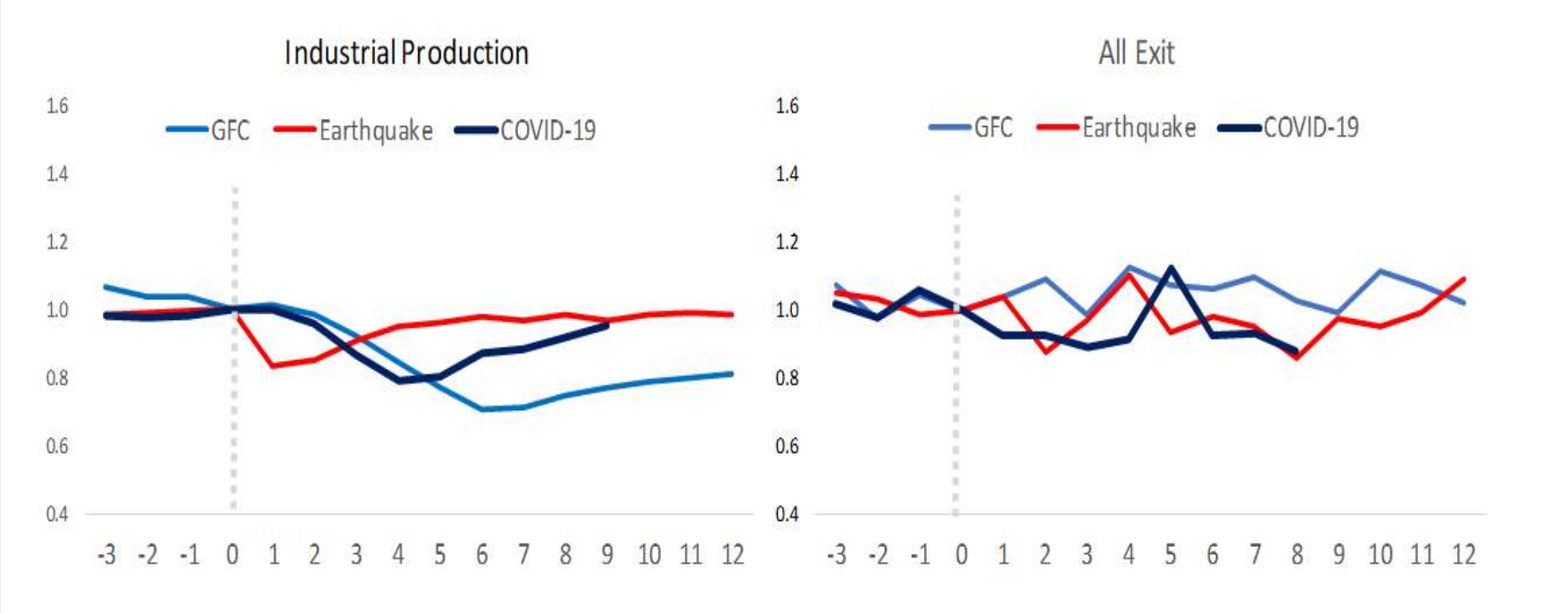
- Lessons we can draw for the Post-COVID

Firm exit and entry rates in Japan are low compared to other advanced countries.



Source: OECD Economic Surveys: Japan, 2017

How did Japanese firms respond to economic shocks?



Note. X-axis represents the number of months before and after the time of the major events. Time t=1 denotes the month when the major event broke out. Y-axis is normalized at time t=0.

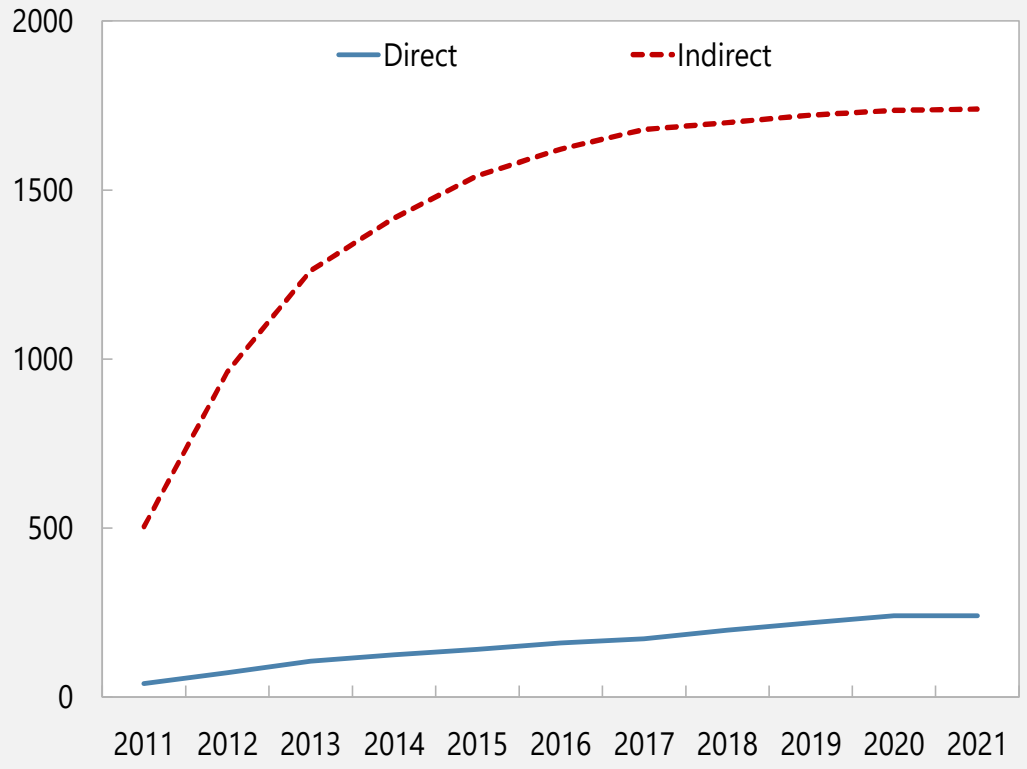
Economic shocks have persistent direct and indirect impact on firm exits.

Firm bankruptcy due to Great East Japan Earthquake

	Direct	Indirect	Total
2011	40	504	544
2012	32	458	490
2013	34	299	333
2014	19	156	175
2015	16	125	141
2016	19	79	98
2017	13	58	71
2018	25	20	45
2019	22	22	44
2020	20	14	34
2021	0	4	0
Total	240	1,739	1,979

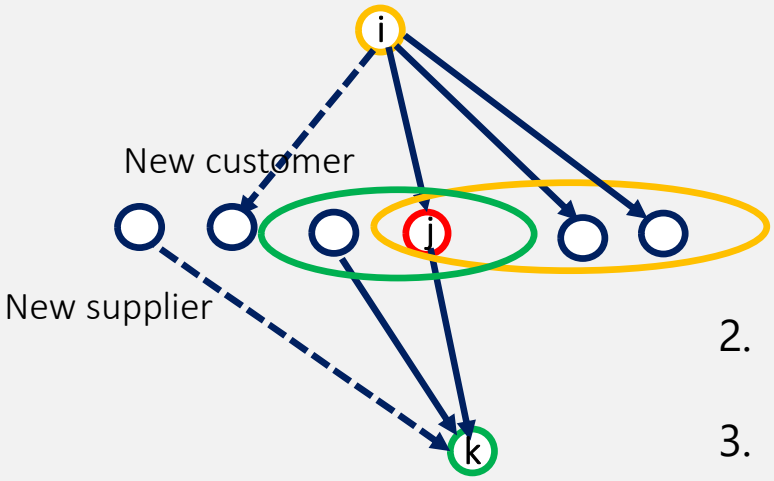
Cumulative Number of Firm Bankruptcies due to the 2011 Earthquake

(Number of firms)



Source: “震災から10年”「東日本大震災」関連倒産状況（2月28日現在）, Tokyo Shoko Research Ltd. (February 28, 2021)

Firm Network of Supplier-Consumer Linkages



1. If firm j exits, how does it propagate to its consumer (k) firm and supplier firm (i)?
   a. Sales growth
   b. Firm Exits
   c. New business connections
2. Does the health of firm j affect the propagation mechanism?
3. Does the health of connected firms (i or k) affect the propagation mechanism?

$Average\ Partner\ Firm\ Exits_{i,t,s/c}$: *for each firm i and year t, share of partners (suppler or customer) that exited*

Partner firms' exits are correlated with firm exits.

	(1)	(2)	(3)	(4)
	Total Exit Rate (t)	**Bankruptcy (t)**	**Voluntary Closures (t)**	**M&A (t)**
Average Partner Exit Rate (t) (Supplier)	0.0174***	0.0154***	-0.00222	0.00415***
	(0.00277)	(0.00175)	(0.00192)	(0.00100)
Controls	Y	Y	Y	Y
Observations	330,989	330,989	330,989	330,989

	(1)	(2)	(3)	(4)
	Total Exit Rate (t)	**Bankruptcy (t)**	**Voluntary Closures (t)**	**M&A (t)**
Average Partner Exit Rate (t) (Consumer)	0.0319***	0.0253***	0.00210	0.00446***
	(0.00290)	(0.00183)	(0.00201)	(0.00105)
Controls	Y	Y	Y	Y
Observations	330,989	330,989	330,989	330,989

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

- An increase in partner's exit rate is positively correlated with the exit of firms, except for voluntary closures (Hong et al. (2020)).

The Great East Japan Earthquake of 2011

Earthquake affected areas: 41 municipalities total

-"36 Severely Affected Municipalities" by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) on April 28, 2011

-" Evacuation Zone": 13 more municipalities, as the evacuation zone (8 overlaps with MLIT)

Identification Strategy:

- IV regression using connections to firms in municipalities directly affected by the Earthquake

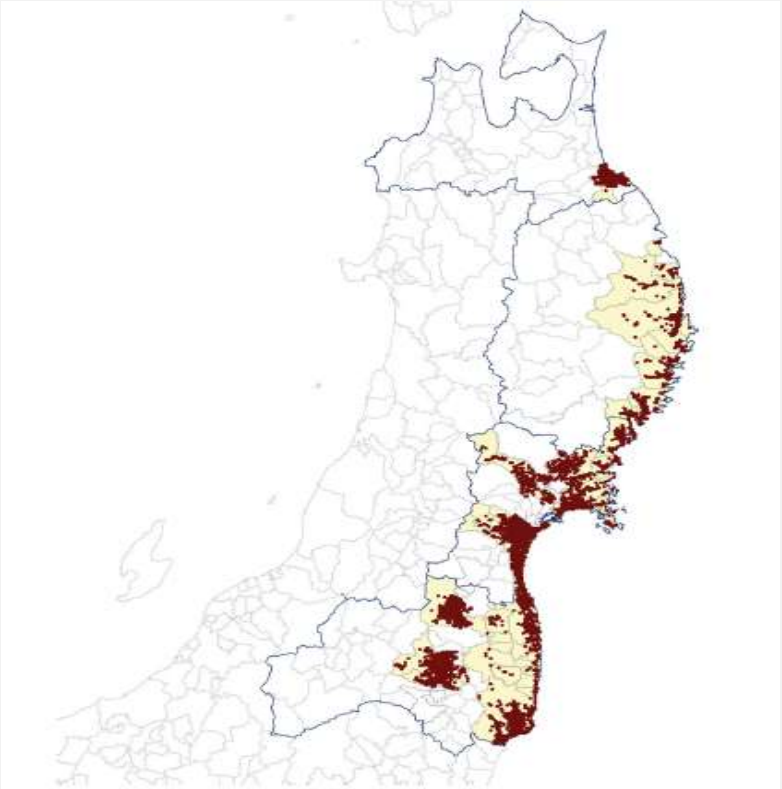


FIGURE IV
Headquarters Locations of Firms in the Disaster Area

Source: Carvalho et al. (2016)

IV Strategy using the 2011 Tohoku Earthquake

1st Stage:

$$Z_{s/c} = Average\ Partner\ Firm\ Exits_{i,t,s/c} = \alpha_{i,t} + \beta deg\,1\_s(/\,c)_i + \varepsilon_{i,t}$$

$Average\ Partner\ Firm\ Exits_{i,t,s/c}$: *for each firm i and year t, share of partners (suppler or customer) that exited*

$deg\,1\_s(\ or\ \deg 1\_c)$ *: dummy variable 1 if supplier (or consumer) of the first-degree connection was located in the affected areas in 2010 data (before the Earthquake), 0 if otherwise*

2nd Stage

$$y_{i,s,t} = \alpha_i + \alpha_s + \alpha_t + \beta Z_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t}$$

$y_{i,s,t}$: *firm exit dummy, log of sales growth, number of new connections for firm i, sector s, year t*

Firm controls include the age of firms, age of CEOs, change in CEO (dummy), number of consumers, number of suppliers, sales growth, number of employees

Firm exits increase partner firms' bankruptcies, but the propagation depends on the position of the supply chain.

	Bankruptcy (t)	Bankruptcy (t+1)	Bankruptcy (t+2)	Bankruptcy (t+3)
Average partner exit rate (supplier)	0.217	0.726*	0.409	0.596*
	(0.313)	(0.397)	(0.322)	(0.307)
Controls	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	330,989	330,989	330,989	330,989

	(1) Bankruptcy (t)	(2) Bankruptcy (t+1)	(3) Bankruptcy (t+2)	(4) Bankruptcy (t+3)
Average partner exit rate (consumer)	5.106	1.632	3.796	-0.535
	(8.125)	(2.900)	(6.789)	(1.130)
Controls	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	330,989	330,989	330,989	330,989

Supplier firm exits in the Earthquake-affected areas lead to partner firms' bankruptcies, but consumer firm exits do not.

Firm health of the original firm matters for propagation – healthier firms have stronger propagation for extensive margin adjustments.

	Bankruptcy			
	t	**t+1**	**t+2**	**t+3**
	Suppliers at the origin			
Average firm exits (health suppliers)	1.668***	1.097**	1.219***	1.174***
	(0.553)	(0.473)	(0.456)	(0.422)
Average firm exits (unhealthy suppliers)	-19.63	-0.589	-9.086	-8.839
	(50.39)	(3.658)	(20.79)	(34.62)
	Consumers at the origin			
Average firm exits (health consumers)	3.863**	2.323**	2.666*	1.784**
	(1.823)	(1.183)	(1.379)	(0.903)
Average firm exits (unhealthy consumers)	5.761	7.059	4.648	8.969
	(7.626)	(9.522)	(6.760)	(10.64)

Firm exits affect partner firms' intensive margin adjustment, but less persistent than extensive margin adjustment.

	Log (Sales Growth)			
	t	**t+1**	**t+2**	**t+3**
	Suppliers at the origin			
Average firm exits (health suppliers)	-3.222*	-1.491	1.065	2.649*
	(1.705)	(1.496)	(1.346)	(1.479)
Average firm exits (unhealthy suppliers)	55.24	-14.65	-39.70	3.938
	(150.0)	(82.03)	(178.9)	(39.08)
	Consumers at the origin			
Average firm exits (health consumers)	-12.31**	-0.180	6.209	9.457*
	(6.108)	(2.846)	(4.810)	(5.447)
Average firm exits (unhealthy consumers)	-18.97	-17.02	-13.02	-8.460
	(25.20)	(27.28)	(18.33)	(14.12)

Exits of healthier firms also affect the network formation of partner firms.

	Number of New Connections			
	t	**t+1**	**t+2**	**t+3**
	Suppliers at the origin			
Average firm exits (health suppliers)	-142.7***	-159.8***	-148.1***	-143.4***
	-36.35	(42.95)	(37.61)	(37.05)
Average firm exits (unhealthy suppliers)	-18.44	-58.32	-5.927	-29.03
	(52.26)	(143.1)	(23.96)	(117.9)
	Consumers at the origin			
Average firm exits (health consumers)	-199.8**	-192.5***	-227.5**	-201.0**
	(77.97)	(74.22)	(101.2)	(81.64)
Average firm exits (unhealthy consumers)	-14.17	-33.72	-15.10	-86.39
	(21.84)	(52.99)	(32.30)	(308.1)

When healthy firms exit, new network formations are negatively affected for connected firms. Such effects are not observed when unhealthy firms exit.

Conclusion and Policy Implications

- When healthy firm exits, the size and persistence is much stronger for unhealthy firms. Healthy firm exits affect partner firms' sales growth, firm exits and new network formation.

- The pace of recovery differs depending on the margin of adjustment: extensive vs. intensive

- Different types of firm exits should be considered differently (Hong et al. (2020)).

- Should we rethink the cleansing mechanism when firm network enters the picture?

  What if firm exits result in a cascade of firm failures?
  What if firms survive and become productive with new connections?

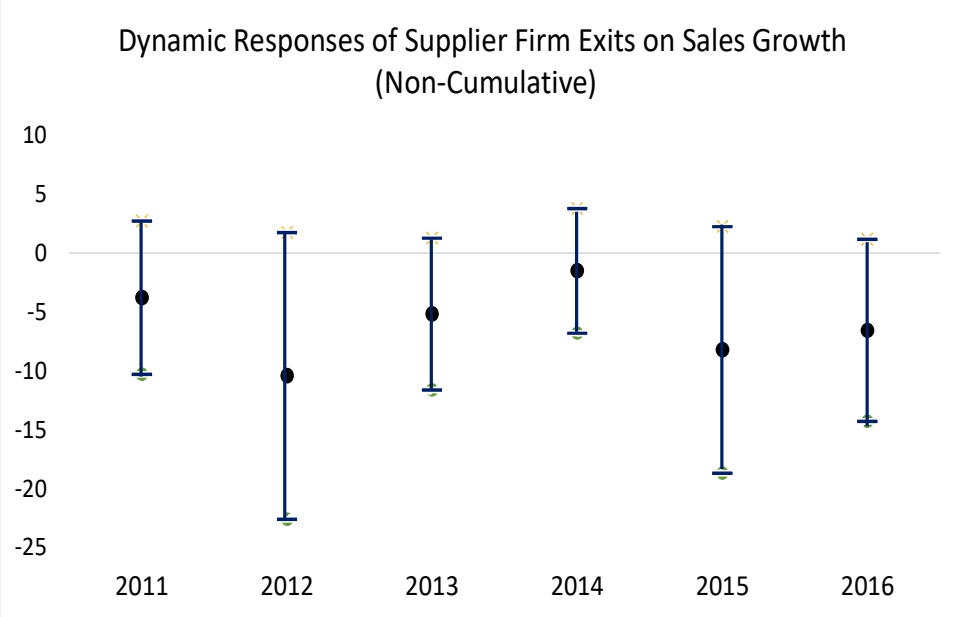
Appendix

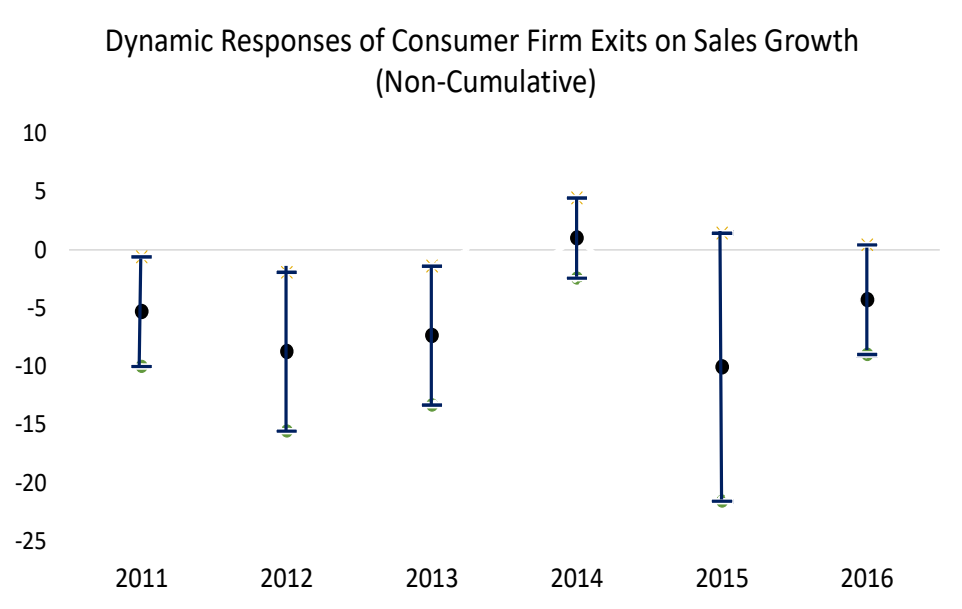
3. Firm exits are correlated with partner firms' sales growth and connections.

	(1)	(2)
	Log (Sales Growth) (t)	**Log (Sales Growth) (t)**
Average Partner Exit Rate (t) (Supplier)	-0.0126*** (0.000647)	
Average Partner Exit Rate (t) (Consumer)		-0.0126*** (0.000646)
Controls	Y	Y
Observations	347,632	347,632
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1		

	(1)	(2)		(1)	(2)
	New Connections (Supplier, t)	**New Connections (Consumers,t)**		**New Connections (Supplier, t)**	**New Connections (Consumers,t)**
Average Partner Exit Rate (t) (Supplier)	0.316*** (0.0106)	0.0322*** (0.0114)	***Average Partner Exit Rate (t) (consumer)***	0.0362*** (0.0111)	0.228*** (0.0119)
Controls	Y	Y	Controls	Y	Y
Observations	330,989	330,989	Observations	330,989	330,989
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1					

….while the impact is not so persistent.





Note: Blue dots represent the coefficients of the second stage IV regression. Bar markers represent 95% confidence interval.

Consumer firms' exits affect partner firms' sales growth.

Firm exits increase partner firms' bankruptcies, only when supplier firms exit.