Granularity in International Markets

Isabelle Mejean

Granularity and Networks
in a Global Economy
MIE, 2nd year

Motivating literature

- While the early granularity literature has focused on the distribution of firms' size as a determinant of the propagation of micro shocks to the aggregate economy, production networks are the topic of an increasing literature
- Acemoglu et al (2012) : When there are sufficiently strong interconnections between firms/sectors, shocks to upstream units propagate throughout the value chain
- Transmission of shocks through production networks is further amplified when potential nonlinearities are taken into account (eg when inputs display some complementarities) (Fahri and Baqaee, 2017), when sectors display external economies of scale (Baqaee, 2018)

Networks in international markets

- The intuitions surrounding this literature extend naturally to an **open-economy context** because
  - Large firms are more likely to export abroad *and* to import from abroad (Bernard and Jensen, 1995, Antras et al, 2017)
  - Large firms are also more likely to engage in multinational activities (Melitz et al., 2004)
  - Increasing international vertical fragmentation of production processes (Hummels et al, 2001)

$\Rightarrow$ International markets characterize by the magnitude of interdependence between firms

Measurement issues

- At the sector level, Input-Output Tables at various levels of details across countries
- Also some (imperfect) information at the international level (WIOD)
- More recently, researchers have been collecting data on firm-to-firm linkages
  - Within a country (VAT transactions) : Carvalho et al (2016), Barrot and Sauvagnat (2016), Dhyne et al (2015)
  - Across countries (Customs / Intra-EU VAT transactions) : Note in such datasets, the graph has a particular *bipartite* structure : Kramarz et al (2018), Bernard et al (2018)

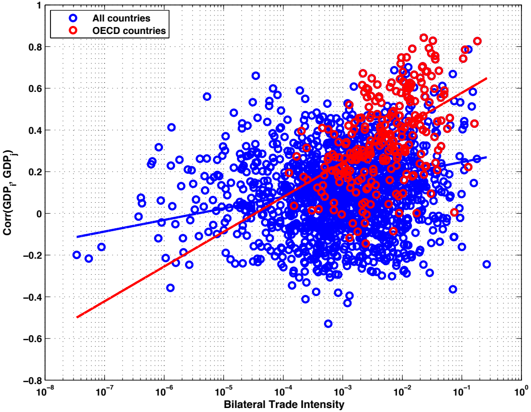
Why do we care ? International Comovements

TABLE – The magnitude of bilateral comovements in output

Output Correlation	Obs	Mean	Std. Dev.	Min	Max
			Extended Sample		
Yearly growth Rates	1176	0.114	0.188	-0.479	0.739
Band Pass filtered, yearly	1176	0.087	0.205	-0.611	0.723
			Restricted Sample		
Quarterly growth Rates	210	0.265	0.173	-0.326	0.756
Yearly growth Rates	210	0.231	0.203	-0.387	0.739
Band Pass filtered, quarterly	210	0.127	0.208	-0.706	0.742
Band Pass filtered, yearly	210	0.198	0.234	-0.559	0.723

Note : This table reports summary statistics on the correlation coefficients in output, computed systematically for all country pairs in an extended sample of 49 countries and a restricted sample of 21 countries. Source : Imbs (2003)

IBC Comovement and Trade



- Frankel and Rose (1998)
- Key unresolved questions :
  - transmission through linkages or common shocks ? (Imbs, 2004)
  - micro-underpinnings of the relationship ? "Trade-comovement puzzle," (Kose and Yi, 2006, Johnson, 2014)

Networks in Closed-Economies

Intuition

- Acemoglu et al (2012) : When economic units are linked through production networks, microeconomic shocks can propagate along value chains, which amplifies the aggregate impact of the shock
- Shocks to the most "central" units in the network have a disproportionate effect on the aggregate output
- Structure of production networks shapes the amount of granularity with firms/sectors' "degree"/"influence vector" determining their "size"

Anecdotal evidence

- Domino effect across production chain in the French economy due to poor performances at Renault and Peugeot ; e.g., a job lost in Renault leads to 2 or 3 disappearing in parts makers (Le Point, July 23, 2012)
- Natural disasters : Supply chain disruptions in Japan have forced at least one global automaker to delay the launch of two new models and are forcing other industries to shutter plants... The automaker is just one of dozens, if not hundreds, of Japanese manufacturers facing disruptions to their supply chains as a result of the quake, the subsequent tsunami and a still-unresolved nuclear threat. (Reuters, March 23, 2011)

Firm's size in IO networks

- When firms/sectors are inter-related through IO linkages, the "size" of a firm is larger than its contribution to aggregate GDP
- Gabaix' results generalize to an economy with intermediate goods but the proper definition of the Herfindahl index is based on Domar weights :

$$Herf = \sum_f (w_f)^2 , \quad w_f = \frac{Sales_f}{GDP}, \quad \sum_f w_f > 1$$

- Acemoglu et al (2012) : In IO networks, large/central firms not only contribute more to aggregate GDP. Their links with other firms/sectors can also be a *propagation channel* for idiosyncratic shocks $\Rightarrow$ Amplification mechanism
- Early work by Long and Plosser (1983), Stockman (1988), Horvath (1998, 2000), Dupor(1999)

IO Networks and shocks propagation

- With IO linkages, productivity shocks to upwards firms transmit to downward firms through input prices
- Role of networks as an amplification mechanism depends on their shape :
  - Symmetric networks induce perfect diversification :

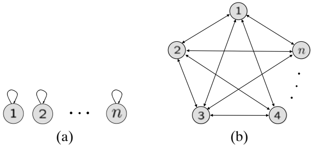


FIGURE 1.—The network representations of two symmetric economies. (a) An economy in which no sector relies on other sectors for production. (b) An economy in which each sector relies equally on all other sectors.

$\Rightarrow$ Idiosyncratic shocks average out rapidly (at the rate $\sqrt{N}$)

IO Networks and shocks propagation

- With IO linkages, productivity shocks to upwards firms transmit to downward firms through input prices
- Role of networks as an amplification mechanism depends on their shape :
  - Symmetric networks induce perfect diversification
  - "Star networks" display extreme amplification

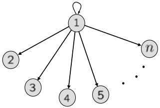


FIGURE 2.—An economy where one sector is the only supplier of all other sectors.

$\Rightarrow$ Idiosyncratic shocks do not average out, even when N tends to infinity

A static model of IO networks

- Representative household endowed with one unit of labor, supplied inelastically and has CD preferences over sectors :

$$C = A \prod_{i=1}^{n} c_i^{\theta_i}$$

- Technology is Cobb-Douglas across labor and inputs :

$$y_j = e^{z_j} l_j^{\alpha_j} \prod_{i=1}^{n} x_{ji}^{a_{ji}}, \quad \alpha_j + \sum_i a_{ji} = 1$$

Summarized by an IO matrix (row j is input usage of sector j) :

$$\mathbf{A} = \begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{pmatrix}$$

A static model of IO networks

- Market clearing :

$$y_j = c_j + \sum_i x_{ij}, \qquad 1 = \sum_j l_j$$

- Optimal conditions :
  - Consumers :

$$p_j c_j = w\theta_j$$

  - Firms :

$$p_j = \frac{1}{e^{z_j}} \left(\frac{w}{\alpha_j}\right)^{\alpha_j} \prod_{i=1}^{n} \left(\frac{p_i}{a_{ji}}\right)^{a_{ji}}$$

$$p_i x_{ji} = a_{ji} p_j y_j$$

$$w l_j = \alpha_j p_j y_j$$

A static model of IO networks

- Equilibrium :
  - Optimal prices :

$$\ln \mathbf{p} = (\mathbf{I} - \mathbf{A})^{-1}(\mathbf{\Omega} + \boldsymbol{\alpha}. * \ln w - \mathbf{z})$$

$$\textit{where} \quad \mathbf{\Omega} = (\{\Omega_j = -\alpha_j \ln \alpha_j - \sum_{i=1}^{n} a_{ji} \ln a_{ji}\})$$

  - Market clearing :

$$\ln \mathbf{p} + \ln \mathbf{y} = \ln[(\mathbf{I} - \mathbf{A}')^{-1}\boldsymbol{\theta}. * w]$$

  - Using w as numéraire :

$$\ln \mathbf{y} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{z} - (\mathbf{I} - \mathbf{A})^{-1}\mathbf{\Omega} + \ln[(\mathbf{I} - \mathbf{A}')^{-1}\boldsymbol{\theta}]$$

  - Finally :

$$d \ln \mathbf{y} = \underbrace{(\mathbf{I} - \mathbf{A})^{-1}}_{\textit{Leontief inverse}} \mathbf{dz}$$

Implications for aggregate fluctuations

- With iid productivity shocks :

$$
\begin{aligned}
& Var(d \ln \mathbf{y}) = (\mathbf{I} - \mathbf{A})^{-1} Var(\mathbf{dz})[(\mathbf{I} - \mathbf{A})^{-1}]' \\
\text{and} \quad & Var(d \ln RGDP) = \mathbf{v}' Var(\mathbf{dz}) \mathbf{v} \\
\text{where} \quad & \mathbf{v} = \boldsymbol{\theta}'(\mathbf{I} - \mathbf{A})^{-1}
\end{aligned}
$$

Note that $\mathbf{v}$ is also the sales vector :

$$
v_i = \frac{p_i x_i}{\sum_j p_j x_j}
$$

  - Aggregate productivity depends on the distribution of influence vectors ($\sum_i v_i^2$)
  - Productivity shocks transmit downstream (through prices). No upstream propagation under Cobb-Douglas technologies and preferences
  - See Acemoglu, Akcigit, and Kerr (2015) for a model with supply shocks propagating downstream and demand shocks propagating upstream

IO networks and shocks propagation

- Role of networks as an amplification mechanism depends on their shape :
  - Extreme cases : Symmetric networks / "Star networks"
  - More generally, the rate at which the aggregate impact of idiosyncratic shocks vanishes is small when :
    - i) first-order interconnections are highly concentrated (a single firm/sector is a supplier to a disproportionally large number of firms/sectors), or
    - ii) high-order interconnections are important (a single firm/sector is at the top of a long chain of interconnections which can induce cascade effects)

IO networks and shocks propagation

- Distributions of first- and second-order interconnectivity

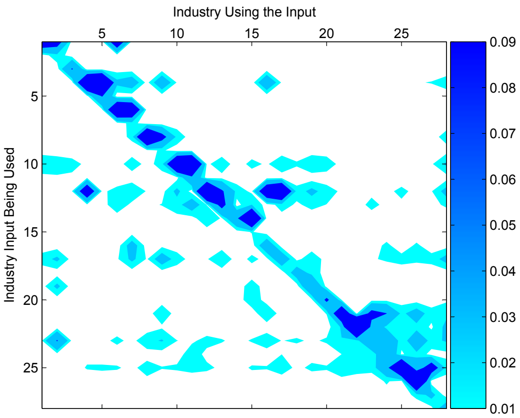
$$\{d_i \equiv \sum_j a_{ji}\}, \quad \{f_i = \sum_{j \neq i} \sum_{k \neq i,j} a_{ji} a_{ki} d_j d_k\}$$

can be written as power laws :

$$Pr(d > s) = c_d s^{-\beta}, \quad Pr(f > r) = c_f r^{-\zeta}$$

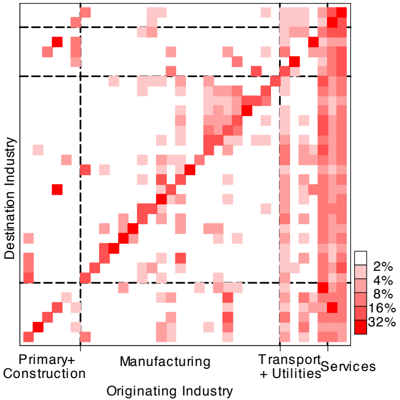
- When number of sectors n increases, output volatility decays at a rate that depends on $min[\beta, \zeta]$
- When either β or $\zeta \in (1, 2)$, convergence rate is lower than $\sqrt{n}$

Empirical evidence : Sectoral linkages



Source: 28 manufacturing sectors, BEA

Empirical evidence : Sectoral linkages



Source: Atalay (2017) (Data: OECD)

Empirical evidence : Sectoral linkages

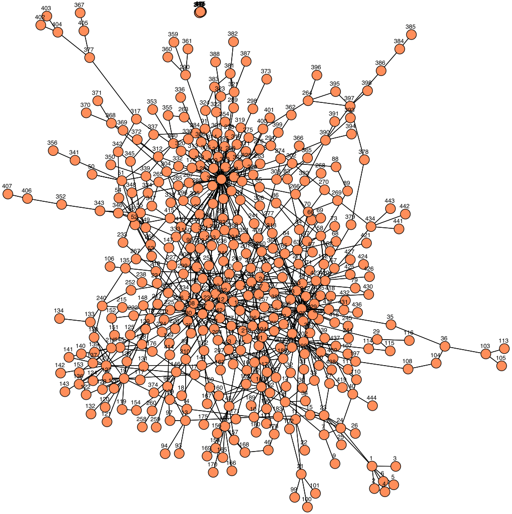


FIGURE 3.—Intersectoral network corresponding to the U.S. input–output matrix in 1997. (Source: Bureau of Economic Analysis. See Section 4 for more details on the data.) Each vertex corresponds to a sector in the 1997 benchmark detailed commodity-by-commodity direct requirements table. For every input transaction above 5% of the total input purchases of a sector, a link is drawn between that sector and the input supplier.

Empirical evidence : Sectoral linkages

Distribution of first-order outdegrees

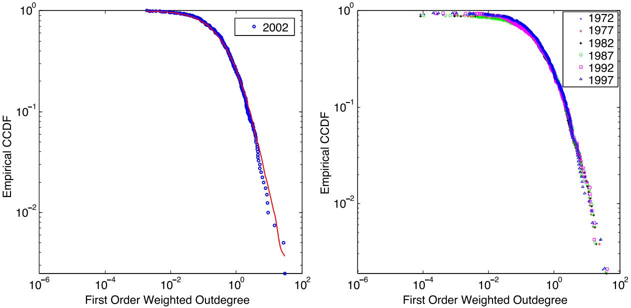


FIGURE 8.—Empirical counter-cumulative distribution function of first-order degrees.

Source: Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi (2012)

Empirical evidence : Sectoral linkages

Distribution of second-order outdegrees

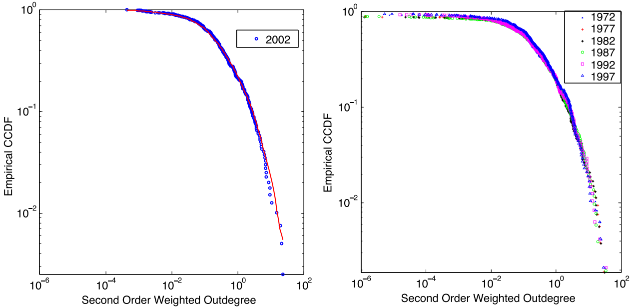


FIGURE 9.—Empirical counter-cumulative distribution function of second-order degrees.

Source: Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi (2012)

Empirical evidence : Sectoral linkages

TABLE I

OLS ESTIMATES OF β AND ζ[a]

	1972	1977	1982	1987	1992	1997	2002
$\widehat{\beta}$	1.38 (0.20; 97)	1.38 (0.19; 105)	1.35 (0.18; 106)	1.37 (0.19; 102)	1.32 (0.19; 95)	1.43 (0.21; 95)	1.46 (0.23; 83)
$\widehat{\zeta}$	1.14 (0.16; 97)	1.15 (0.16; 105)	1.10 (0.15; 106)	1.14 (0.16; 102)	1.15 (0.17; 95)	1.27 (0.18; 95)	1.30 (0.20; 83)
n	483	524	529	510	476	474	417

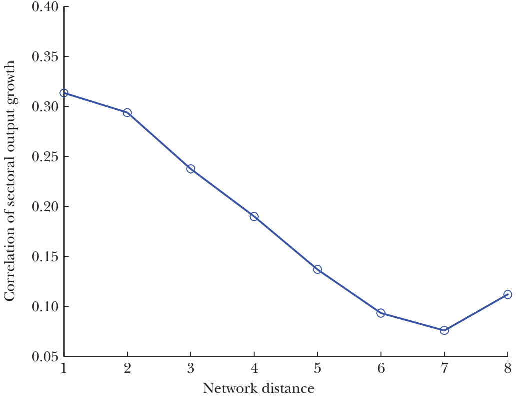
[a]The numbers in parentheses denote the associated standard errors (using Gabaix and Ibragimov (2011) correction) and the number of observations used in the estimation of the shape parameter (corresponding to the top 20% of sectors). The last row shows the total number of sectors for that year.

$$\Longrightarrow \{\hat{\beta}, \hat{\zeta}\} \in (1, 2)$$

Source: Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi (2012)

- Aggregate volatility decay at a rate bounded by $[n^{.30}, n^{.46}] < \sqrt{n}$
- Numerical application based on the US economy (2,295 sectors, $\sigma_i = .058$) : In a symmetric economy, $\sigma_A = .058/\sqrt{2,295} = .001$ / Under the existing distribution of influence vectors, $\sigma_A = .058/(2,295)^{.015} = .018$

Empirical evidence : Sectoral linkages and output growth comovements

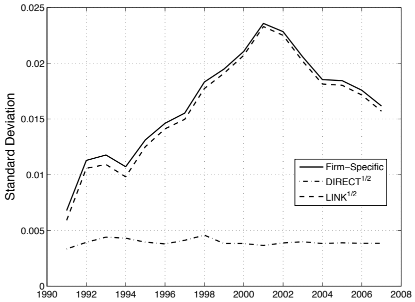


Source: Carvalho (2014) (Network distance based on detailed BEA I-O data)

Firm-level evidence : Output growth comovements

$$\sigma^2_{F|\tau} = \sum_{g,m} \sum_{f,n} w_{gm\tau-1} w_{fn\tau-1} Cov(\varepsilon_{gmt}, \varepsilon_{fnt})$$

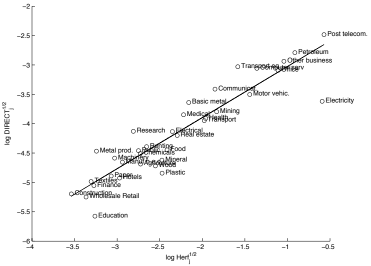
$$= \underbrace{\sum_{f,n} w^2_{fn\tau-1} Var(\varepsilon_{fnt})}_{Direct} + \underbrace{\sum_{g\neq f, m\neq n} \sum_{f,n} w_{gm\tau-1} w_{fn\tau-1} Cov(\varepsilon_{gmt}, \varepsilon_{fnt})}_{Linkages}$$



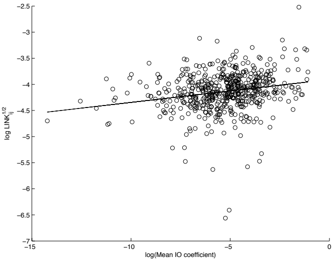
Notes : Source : di Giovanni et al. (2014)

Firm-level evidence : Output growth comovements

Direct

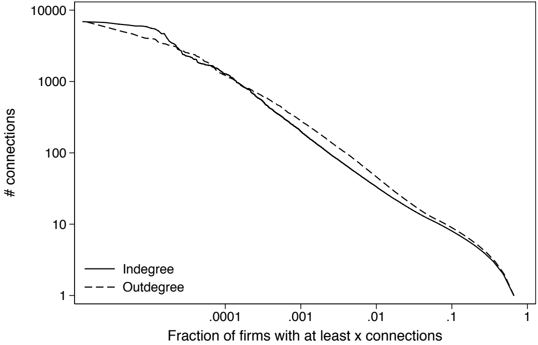


Linkages



Notes : The left panel plots the sectoral volatility attributable to the individual variance of firm-specific components ($\sum_{(f,n)\in j} w_{fn}^2 Var(\varepsilon_{fnt})$) against the Herfindahl of sales in that sector ($\sum_{(f,n)\in j} w_{fn}^2$). The right panel plots, for each pair of sectors, the covariance attributable to individual covariance terms in the firm-specific components ($\sum_{(f,n)\in j} \sum_{(g,m)\in i} w_{fn} w_{gm} Cov(\varepsilon_{fnt}, \varepsilon_{gmt})$) against the magnitude of IO linkages between those sectors. Source : di Giovanni et al. (2014)

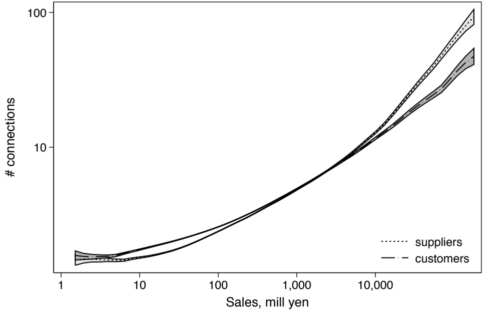
Firm-level evidence : Indegree and outdegree CDFs



Source: Bernard, Moxnes, and Saito (2015), log-log scale

Note : Japanese data for 2005. In-degree : Number of buyers per seller. Out-degree : Number of suppliers per buyer

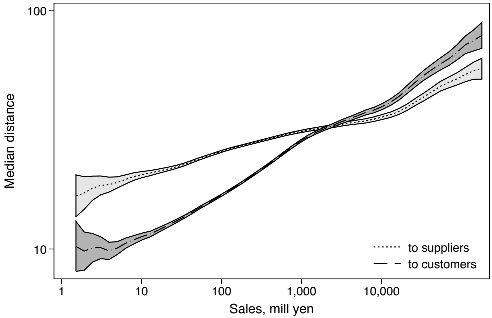
Firm-level evidence : Size, Indegree and Outdegree



Source: Bernard, Moxnes, and Saito (2015)

Note : Japanese data for 2005.

Firm-level evidence : Size and Median Distance to Connections



Source: Bernard, Moxnes, and Saito (2015)

Note : Japanese data for 2005.

Firm-level evidence : Within and Between Firms Connections

TABLE 1—ESTABLISHMENT-LEVEL SHARES OF INTERNAL SHIPMENTS

	Percentile						
Internal share of:	50th	75th	90th	95th	Fraction = 0	Fraction = 1	Weighted mean
Panel A. Benchmark							
Establishment shipment counts	0.4%	7.3%	32.2%	62.7%	49.7%	1.2%	14.6%
Establishment dollar value of shipments	<0.1%	7.0%	37.6%	69.5%	49.7%	1.2%	16.0%
Establishment total weight of shipments	<0.1%	7.1%	38.4%	69.9%	49.7%	1.2%	16.0%

Notes: These tables report shares of upstream establishments' shipments that are internal to their firm. The sample consists of 67,500 establishment-years aggregated from about 6.3 million shipments. For data confidentiality reasons, the reported percentiles are averages of immediately surrounding percentiles, e.g., the median $= 0.5 \times$ (forty-ninth percentile + fifty-first percentile).

Source: Atalay, Hortaçsu, and Syverson (2014)

Note : US data for 2005.

Firm-level evidence : Large firms in IO Networks

- De Bruyne et al (2017) : Use Belgian firm-to-firm data (value)
- Stylized facts on firm-to-firm IO networks :
  - 3.5 millions F2F relationships in a sample of 80,000 firms
  - 67,000 firms have at least one business customers (Median=11 business customers)
  - Almost all firms have at least one supplier (Median=28 suppliers)
  - Highly skewed distribution of firms' size / of firms' influence factor
- Consequences for granular fluctuations :
  - Once indirect influences are taken into account, top 100 firms account for about 90% of the volatility
  - The most central firms are found in a number of business services (Distribution of fuels, Renting of light vehicles, Temporary employment agencies), and a couple of manufacturing sectors (Basic chemicals and motor vehicles)
  - Distribution of the firm-level influence vectors is closed to a log-normal

Firm-level : Shocks to supply chains

- Barrot and Sauvagnat (2016) : Impact of major natural disasters on US supply chains

- Data :
  - Supplier-customer links reported by publicly listed firms (all customers accounting for more than 10% of sales)
  - Time-series on natural disasters linked to value chains using information on headquarters' location
  - Proxies for the specificity of traded inputs as a measure of how costly it is to replace the supplier hit by a shock

- DIID empirical strategy :

$$\Delta Sales_{i,t-4,t} = \alpha_1 HitsOneSupplier_{i,t-4} + \alpha_2 HitsFirm_{i,t-4} + \eta_i + \eta_t + \varepsilon_{i,t}$$

Identifying Assumptions

- Role of input specificity : $HitsOneSupplier_{i,t-4}$ interacted with a dummy for whether the input is specific or not

- Higher order effects : Impact of a shock hitting a consumer's supplier

Firm-level : Shocks to supply chains

Downstream Propagation—Baseline

Panel A		Sales Growth $(t-4,t)$		
Disaster hits one supplier $(t-4)$	–0.031***	–0.027***	–0.029***	–0.019**
	(0.009)	(0.008)	(0.008)	(0.008)
Disaster hits firm $(t-4)$	–0.031***	–0.029***	–0.005	–0.003
	(0.011)	(0.011)	(0.009)	(0.009)
Number of suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes
Size, age, ROA × year-quarter FE	No	Yes	Yes	Yes
State-year FE	No	No	Yes	Yes
Industry-year FE	No	No	No	Yes
Observations	80,574	80,574	80,574	80,574
R^2	0.234	0.262	0.300	0.342

Source : Barrot and Sauvagnat (2016)

Firm-level : Shocks to supply chains

Downstream Propagation—Input Specificity

	Sales Growth $(t-4,t)$					
Supplier Specificity	Diff.		R&D		Patent	
Disaster hits one nonspecific supplier $(t-4)$	−0.002 (0.012)	−0.002 (0.011)	−0.018 (0.011)	−0.011 (0.011)	−0.020* (0.011)	−0.016 (0.010)
Disaster hits one specific supplier $(t-4)$	−0.050*** (0.010)	−0.043*** (0.010)	−0.039*** (0.014)	−0.032** (0.014)	−0.039*** (0.011)	−0.034*** (0.012)
Disaster hits firm $(t-4)$	−0.031*** (0.011)	−0.029*** (0.011)	−0.031*** (0.011)	−0.029*** (0.011)	−0.031*** (0.011)	−0.029*** (0.011)
Number of suppliers	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Size, age, ROA × year-quarter FE	No	Yes	No	Yes	No	Yes
Observations	80,574	80,574	80,574	80,574	80,574	80,574
R^2	0.234	0.262	0.234	0.261	0.234	0.262

Notes. This table presents estimates from panel regressions of firms' sales growth relative to the same quarter in the previous year on two dummies indicating whether (at least) one specific supplier and whether (at least) one nonspecific supplier is hit by a major disaster in the same quarter of the previous year. In the first and second columns, a supplier is considered as specific if its industry lies above the median of the share of differentiated goods according to the classification provided by Rauch (1999). In the third and fourth columns, a supplier is considered specific if its ratio of R&D expenses over sales is above the median in the two years prior to any given quarter. In the fifth and sixth columns, a supplier is considered as specific if the number of patents it issued in the previous three years is above the median. All regressions include a dummy indicating whether the firm itself is hit by a major disaster in the same quarter in the previous year as well as fiscal quarter, year-quarter, and firm fixed effects. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In the second, fourth, and sixth columns, we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA, respectively) interacted with year-quarter dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Source : Barrot and Sauvagnat (2016)

Firm-level : Shocks to supply chains

HORIZONTAL PROPAGATION—RELATED SUPPLIERS' SALES GROWTH

	Sales Growth $(t-4,t)$			
Supplier Specificity		Diff.	R&D	Patent
Disaster hits firm $(t-4,t-1)$	−0.040***	−0.040***	−0.041***	−0.040***
	(0.013)	(0.013)	(0.013)	(0.013)
Disaster hits one customer $(t-4,t-1)$	0.002	0.001	0.001	0.002
	(0.021)	(0.021)	(0.021)	(0.021)
Disaster hits one customer's supplier $(t-4,t-1)$	−0.038***			
	(0.010)			
Disaster hits one customer's specific supplier $(t-4,t-1)$		−0.047***	−0.048***	−0.040***
		(0.013)	(0.014)	(0.013)
Disaster hits one customer's non-specific supplier $(t-4,t-1)$		−0.011	−0.013	−0.015
		(0.013)	(0.013)	(0.013)
Number of customers' Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes
Size, age, ROA × year-quarter FE	Yes	Yes	Yes	Yes
Observations	139,976	139,976	139,976	139,976
R^2	0.192	0.192	0.192	0.192

Notes. This table presents estimated coefficients from panel regressions of firms' sales growth relative to the same quarter in the previous year on one dummy indicating whether one of the firm's customers' other suppliers is hit by a major disaster in the previous four quarters. The second and fourth columns split customers' other suppliers into specific and nonspecific suppliers. All regressions include two dummies indicating whether the firm itself is hit in the previous four quarters and whether one of the firm's customer is hit in the previous four quarters. All regressions also control for the number of customers' suppliers (dummies indicating terciles of the number of customers' suppliers). All regressions include fiscal quarter, year-quarter, and firm fixed effects as well as firm-level characteristics (dummies indicating terciles of size, age, and ROA, respectively) interacted with year-quarter dummies. Standard errors presented in parentheses are clustered at the firm level. Regressions contain all firm-quarters of our supplier sample (described in Table II, Panel B) between 1978 and 2013. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Source : Barrot and Sauvagnat (2016)

Firm-level : Shocks to supply chains

- Carvalho, Nirei, Saito and Tahbaz-Salehi (2016) : Impact of major natural disasters on Japanese supply chains
- Data :
  - Supplier-customer links compiled by a major private credit reporting agency
  - Exploit the natural experiment of the March 2011 earthquake : Massive and localized, -3.1% annual growth in the most severely affected areas but only 4.7% of aggregate Japanese output
  - Localization of firms used to identify directly affected firms
- Model has CES production functions, thus a propagation of supply shocks upstream, downstream and horizontally

Firm-level : Shocks to supply chains

- DIID empirical strategy :

$$\Delta \ln Sales_{i,p,s} = \beta_{down} Downstream_i + \beta_{up} Upstream_i + \gamma' X_i + \mu_p + \lambda_s + \varepsilon_i$$

- Control for indirect propagation using measures of network distance :

$$\Delta \ln Sales_{i,p,s} = \sum_{k=1}^{4} \beta_{down}^k Downstream_i^k + \sum_{k=1}^{4} \beta_{up}^k Upstream_i^k + \gamma' X_i + \mu_p + \lambda_s +$$

- Control for horizontal propagation :

$$\begin{aligned} \Delta \ln Sales_{i,p,s} &= \beta_{horiz} Horizontal_i + \sum_{k=1}^{4} \beta_{down}^k Downstream_i^k \\ &+ \sum_{k=1}^{4} \beta_{up}^k Upstream_i^k + \gamma' X_i + \mu_p + \lambda_s + \varepsilon_i \end{aligned}$$

Note : Expected sign of β_{horiz} depends on the substitutability between inputs and the substitutability with primary factors

Firm-level : Shocks to supply chains

	Post-Earthquake Sales Growth Rate	
	(1)	(2)
Downstream Distance 1	−0.007***	−0.020***
	(0.002)	(0.003)
Downstream Distance 2		−0.013***
		(0.003)
Downstream Distance 3		−0.013***
		(0.003)
Downstream Distance 4		−0.011***
		(0.004)
Upstream Distance 1	−0.0003	−0.012***
	(0.0024)	(0.003)
Upstream Distance 2		−0.007***
		(0.003)
Upstream Distance 3		−0.007**
		(0.003)
Upstream Distance 4		0.001
		(0.004)
Constant	−0.029**	−0.021***
	(0.010)	(0.010)
Firm Controls	Yes	Yes
Prefecture FE	Yes	Yes
Industry FE	Yes	Yes
Observations	419,897	419,897
R^2	0.022	0.022

Notes: This table presents estimates from regressing firms' post-earthquake sales growth rates on various dummy variables indicating direct and indirect supplier-customer relationships with disaster area firms. The first column reports the estimated coefficients of regression (4). The second column reports the estimated coefficients of regression (5). Firm controls include the logarithm of the number of transaction partners, age, logarithm of the number of employees, distance to the disaster area, and number of plants. Robust standard errors are presented in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Source : Carvalho et al (2016)

No significant impact of horizontal propagation

Firm-level : Shocks to supply chains

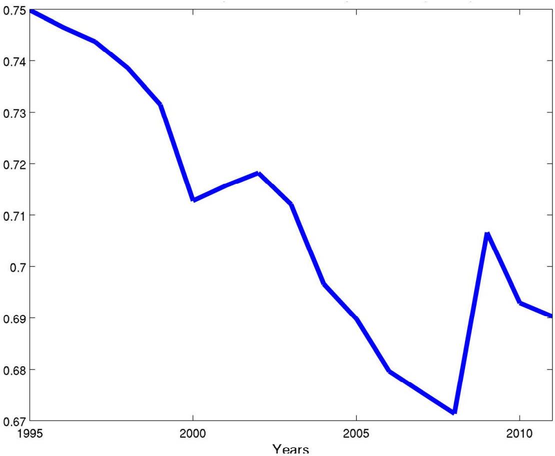
- Aggregate decline in manufacturing output the year of the earthquake is about 1.9%
- With 18,187 firms in the disaster area, accounting for 1.3% of sales in the sample, direct effect cannot account for a large share (maximum -.06 percentage point)
- Direct and indirect propagation can account for a 1.2 percentage point decline
- Downstream propagation is the main driver (1.1 percentage point reduction)

Firm-to-Firm International Linkages

Firm-to-firm international linkages

- 2/3 of international trade involve intermediate goods, i.e. firm-to-firm relationships
- Firms participating to international markets are different :
  - Exporters are larger than the average (Bernard and Jensen, 1995, Mayer and Ottaviano, 2007)
  - Importers are larger than the average (Antras et al, 2017)
  - They might also be more connected to domestic firms (thus connecting them indirectly to foreign countries)
- A large fractions of these firm-to-firm transactions take place within multinational firms, across affiliates located in different countries

Increasing fragmentation of production processes



Note : This figure presents the yearly ratio of value added over gross exports, at the world level. The decreasing trend is consistent with the raising intensity of international production sharing. Source : World Input Output database.

International fragmentation of production processes

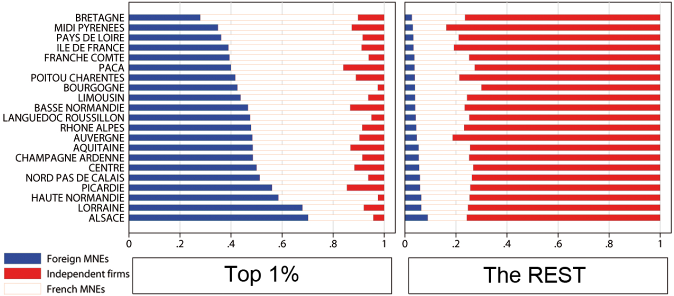
Table 5: Some characteristics of the Belgian production network in 2011 (averages).

	(1)	(2)	(3)	(4)	(5)	(6)
Upstreamness	2.596	2.170	1.640	1.827	1.442	1.818
Downstreamness	1.981	1.914	1.998	1.667	1.590	1.735
Total length	3.577	3.084	2.638	2.494	2.032	2.553
Relative position	0.447	0.486	0.584	0.497	0.563	0.511
Share of (directly and indirectly) exported turnover	0.281	0.215	0.040	0.079	0.031	0.084
Share of (direclty and indirectly) imported inputs in turnover	0.090	0.121	0.091	0.060	0.042	0.069
Share of direct exporters	0.056	0.191	0.012	0.045	0.014	0.049
Share of direct and indirect exporters	0.903	0.916	0.891	0.805	0.642	0.819
Share of direct importers	0.045	0.238	0.032	0.085	0.065	0.087
Share of direct and indirect importers	0.996	0.995	0.996	0.988	0.990	0.990

Notes : (1) Primary sector, (2) Manufacturing, (3) Electricity, gas and water supply + Construction, (4) Market services, (5) Non-market services, (6) Total economy.

Note : Upstreamness measures the number of transactions that are required for the firm's output to reach final consumers. Downstreamness measures the number of transactions that have been needed to produce the firm's output. Source : Dhyne, Magerman and Rubinova (2015)

MNEs are different



Note : This figure presents the (average over 1999-2004) ownership structure of the 1% largest firms and the 99% smallest firms, for each French region in terms of value added. The results stand for manufacturing, extractive, and agricultural industries. Source : Kleinert et al (2014).

- In the French manufacturing sector in 1999, affiliates of foreign MNEs represent 5% of firms but 25% of employment, 1/3 of value added and 50% of aggregate trade (Kleinert et al, 2014)

International Networks, Transmission of Shocks and International Business Cycles

AAK : International Transmission of Shocks

- Acemoglu, Akcigit & Kerr (2015) : Impact of the "Chinese trade shock" on the US economy

- A model of IO sectoral linkages with (downstream) propagation of supply shocks and (upstream) propagation of demand shocks (extension of Acemoglu et al, 2012, See paper)

$$
\begin{aligned}
d \ln Y_{it} &= \eta_t + \psi d \ln Y_{it-1} + \beta^{own} Shock_{it-1} + \beta^{up} Upstream_{it-1} \\
&+ \beta^{down} Downstream_{it-1} + \varepsilon_{it}
\end{aligned}
$$

where

$$
\begin{aligned}
Upstream_{it} &= \sum_j a_{ji} \frac{Sales_j}{Sales_i} Shock_{jt} \\
Downstream_{it} &= \sum_j a_{ij} Shock_{jt}
\end{aligned}
$$

- Use the (instrumented) rise of import competition from China as a proxy for a negative demand shock to the domestic sector i (See Autor et al, 2013, for details)

AAK : International Transmission of Shocks

Table 2a: Baseline for China trade shock analysis

	Δ Log real value added		Δ Log employment		Δ Log real labor productivity	
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Dependent variable t-1	0.019	0.020	0.149***	0.132***	-0.117***	-0.120***
	(0.025)	(0.025)	(0.020)	(0.019)	(0.028)	(0.033)
Δ Dependent variable t-2		0.047**		0.109***		-0.057
		(0.024)		(0.020)		(0.037)
Δ Dependent variable t-3		0.033		0.089***		-0.002
		(0.021)		(0.016)		(0.033)
Downstream effects t-1	-0.140	-0.124	-0.056	-0.044	-0.100	-0.108
	(0.086)	(0.081)	(0.040)	(0.037)	(0.099)	(0.099)
Upstream effects t-1	0.076***	0.076***	0.049***	0.039***	0.021	0.021
	(0.024)	(0.023)	(0.016)	(0.015)	(0.013)	(0.014)
Own effects t-1	0.034***	0.031***	0.023***	0.018***	0.007	0.007
	(0.009)	(0.009)	(0.005)	(0.004)	(0.007)	(0.007)
Observations	6560	5776	6560	5776	6560	5776
p-value: Upstream=Own	0.078	0.058	0.108	0.161	0.320	0.341

Notes: Estimations consider network structures and the propagation of trade shocks. Baseline trade shocks for manufacturing industries are the lagged change in imports from China relative to 1991 US market volume, following Autor et al. (2013). A negative value is taken such that positive coefficients correspond to likely beneficial outcomes, similar to other shocks. Explanatory variables aggregate these industry-level components by the indicated network connecting industries. These network explanatory variables are expressed as lagged changes in non-log values. Downstream and upstream flows use the Leontief inverse to provide the full chain of material interconnections within manufacturing. All trade analyses instrument the direct and network effects from US imports with the rise in Chinese imports in eight other advanced countries. Upstream=Own test uses the exact formula discussed in the text and is calculated through unreported auxiliary regressions. Variables are winsorized at the 0.1% level and initial shocks are transformed to have unit standard deviation for interpretation. Estimations include year fixed effects, report standard errors clustered by industry, and are unweighted. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Source: Acemoglu, Akcigit, and Kerr (2015)

Aggregate effect of a one Stdev shock is $153 billion of value added and 430,000 jobs (on a base of around $2 trillion of value added and 11 millions jobs in US manufacturing)

dGL : International Comovements

- di Giovanni and Levchenko (2010) : Role of production structure, intra-industry trade and IO linkages for international comovements
- Conceptual framework :

$$y^c = \sum_{i=1}^{I} s_i^c y_i^c, \quad y^d = \sum_{i=1}^{I} s_i^d y_i^d$$

$$\Rightarrow \quad Cov(y^c, y^d) = \sum_i \sum_j s_i^c s_i^d Cov(y_i^c, y_j^d)$$

$$\Leftrightarrow \quad Corr(y^c, y^d) = \frac{1}{\sigma_c \sigma_d} \sum_i \sum_j s_i^c s_j^d \sigma_c^i \sigma_d^j Corr(y_i^c, y_j^d)$$

dGL : International Comovements

- Baseline specification :

$$\rho_{ij}^{cd} = \alpha + \beta_1 \, Trade_{ij}^{cd} + \mathbf{u} + \varepsilon_{ij}^{cd}$$

- Intra- vs Inter-industry effect :

$$\rho_{ij}^{cd} = \alpha + \beta_1 \, Trade_{ij}^{cd} + \beta_2 \mathbf{1}_{[i=j]} \, Trade_{ij}^{cd} + \mathbf{u} + \varepsilon_{ij}^{cd}$$

- Vertical linkages :

$$\rho_{ij}^{cd} = \alpha + \beta_1 \, Trade_{ij}^{cd} + \gamma_1 \left(IO_{ij} \, Exports_i^{cd} + IO_{ji} \, Exports_j^{dc} \right) + \mathbf{u} + \varepsilon_{ij}^{cd}$$

  Can distinguish within and across sectors using the interaction with $\mathbf{1}_{[i=j]}$

dGL : International Comovements

- Data :
  - Sectoral production data (UNIDO) + Bilateral trade flows + IO US data
  - 55 countries, 28 manuf. sectors, 1970-1999
- Implementation :
  - Various measures of trade intensity (normalization)
  - Various sets of fixed effects
- Aggregation :

$$\Delta\hat{\rho}^{cd} = \frac{1}{\sigma_c \sigma_d} \sum_i \sum_j s_i^c s_j^d \sigma_c^i \sigma_d^j \Delta\hat{\rho}_{ij}^{cd}$$

with $\Delta\hat{\rho}_{ij}^{cd}$ the predicted effect of a given change in bilateral trade

dGL : International Comovements

	(1)	(2)	(3)	(4)
Trade	0.0015**	0.0013**	0.0012**	0.0011**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Trade×Same Sector	–	0.0037**	–	0.0016**
	–	(0.0003)	–	(0.0005)
Trade×IO	–	–	0.0242**	0.0239**
	–	–	(0.0015)	(0.0025)
Trade×Same Sector×IO	–	–	–	-0.0073^{+}
	–	–	–	(0.0040)
Observations	653,588	653,588	653,588	653,588
R^2	0.173	0.173	0.173	0.173

Note: All specifications use Trade/GDP and country- and sector-pair effects

Source : di Giovanni and Levchenko (2010)

dGL : International Comovements

$$\Delta\rho^{cd} = \underbrace{\frac{1}{\sigma_c\sigma_d}\sum_i s_i^c s_i^d \sigma_c^i \sigma_d^i (\hat{\beta}_1 + \hat{\beta}_2)\Delta Trade_{ii}^{cd}}_{Within-Sector} + \underbrace{\frac{1}{\sigma_c\sigma_d}\sum_i \sum_{j\neq i} s_i^c s_j^d \sigma_c^i \sigma_d^j \hat{\beta}_1 \Delta Trade_{ij}^{cd}}_{AcrossSectors}$$

Specification	Total Effect	Cross-Sector Component	Within-Sector Component
Baseline: Pooled			
$\Delta\rho^{cd}$	0.032	–	–
	(0.002)	–	–
Separate Within- and Cross-Sector Coefficients			
$\Delta\rho^{cd}$	0.034	0.0274	0.0061
	(0.002)	(0.0020)	(0.0004)
Share of Total		**0.82**	**0.18**

Note: Why cross-sector so important? As long as economies are diversified, production shares small, so within-sector component is small (even with larger elasticity)

dGL : International Comovements

$$\Delta\rho^{cd} = \underbrace{\frac{1}{\sigma_c\sigma_d}\sum_i\sum_j s_i^c s_j^d \sigma_c^i \sigma_d^j \hat{\beta}_1 \Delta Trade_{ij}^{cd}}_{Main\ Effect} + \underbrace{\frac{1}{\sigma_c\sigma_d}\sum_i\sum_j s_i^c s_j^d \sigma_c^i \sigma_d^j (IO_{ij} + IO_{ji})\hat{\gamma}_1 \Delta Trade_{ij}^{cd}}_{Vertical\ Linkage\ Effect}$$

Specification	Total Effect	Main Effect		Vertical Linkage Effect	
Baseline: Pooled					
$\Delta\rho_A$	0.035	0.025		0.010	
	(0.002)	(0.002)		(0.001)	
Share of Total		**0.71**		**0.29**	
		Within-Sector Component	Cross-Sector Component	Within-Sector Component	Cross-Sector Component
Separate Within- and Cross-Sector Coefficients					
$\Delta\rho_A$	0.035	0.0035	0.0231	0.0034	0.0050
	(0.002)	0.0007	0.0020	(0.0007)	(0.0005)
Share of Total		**0.10**	**0.66**	**0.10**	**0.14**

Source : di Giovanni and Levchenko (2010)

KMT : International Comovements

- Kleinert et al (2014) provide evidence that multinational firms are a source of international comovements
- Underlying argument :
  - MNEs are responsible for a large share of the economic activity in a region/country
  - MNEs are a potential source of transmission of shocks (e.g. through intra-firm trade or IO relationships)
- Identification strategy :
  - Use the heterogeneity across French regions in the location of foreign MNEs' affiliates
  - Measure business cycle comovements by the output correlation coefficient bw one region and a given foreign country
  - Tested hypothesis : Regions with more affiliates of foreign MNEs should be more strongly correlated with the business cycle in the country of origin of those firms

KMT : International Comovements

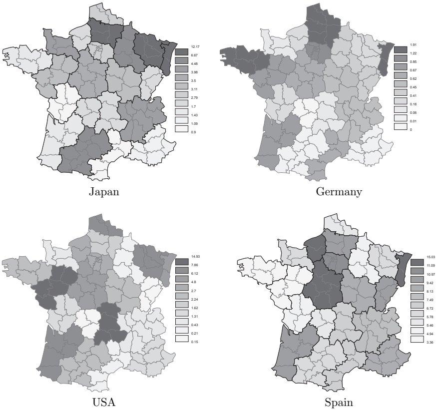


Figure 2. : Share of foreign affiliates in regional value added, by country of origin of the parent, 2004 (% total)

Note: The Figure describes the share of foreign affiliates in regional value added for manufacturing extractive, and agricultural industries in2004, 2004. Foeign affiliates with a headquarter in Germany, Japan, Spain, and the US are considered.
Source: The figure is based on the authors' computations relying on 3 data sets: BRN, STOJAN, and LIFI.

Source : Kleinert et al (2014).

KMT : International Comovements

Table 3—: Foreign Affiliates and Business Cycle Correlations

Dep. variable: ρ_{cr}*=Correlation of growth rate of GDPs*	(1)	(2)	(3)	(4)
$FME_{cr}(Empl.)$	12.72***		11.01***	11.39***
	(4.053)		(3.431)	(3.509)
BT_{cr}		20.42***	15.36*	11.45
		(2.680)	(1.951)	(1.508)
IIT_{cr}				0.06
				(1.345)
$DISIM_{cr}$				-0.06***
				(-4.460)
Region FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Observations	3,402	3,402	3,402	3,329
R^2	0.691	0.690	0.691	0.695

Note: This table investigates the determinants of the bilateral comovement of business cycles between French regions and 162 countries. The comovement is measured by the correlation of the yearly growth of region r and country c GDPs over the 1990-2006 period. The explanatory variables are the share of employment (FME_{cr}) generated by foreign affiliates from country c in region r, the bilateral trade (BT_{cr}) between region r and country c, normalized by the two GDPs, the share of intra-industry trade (IIT_{cr}) between region r and country c, and the dissimilarity ($DISIM_{cr}$) of country c and region r in terms of specialization. All regressions include region and country fixed effects. Robust t-statistics are reported between parentheses. *, **, and *** indicate significance at the 10, 5, and 1 percent levels respectively.

Source : Kleinert et al (2014).

dGLM : International Comovements

- di Giovanni et al (2018) study the role of individual firms in driving aggregate comovements
- Underlying argument :
  - Distribution of firms' size is highly skewed
  - Large firms are more likely to have **direct connections** with foreign countries through exports, imports, and MNE linkages
  - Potentially helps propagate (macro and individual shocks) across countries
- Can help distinguish between transmission of shocks and common shocks in Frankel and Rose's type regressions

dGLM : Conceptual Framework

- Correlation between France and country $\mathcal{C}$:

$$\rho\left(\gamma_{At}, \gamma_{\mathcal{C}t}\right) = \frac{Cov\left(\gamma_{At}, \gamma_{\mathcal{C}t}\right)}{\sigma_A \sigma_{\mathcal{C}}} \tag{1}$$

- Aggregate growth rate (Intensive margin) :

$$\gamma_{At} = \sum_f w_{ft-1} \gamma_{ft} \tag{2}$$

▸ Extensive Margin

- Plugging (2) into (1), aggregate correlation can be written as :

$$\rho\left(\gamma_{At}, \gamma_{\mathcal{C}t}\right) = \sum_f w_{ft-1} \frac{\sigma_f}{\sigma_A} \rho\left(\gamma_{ft}, \gamma_{\mathcal{C}t}\right) \tag{3}$$

dGLM : Micro Evidence I

- Estimation equation

$$\rho\left(\gamma_{ft}, \gamma_{\mathcal{C}t}\right) \quad = \quad \beta \textbf{DIRECT}_{f,\mathcal{C}} + \delta_f + \delta_{\mathcal{C}} + \eta_{f,\mathcal{C}}$$

where

$$\textbf{DIRECT}_{f,\mathcal{C}} = [EX_{f,\mathcal{C}} \quad IM_{f,\mathcal{C}} \quad AFF_{f,\mathcal{C}} \quad HQ_{f,\mathcal{C}}]$$

- Refine the interpretation of macro results
  - Comovements through the transmission of shocks (Frankel and Rose, 1998)
  - Connected countries are more similar, thus subject to common shocks (Imbs, 2004)

dGLM : Micro Evidence II

- Augmented specification : Indirect linkages

$$\rho(\gamma_{ft}, \gamma_{\mathcal{C}t}) = \beta \mathbf{DIRECT}_{f,\mathcal{C}} + \beta_5 DS_{f,j,\mathcal{C}} + \beta_6 US_{f,j,\mathcal{C}} + \delta_f + \delta_{\mathcal{C}} + \eta_{f,\mathcal{C}}$$

$$\text{where} \quad DS_{f,j,\mathcal{C}} = \underbrace{INPUTINT_f}_{f\text{'s total input usage intensity}} \sum_i IO_{ij} \frac{NIM_{i,\mathcal{C}}}{N_i}$$

$$US_{f,j,\mathcal{C}} = \underbrace{DOMINT_f}_{f\text{'s domestic sales intensity}} \sum_i IO_{ji} \frac{NEX_{i,\mathcal{C}}}{N_i}$$

Intensity with which firm f interacts with internationally connected firms

- With perfect (firm-to-firm) data : $DS^*_{f,\mathcal{C}} = \sum_g IO_{gf} IM_{g,\mathcal{C}}$

dGLM : From Micro to Macro

1. Contribution of directly connected firms

$$\rho\left(\gamma_{At},\gamma_{\mathcal{C}t}\right)=\frac{\sigma_{I_{\mathcal{C}}}}{\sigma_A}\rho\left(\sum_{f\in I_{\mathcal{C}}}w_{ft-1}\gamma_{ft},\gamma_{\mathcal{C}t}\right)+\frac{\sigma_{I_{\mathcal{C}}^c}}{\sigma_A}\rho\left(\sum_{f\in I_{\mathcal{C}}^c}w_{ft-1}\gamma_{ft},\gamma_{\mathcal{C}t}\right)$$

2. Change in the aggregate correlation

$$\widehat{\Delta\rho}\left(\gamma_{At},\gamma_{\mathcal{C}t}\right)=\sum_{f}w_{ft-1}\frac{\sigma_f}{\sigma_A}\widehat{\Delta\rho}\left(\gamma_{ft},\gamma_{\mathcal{C}t}\right)$$

with

$$\begin{aligned}\widehat{\Delta\rho}\left(\gamma_{ft},\gamma_{\mathcal{C}t}\right) \quad = \quad & -\widehat{\beta}_1\mathbf{1}\left(EX_{f,\mathcal{C}}=1\right)-\widehat{\beta}_2\mathbf{1}\left(IM_{f,\mathcal{C}}=1\right)\\ & -\widehat{\beta}_3\mathbf{1}\left(AFF_{f,\mathcal{C}}=1\right)-\widehat{\beta}_4\mathbf{1}\left(HQ_{f,\mathcal{C}}=1\right)\\ & \left(-\widehat{\beta}_5 DS_{f,j,\mathcal{C}}-\widehat{\beta}_6 US_{f,j,\mathcal{C}}\right)\end{aligned}$$

dGLM : Data Description

- Merge three large datasets :
  - Fiscal administration : firm tax forms from BRN and RSI (small firms) : value added, sales
  - Customs : partner-country exports and imports
  - *Liaisons Financieres* Database : multinational ownership
- Study comovement with 10 of France's largest trading partners over 1993–2007
  - Replace Switzerland with Brazil to include another major non-European trading partner
- Winsorize micro-level growth rates at 100%

dGLM : Summary Statistics for Whole Economy

	No. firms	Value Added		
		Mean	Median	Share in total
All Firms	998,531	1,165	211	1.00
Importers	189,863	3,516	515	0.72
Exporters	200,775	3,219	477	0.71
Affiliates of foreign multinationals	30,654	7,061	1,335	0.25
Firms with foreign affiliates	1,786	65,829	2,279	0.14

Notes : valued added is reported in thousands of euros. Importers/exporters account for 93% of manufacturing value added.

dGLM : Estimation Results

TABLE – Micro-level estimation results

	(1) Baseline	(2) Baseline	(3) Baseline	(4) Baseline	(5) Baseline	(6) Sales	(7) MFG
Dep. Var : $\rho(\gamma_{ft}, \gamma_{Ct})$							
Importer	0.029[a]	0.025[a]	0.013[a]	0.013[a]	0.012[a]	0.018[a]	0.011[a]
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Exporter	0.035[a]	0.020[a]	0.005[a]	0.005[a]	0.006[a]	0.011[a]	0.005[a]
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
French Multinational	0.023[b]	0.021[b]	0.009	0.009	0.009	0.017[c]	0.002
	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.013)
Affiliate of a Foreign MNE	0.028[a]	0.028[a]	0.010[a]	0.010[a]	0.009[a]	0.014[a]	0.011[a]
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
Observations	8,363,760	8,363,760	8,363,760	8,363,440	8,363,750	8,928,330	1,234,760
Adjusted R^2	0.001	0.281	0.287	0.288	0.289	0.285	0.285
Firm FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	Yes	No	No	Yes	Yes
Country×Region FE	No	No	No	Yes	No	No	No
Country×Sector FE	No	No	No	No	Yes	No	No
# of Xing links	403,180	403,180	403,180	403,092	403,180	418,915	202,454
# of Ming links	573,347	573,347	573,347	573,222	573,347	593,338	216,471
# of Affiliates	25,385	25,385	25,385	25,382	25,385	27,786	7,115
# of HQ links	3,046	3,046	3,046	3,043	3,046	3,626	815
# of Firm FEs		836,376	836,376	836,344	836,375	892,833	123,476
# of Country FEs			10			10	10
# of Country×Region FEs				960			
# of Country×Sector FEs					1,090		

dGLM : Estimation Results : Indirect Linkages

	(1)	(2)	(3)	(4)
	Panel A : Whole Economy		**Panel B : Manufacturing Sector**	
Dep. Var : $\rho(\gamma_{ft}, \gamma_{\mathcal{C}t})$				
Importer	0.011^a	0.011^a	0.007^a	0.007^a
	(0.001)	(0.001)	(0.002)	(0.001)
Exporter	0.003^a	0.006^a	0.004^b	0.005^a
	(0.001)	(0.001)	(0.002)	(0.002)
French Multinational	0.009	0.008	0.002	0.006
	(0.008)	(0.008)	(0.013)	(0.013)
Affiliate of a Foreign MNE	0.011^a	0.010^a	0.011^a	0.011^a
	(0.002)	(0.002)	(0.004)	(0.004)
Indirect importers	0.225^a	0.052^a	0.226^a	0.100^a
	(0.016)	(0.021)	(0.028)	(0.032)
Indirect exporters	-0.025^a	0.030^b	0.319^a	0.150^b
	(0.006)	(0.014)	(0.032)	(0.076)
Observations	7,866,970	7,866,960	1,224,130	1,224,130
Adjusted R^2	0.288	0.289	0.286	0.288
Firm FE	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No
Country×Sector FE	No	Yes	No	Yes
# of Xing links	401,722	401,722	202,313	202,313
# of Ming links	571,234	571,234	216,346	216,346
# of Affiliates	24,105	24,105	7,086	7,086
# of HQ links	3,020	3,020	815	815
# of Firm FEs	786,697	786,696	122,413	122,413
# of Country FEs	10		10	
# of Country×Sector FEs		1,090		600

dGLM : Aggregate Contribution of Directly Connected Firms

Country	Average ρ_A (observed)	Direct component	Indirect component
Belgium	0.758	0.519	0.239
Brazil	-0.269	-0.191	-0.078
China	-0.545	-0.370	-0.175
Germany	0.643	0.396	0.247
Italy	0.630	0.399	0.232
Japan	-0.183	-0.163	-0.021
Netherlands	0.618	0.425	0.193
Spain	0.876	0.543	0.332
United Kingdom	0.010	0.078	-0.069
United States	0.372	0.317	0.055
Average	0.291	0.195	0.096
NB : Manufacturing			
Average	0.484	0.408	0.076

dGLM : International Comovements

- Directly connected firms account for 8% of firms but 56% of aggregate value added
- Because they are systematically more correlated with foreign countries, they account for 70% of observed aggregate correlation in the data
- Severing direct links at the firm level reduces aggregate correlation by 0.1 on average (from .29 on average)

⇒ Individual (large) firms contribute to the transmission of shocks across countries

Conclusion

- International markets organize has networks of (large) firms
- These networks create real transmission channels for shocks across countries
- Can help refine our understanding of international business cycles
- Still a lot that we do not understand :
  - Interaction between finance and the real economy
  - Mechanisms for the propagation

BS (2016) : Identifying assumptions

- Parallel trends assumption : Customer of the firm hit by the natural disaster would have had flat growth in the absence of the treatment

⇒ Null of parallel trends between eventually treated and never treated firms cannot be rejected

- Exclusion restriction : Natural disaster affect the customer only through its disruptive effect on its supplier

⇒ Exclude supplier-customer relationships located within 300 miles of each other

⇒ Check that the impact of the disruption is found significant iif the link is active when the shock hits

- External validity requires that firms do not choose their location, and their suppliers' location by taking into account the potential impact of natural disasters on their supply chain

Back

Intensive and Extensive Margins

[noframenumbering]

$$\tilde{\gamma}_{At} \approx \ln \sum_{f \in I_t} x_{ft} - \ln \sum_{f \in I_{t-1}} x_{ft-1}$$

$$= \ln \frac{\sum_{f \in I_{t/t-1}} x_{ft}}{\sum_{f \in I_{t/t-1}} x_{ft-1}} - \left(\ln \frac{\sum_{f \in I_{t/t-1}} x_{ft}}{\sum_{f \in I_t} x_{ft}} - \ln \frac{\sum_{f \in I_{t/t-1}} x_{ft-1}}{\sum_{f \in I_{t-1}} x_{ft-1}} \right)$$

$$= \underbrace{\gamma_{At}}_{Intensive\ margin} - \underbrace{\ln \frac{\pi_{t,t}}{\pi_{t,t-1}}}_{Extensive\ margin}$$

Focus mostly on the intensive margin Back to framework