Using B2B transactions data for research and analysis : the NBB experience

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BanqueNationaleBank
DE BELGIQUE VAN BELGIË
Eurosystem

A disturbing question in 2014

"How much do non exporters sale abroad ?"

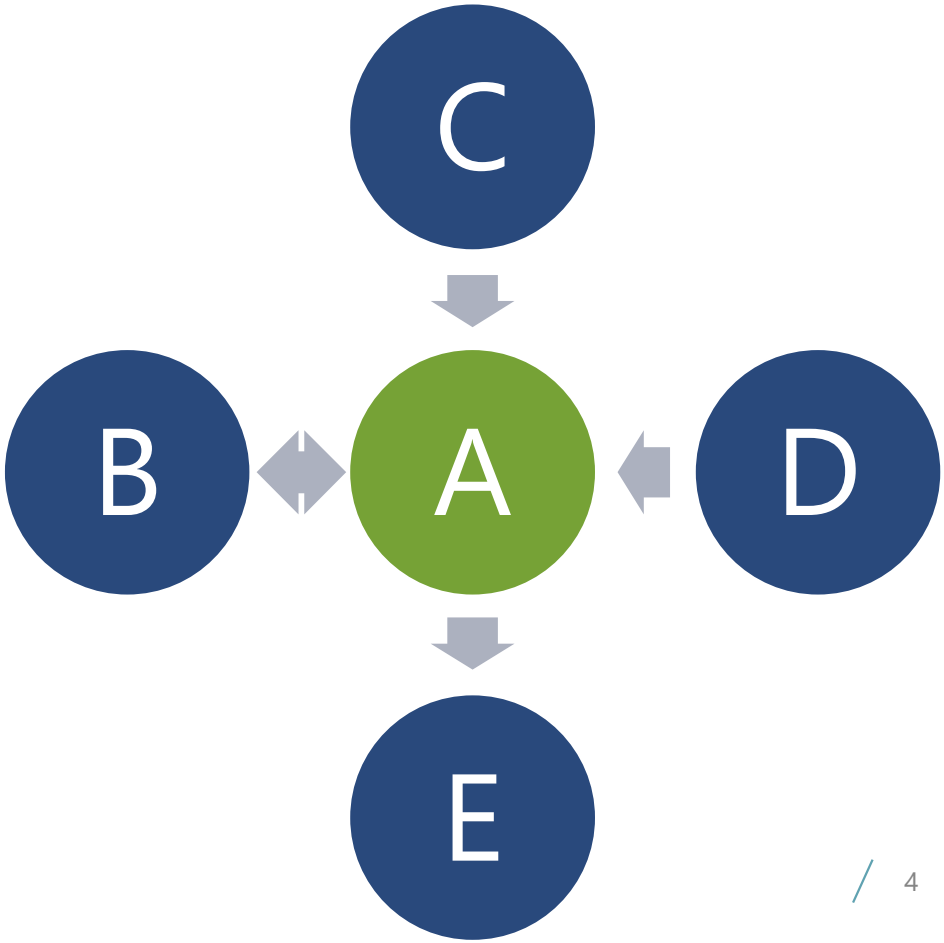
former NBB board member

B2B transaction data at the NBB

- Why does the NBB collect B2B transaction data ?
  - NBB is not only a CB, it's also in charge of compiling national accounts
- Data available from 2000 to 2022 on a yearly basis
- Originally used to for quality control of exports / imports declarations
- Based on the annual declarations of sales by customers (VAT entities) to the tax authority
  - Multiple transactions within a year are aggregated – higher frequency data is not available
  - Any transaction larger than 250 EUR in a given year has to be reported
  - 2002 onwards : reports online => improve the quality of the dataset
  - Covers every type of VAT entities : NFCs and FCs, self-employed, public entities, non profit

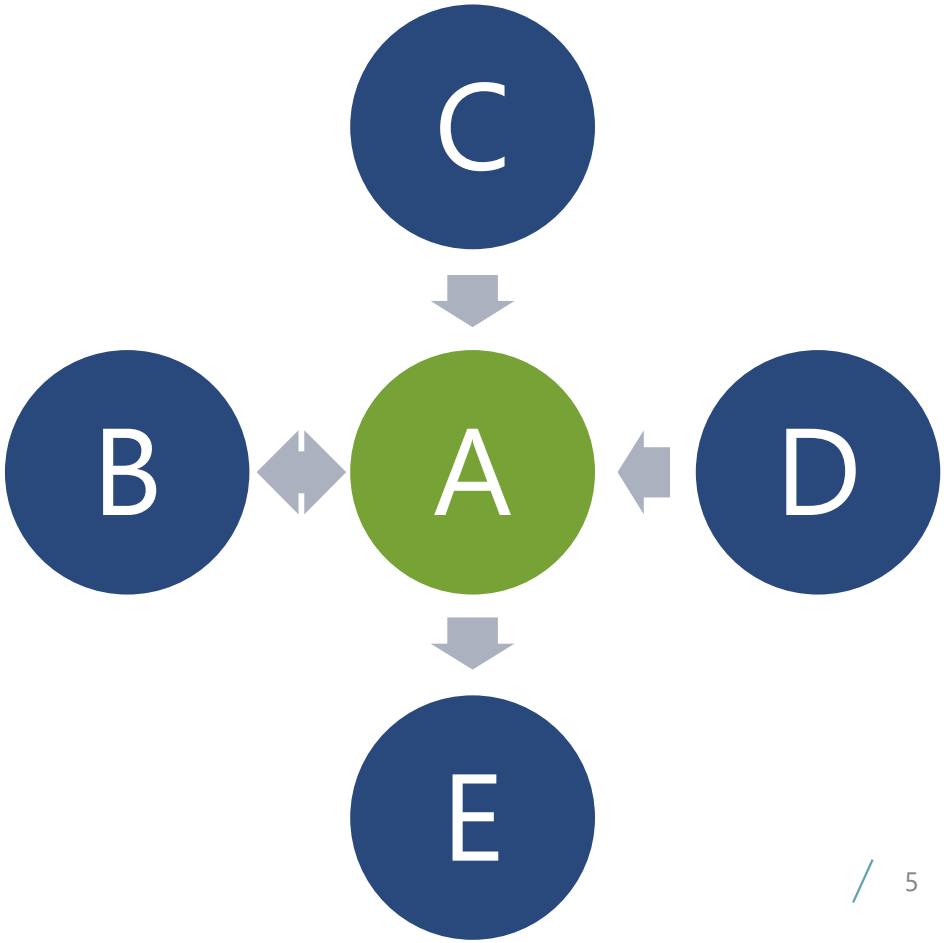
B2B transaction data at the NBB

- Need to be complemented by other data sources
  - Monthly/Quarterly VAT declarations : total sales, input consumption, investments
  - Monthly IntraStat / customs declarations
  - Annual accounts
  - …



B2B transaction data at the NBB

- B2B linkages are not IO linkages
  - IO linkages only cover deliveries of inputs (materials and services)
  - Transactions cover deliveries of material inputs, services, capital goods
  - IO linkages with retailers/wholesalers only captures the delivery of inputs to retailers/wholesalers for their "trade" activities or the value of the services provided by retailers/wholesalers to the other sectors
  - In B2B linkages, sales to retailers/wholesalers capture the value of the products delivered to retailers/wholesalers by their suppliers,



A quick look at the data…

	vat_i	vat_j	year	sales_ij
213650666	5FD337AB7B9F2A56...	1044CA27601F496B0...	2007	1700
213650691	5FD337AB7B9F2A56...	867B113E4DB8872E4...	2007	635
213650730	5FD337AB7B9F2A56...	BE7058DDF709DAC1...	2007	700
213650829	5FD337AB7B9F2A56...	1E34091A9F0A9C3A0...	2007	1200
213650840	5FD337AB7B9F2A56...	AFCC52F150E84FDE...	2007	4052.3999
213650846	5FD337AB7B9F2A56...	9418618F0A96DE2FD...	2007	2814.8
213650868	5FD337AB7B9F2A56...	356386CD69FCDE7B...	2007	620
213671440	91AD75C4DDFEFD9...	91AD75C4DDFEFD93...	2007	1152
213782694	F4D8BA1EF75B5412...	5BDD8472161F843D...	2007	766.96002
215223484	60DFBB5E7354B972...	44C0DBCABECC4867...	2007	5145.6299
215223485	60DFBB5E7354B972...	8E0926ECE6C3EE19...	2007	1719.5601
215223490	60DFBB5E7354B972...	15F91607682767A91...	2007	142585.28
215223499	60DFBB5E7354B972...	31D6DAB92507702DF...	2007	6248
215223501	60DFBB5E7354B972...	6C30A0854722F7251...	2007	6072.1802
215223514	60DFBB5E7354B972...	3473A9C9451F47881...	2007	3550.1399
215223520	60DFBB5E7354B972...	F8F482EB6ADA2FC6...	2007	7871.7598
215223529	60DFBB5E7354B972...	BBE1FBC16DBFA122...	2007	3668.9399

Why the Belgian production network is interesting to look at ?

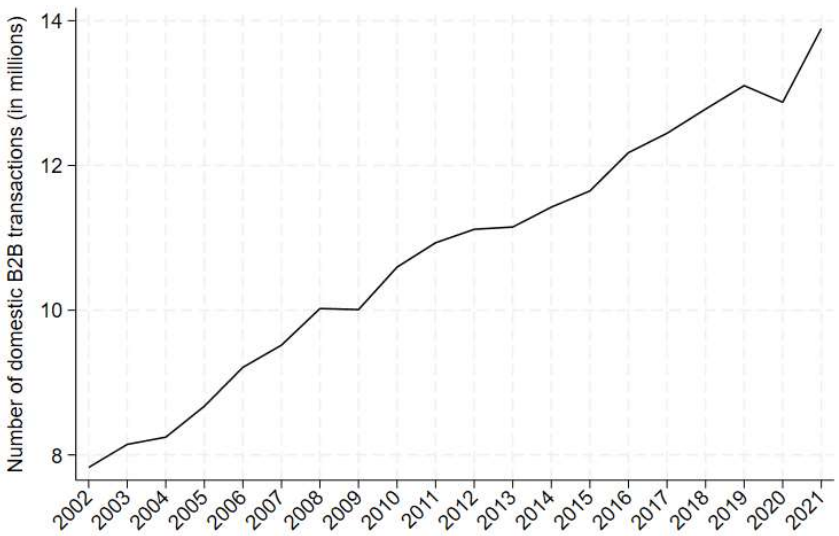
- Small country : longest distance between two cities = 270 km
- High density of firms : more than 500,000 NFC
- Good infrastructure :
  - 155,000 km of roads
  - 3,500 km of railways
  - 2,000 km of waterways
- No natural obstacles (mountains, lakes, …)
- But three regions and two main communities
  - Three regulatory authorities
  - Three official languages
- Domestic trade remains very important : 80% of trade in intermediaries is domestic

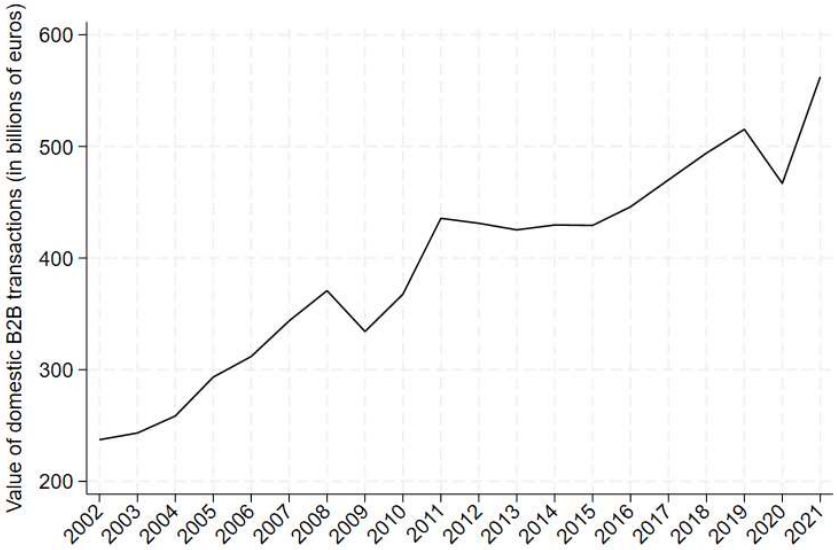
Some stylized facts

- Based on the last vintage of the dataset
- Described in Dhyne, Duprez, Komatsu (2023) [NBB WP 444]
  - 2002-2021
  - only transactions between NFCs

Fact 1 – Number of transactions increases steadily

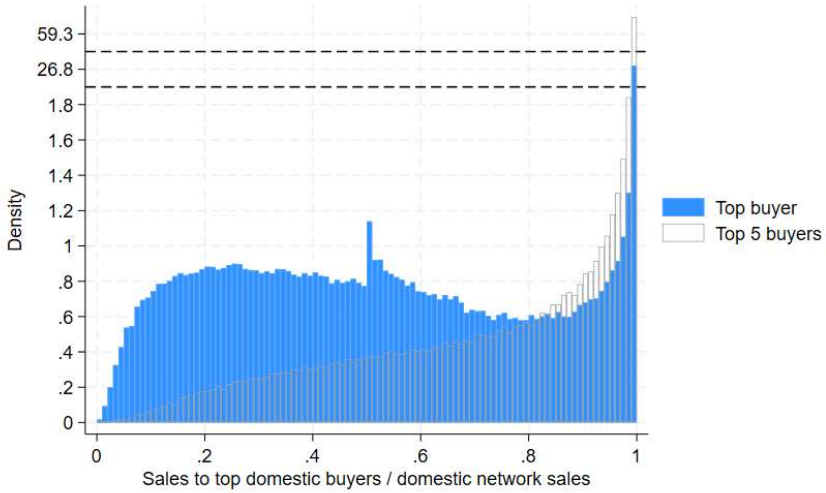
- Number of transactions : from 7.8 millions in 2002 (237 billions EUR)
  to 13.9 millions in 2021 (562 billions EUR)

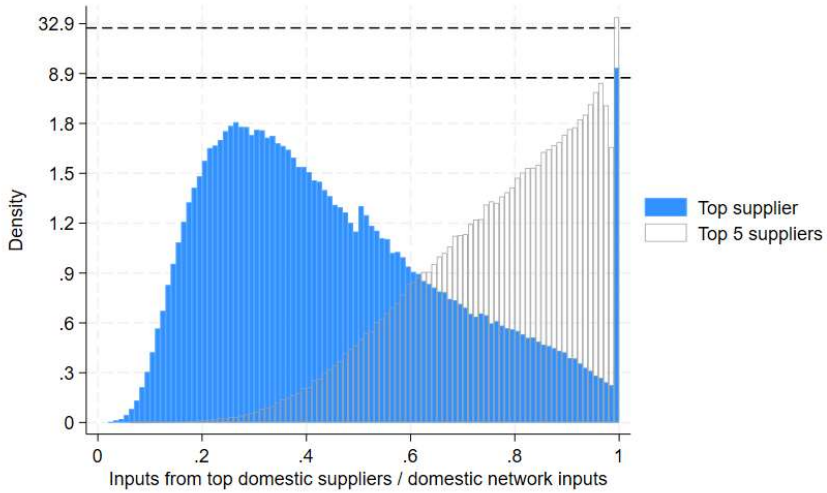




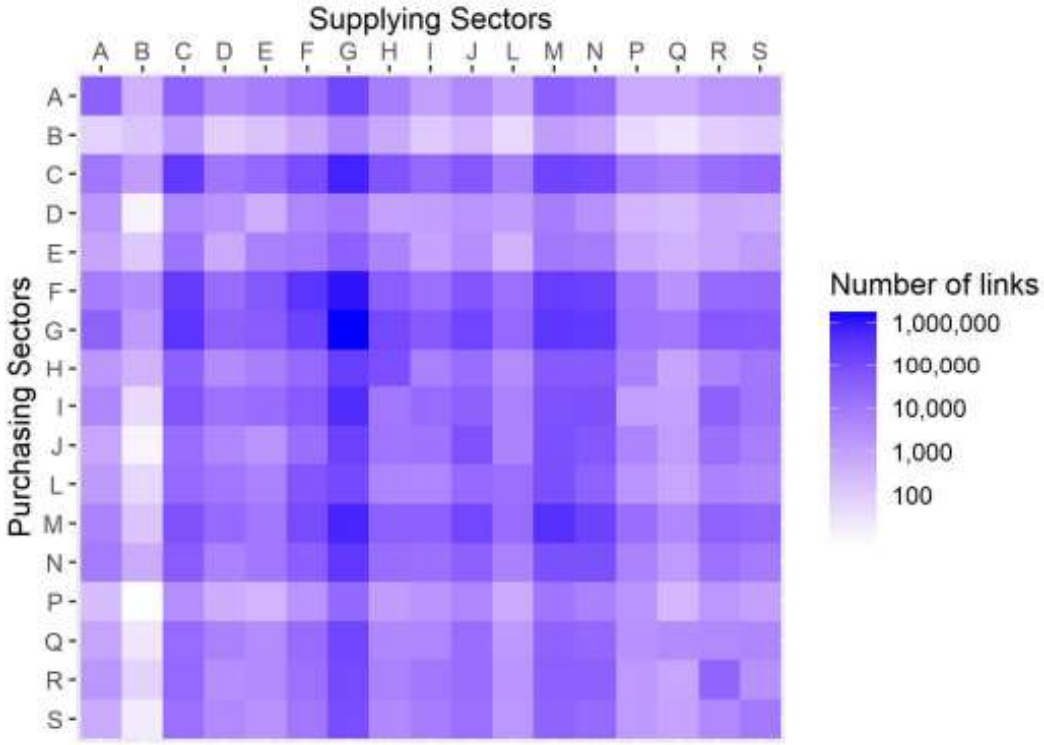
Fact 2 – The distribution of the transactions is highly skewed

			Percentiles				
	Mean	SD	10th	25th	50th	75th	90th
Transactions (in euro)	36456	3178858	358	613	1607	5751	24131
Number of buyers	36	336	1	2	5	17	63
Number of domestic suppliers	26	55	2	5	12	29	58

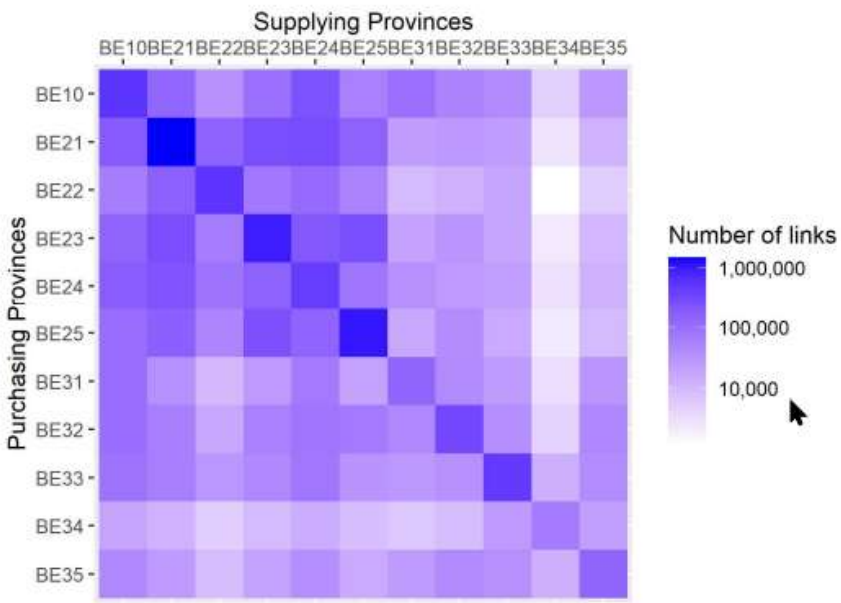


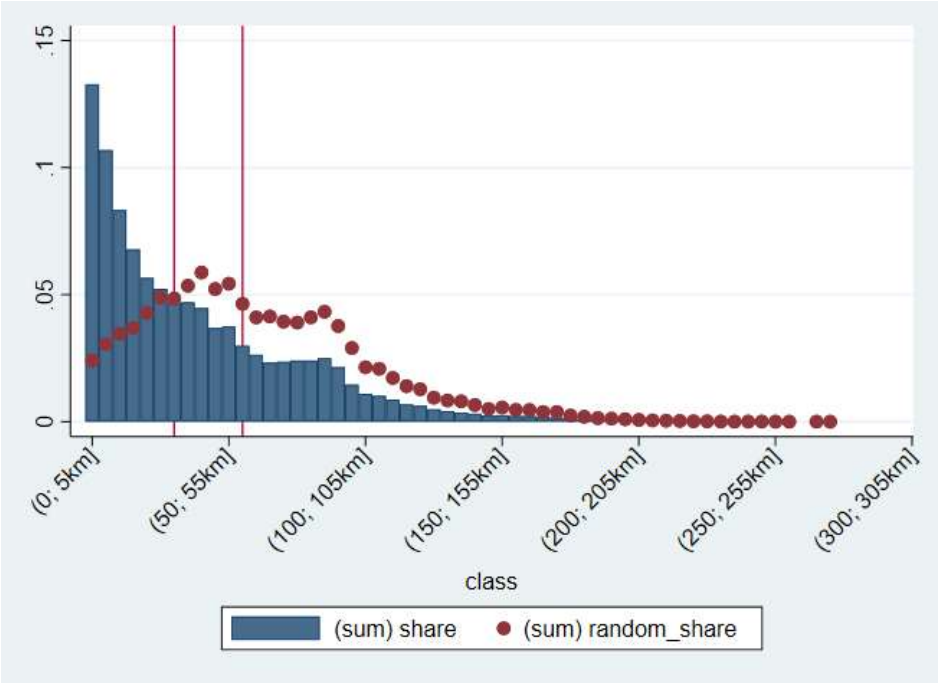


Fact 3 – Wholesalers and retailers are key connecting nodes

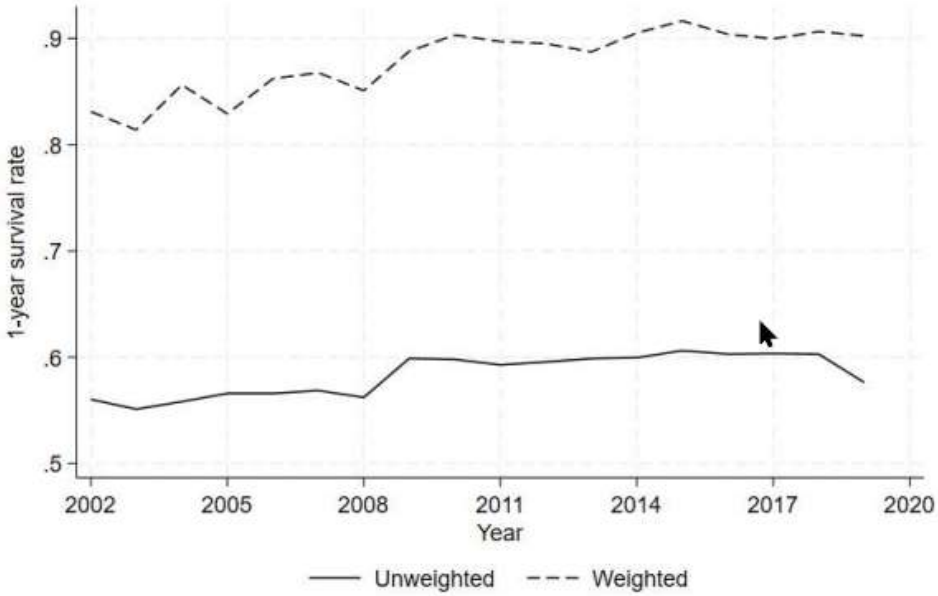


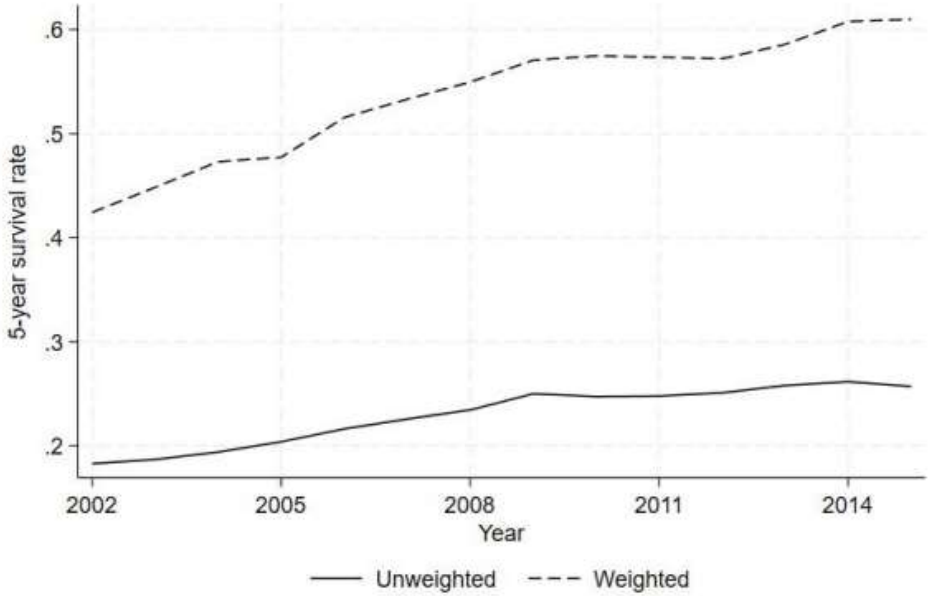
Fact 4 – Trade is mostly local – Belgium is not a village





Fact 5 – There is a high churning rate of transactions





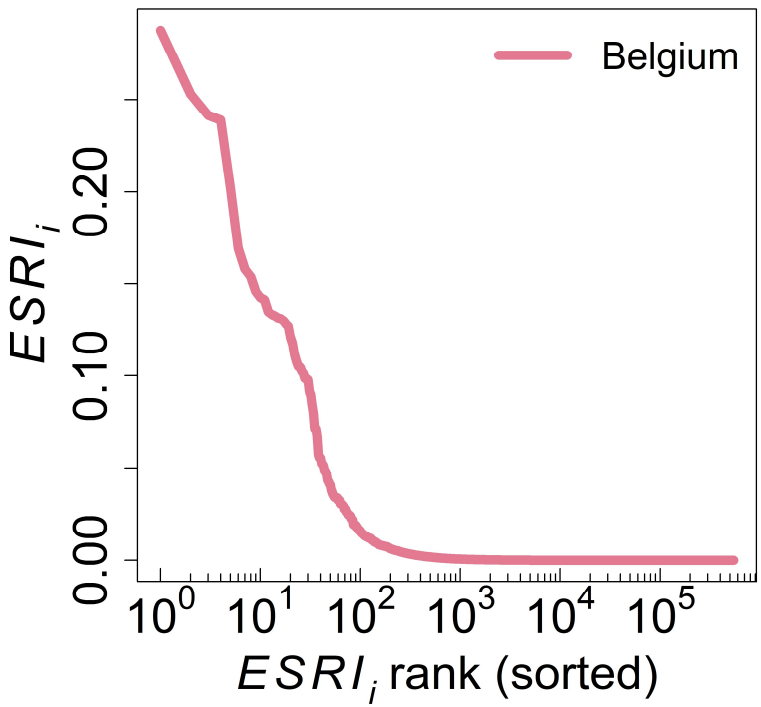
What research / policy relevant questions can be addressed using B2B data ?

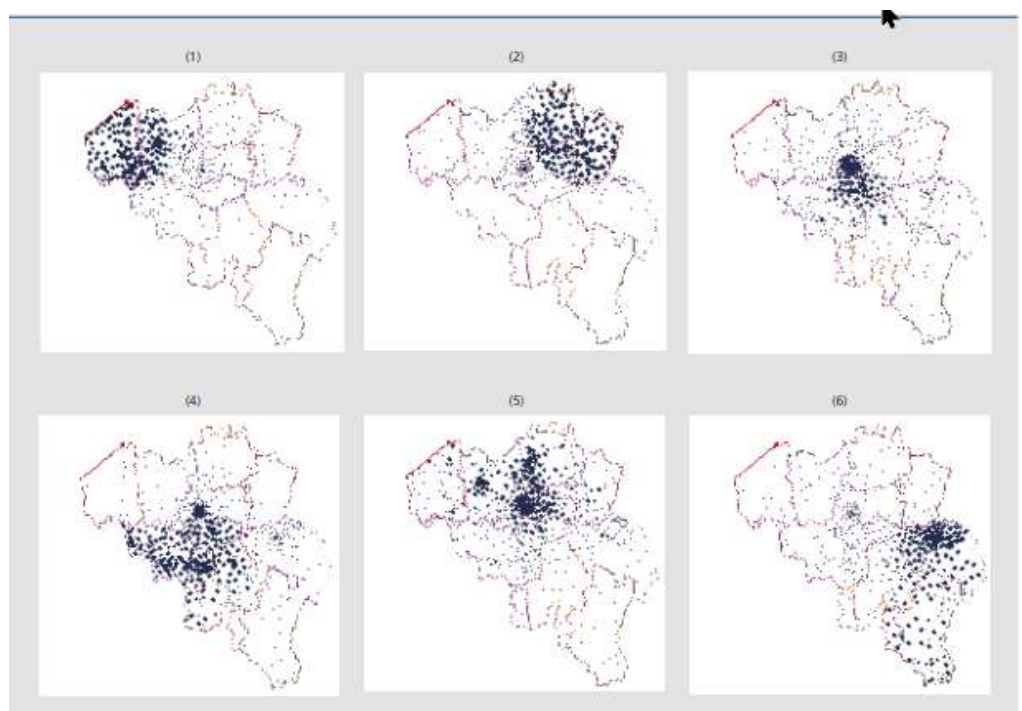
- Organisation of the Belgian production network
  - Measuring position of firms in G/LVCs : network centrality, community detection, …
  - Does local sourcing affect firms performance ?
- Participation to international trade
  - Indirect exposure to trade, learning about foreign demand through B2B linkages,…
- Price setting and markups
  - Passthrough of input costs to producer prices
- Technological spillovers
  - Connections with innovators, connections with superstars…
- Shock propagation : foreign demand shock, monetary policy shock…

…

Organisation of the Belgian production network

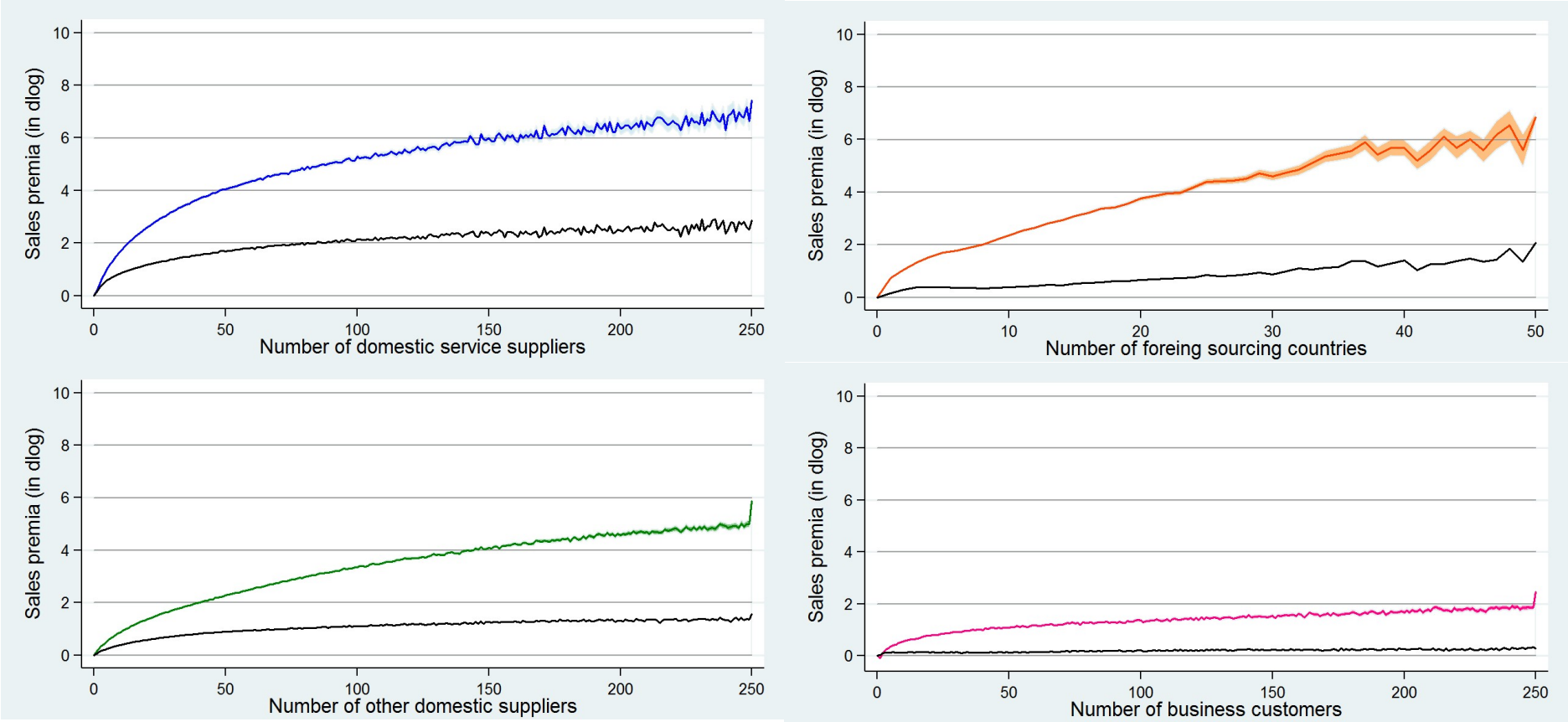
- Centrality = detection of systemic firms
- Community detection = detection of substructures





Dhyne and Duprez, 2017b

Does domestic sourcing matter ? Dhyne and Duprez (2022)



Dhyne, Duprez, 2022

Domestic sourcing – Dhyne and Duprez (2022)

	All firms Service supp. only		All firms All firms		Manuf. firms only Manuf. supp. only	
	Est. coef.	Avg. elast.	Est. coef.	Avg. elast.	Est. coef.	Avg. elast.
$dist_{ij}$	$-0.2471^{(a)}$	$-0.999^{(a)}$	$-0.230^{(a)}$	$-0.919^{(a)}$	$-0.183^{(a)}$	$-0.667^{(a)}$
$\neq Region_{ij}$	$-0.312^{(a)}$	$-0.719^{(a)}$	$-0.235^{(a)}$	$-0.611^{(a)}$	$-0.204^{(a)}$	$-0.526^{(a)}$
$\widetilde{tfp}_{i,t-1}$	$0.023^{(a)}$	$0.094^{(a)}$	$0.026^{(a)}$	$0.103^{(a)}$	$-0.010^{(a)}$	$-0.366^{(a)}$
tfp_{jt}	$0.061^{(a)}$	$0.246^{(a)}$	$0.112^{(a)}$	$0.4484^{(a)}$	$0.103^{(a)}$	$0.377^{(a)}$
$l_{i,t-1}$	$0.143^{(a)}$	$0.576^{(a)}$	$0.122^{(a)}$	$0.4881^{(a)}$	$0.135^{(a)}$	$0.491^{(a)}$
l_{jt}	$0.151^{(a)}$	$0.611^{(a)}$	$0.133^{(a)}$	$0.5313^{(a)}$	$0.070^{(a)}$	$0.254^{(a)}$
Year f.e.			Yes			
i & j census f.e.			Yes			
i & j sector f.e.			Yes			
Other controls			Yes			
Bootstrap	100		100		100	

Dhyne, Duprez, 2022

Participation to international trade

- How close Belgian firms are from the borders and does it matter ? (Dhyne and Rubinova, 2015, Dhyne and Duprez, 2017a)

Number of transactions to buy from the rest of the world	1	2	3	4	≥ 5	∞ [1]	Total
	Panel A: All transactions						
1	1.7	2.3	0.7	0.1	0.0	0.7	**5.4**
2	0.8	25.8	24.2	3.3	0.3	22.1	**76.4**
3	0.0	1.3	3.6	0.8	0.1	10.0	**15.8**
4	0.0	0.0	0.0	0.0	0.0	0.1	**0.1**
≥ 5	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
∞ [1]	0.0	0.4	1.2	0.4	0.0	0.2	**2.3**
Total	**2.5**	**29.8**	**29.7**	**4.5**	**0.4**	**33.1**	**100.0**

TABLE 4 TOTAL FACTOR PRODUCTIVITY AND GVC PARTICIPATION

Explanatory variables	(1)	
Employment (in logarithm)	0.132***	(0.009)
International trade status		
Only exporting	0.343***	(0.034)
Only importing	0.512***	(0.068)
Both exporting and importing	0.872***	(0.078)
Export suppliers		
Rank 1	0.230***	(0.028)
Rank 2	0.142***	(0.033)
Rank 3	0.109**	(0.049)
Import customers		
Rank 1	0.311***	(0.067)
Rank 2	0.295***	(0.066)
Rank 3	0.175**	(0.075)

Participation to international trade

- Learning from your Business partners (Connell Garcia et al., 2019, Ludwig et al., 2023)
  - Connell Garcia : learning about foreign demand through wholesalers and retailers
  - Ludwig et al. : learning about foreign demand through your business partners
    - Is export participation facilitated by interactions in domestic production networks ?
    - Findings :
    - network mediated export signals are an import determinant of export entry
    - Network effect decreases with network size (noise)

$$Pr(y_{id,t} = 1) = Pr\left(\boldsymbol{x_{id,t}} + \delta \sum_{j} \bar{s}_{ij,t-1} \boldsymbol{x_{j,t-1}} + \beta \sum_{j} s_{ij,t-1} y_{jd,t-1} + \psi + \varepsilon_{id,t} > 0 \right)$$

Participation to international trade

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
matching signals	0.0047***					
	(0.0012)					
non-matching signals		-8.22×10^{-6}				
		(7.91×10^{-5})				
total signals			1.48×10^{-7}			
			(7.92×10^{-5})			
EEA signals				-3.5×10^{-5}		
				(0.0001)		
border signals					0.0002	
					(0.0004)	
history signals						0.0001**
						(5.81×10^{-5})
Peer characteristics	yes	yes	yes	yes	yes	yes
Firm destination experience	yes	yes	yes	yes	yes	yes
Firm characteristics	yes	yes	yes	yes	yes	yes
firm FE	yes	yes	yes	yes	yes	yes
destination FE	yes	yes	yes	yes	yes	yes
year FE	yes	yes	yes	yes	yes	yes
nace4 FE	yes	yes	yes	yes	yes	yes
R^2	0.123	0.123	0.123	0.123	0.123	0.123
Observations	473,494	473,494	473,494	473,494	473,494	473,494

Clustered (firm) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

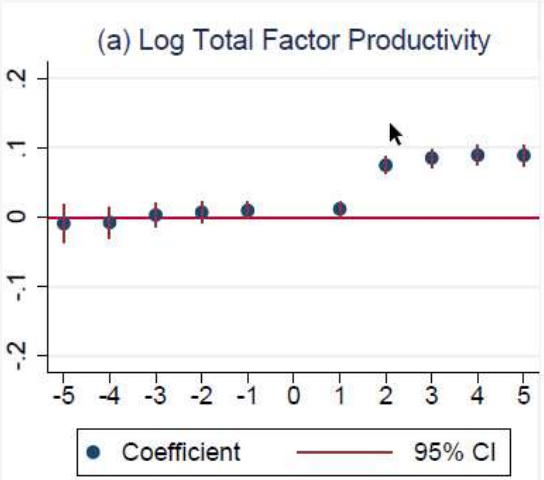
Ludwig et al, 2023

Knowledge / technological spillovers

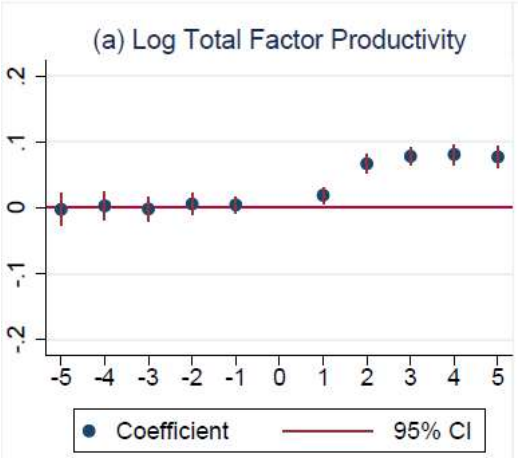
- Amiti et al. (2023) “FDI and superstar spillovers: Evidence from firm-to-firm transactions”
  - Do superstar firms generate positive spillovers?
  - Paper shows positive spillovers from starting to supply superstar firms, broadly defined to include domestic large firms, exporters, and multinationals
  - Placebo tests show no productivity effects from new relationships with non-superstars
  - Over and above productivity related spillovers, the authors document one more spillover channel : the increase in new buyers is particularly strong within the superstar firm's network, a “dating agency” effect

Knowledge / technological spillovers

Gains from selling to Multinationals



Gains from selling to large domestic firms



Important role for raising productivity through superstars' supply chains regardless of their multinational status

Amiti et al, 2023

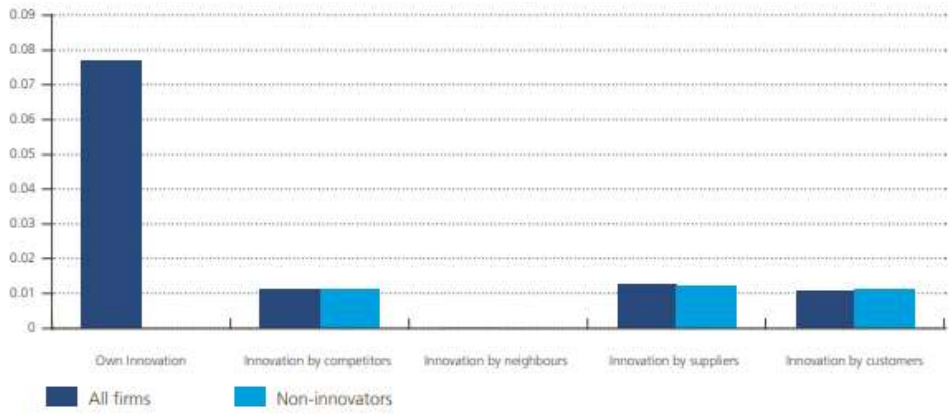
Knowledge / technological spillovers – Innovators (De Mulder, Dhyne, 2022)

- Analysis of the impact of innovation (patenting) on productivity
  - Direct effect
  - Indirect effect
    - Neighbours
    - Competitors
    - Suppliers / Customers

$$Prod_{it} = c + \alpha\, Pat_{it-1} + \beta_1\, Pat_{st-1} + \beta_2\, Pat_{gt-1} + \beta_3\, Pat_{bt-1} + \beta_4\, Pat_{ft-1} + FE_{it} + \varepsilon_{it}$$

Knowledge / technological spillovers – Innovators (De Mulder, Dhyne, 2022)

Variables / specifications	(1)	(2)	(3)	(4)	(5)	(6)
Own patents (α)	0.0811**	0.0826**	0.0812**	0.0764**	0.0799**	0.0771**
Competitors' patents (β_1)		0.0112***				0.0111***
Neighbours' patents (β_2)			0.0011			0.0009
Suppliers' patents (β_3)				0.0137***		0.0126***
Customers' patents (β_4)					0.0112***	0.0108***



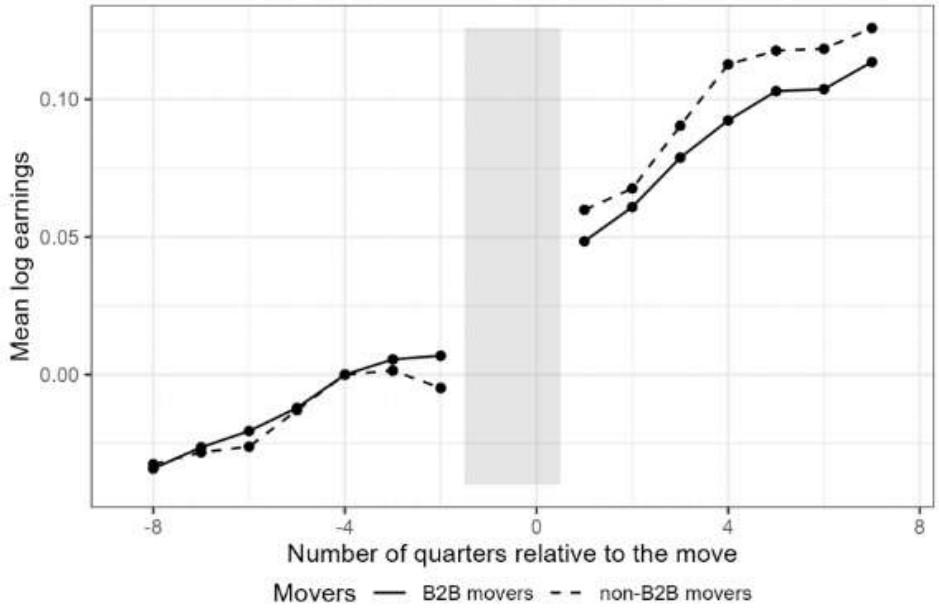
Production network and labor market transition

- Komatsu and Dhyne (2023) "Job Ladder over Production Networks"
  - Belgian workers are well connected through the networks of their employers and face a higher job-finding rate along the supply chain
  - Transitions within the production network leads to lower wage increases than transition outside the production network

Table 1: Share of B2B moves

	Share of moves	
	Data	Random benchmark
All movers		
all B2B moves	0.42	0.20
moves to buyers	0.32	0.14
moves to suppliers	0.23	0.12
moves through key B2B links	0.11	0.02

(a) Raw quarterly earnings

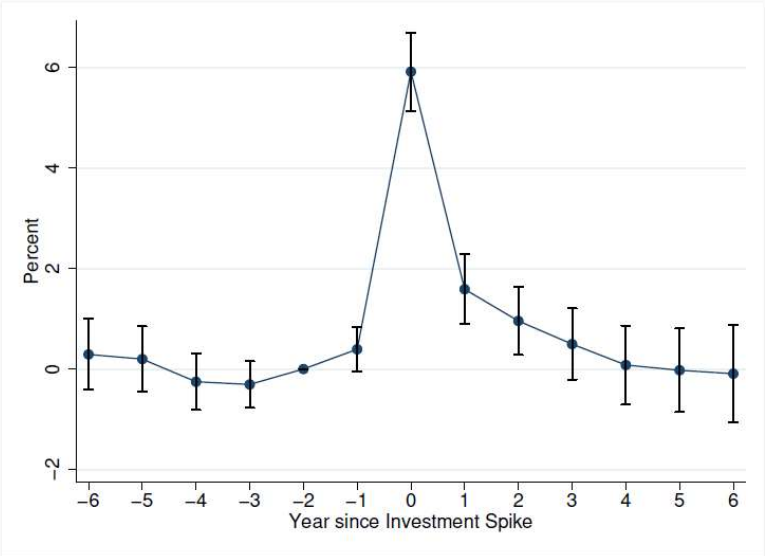


Using B2B linkages to proxy digitalization / robotisation

- Dhyne et al. (2021) : investment in ICT proxied by B2B expenditures from ICT producing sectors and imports of ICT products
  - firms investing an additional euro in ICT increase value added by 1 euro and 35 cents on average.
  - marginal product of ICT investment increases with firm size.
  - aggregate level are much lower due to underinvestment in ICT (ICT capital deepening is low) and misallocation of ICT investments.

Using B2B linkages to proxy digitalization / robotisation

- Bijnens, Humlum and Vanormelingen, (2023) "The Firm Boundaries of Capital-Skill Complementarity"
  - How does modern manufacturing capital (e.g. robots) affect the demand for worker skills?
    - B2B transitions: Purchases from Machine Supplier Industries



Notes: Diff-in-diff relative to industry average of non-spiking firms

- Measuring indirect employment
  - Indirect employment of firm j

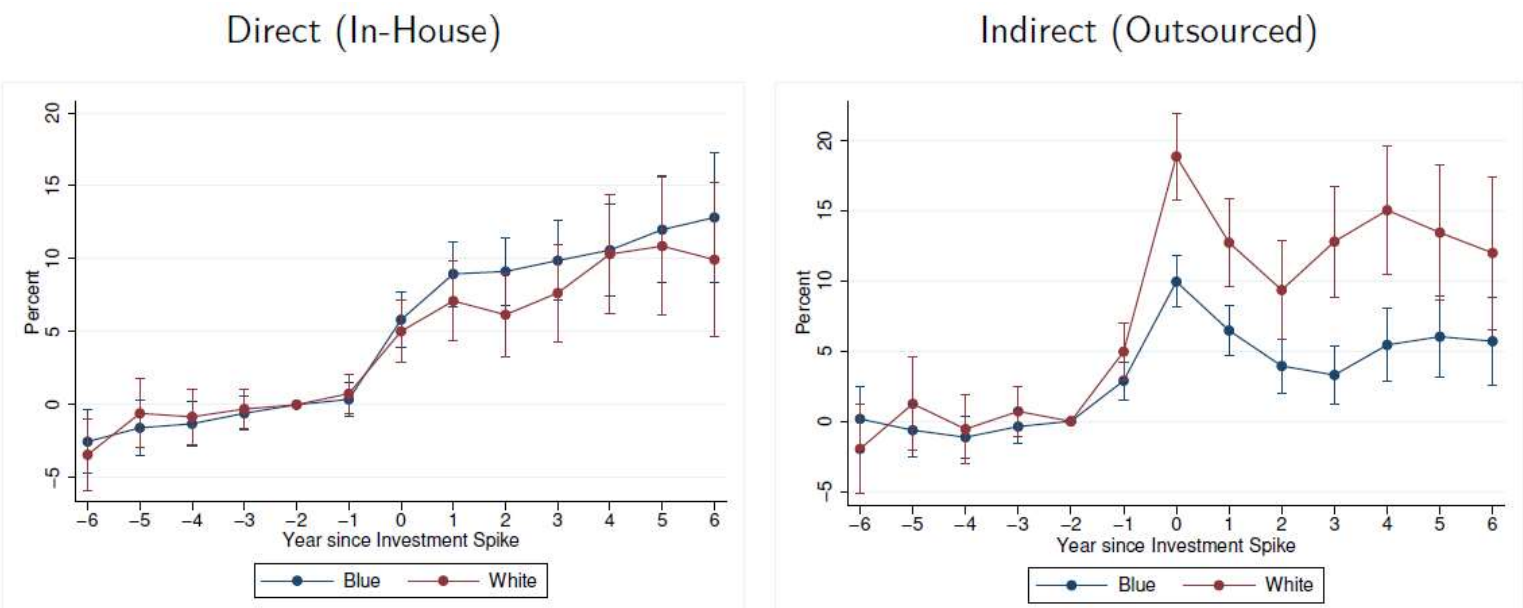
$$L_{jt}^{ind} = \sum_{i \in S} \frac{X_{ijt}}{X_{it}} L_{it},$$

  - where *Xijt* are purchases of firm *j* from firm *i*, and *Lit* total employment in firm *i*

Bijnens et al, 2023

Using B2B linkages to proxy digitalization / robotisation

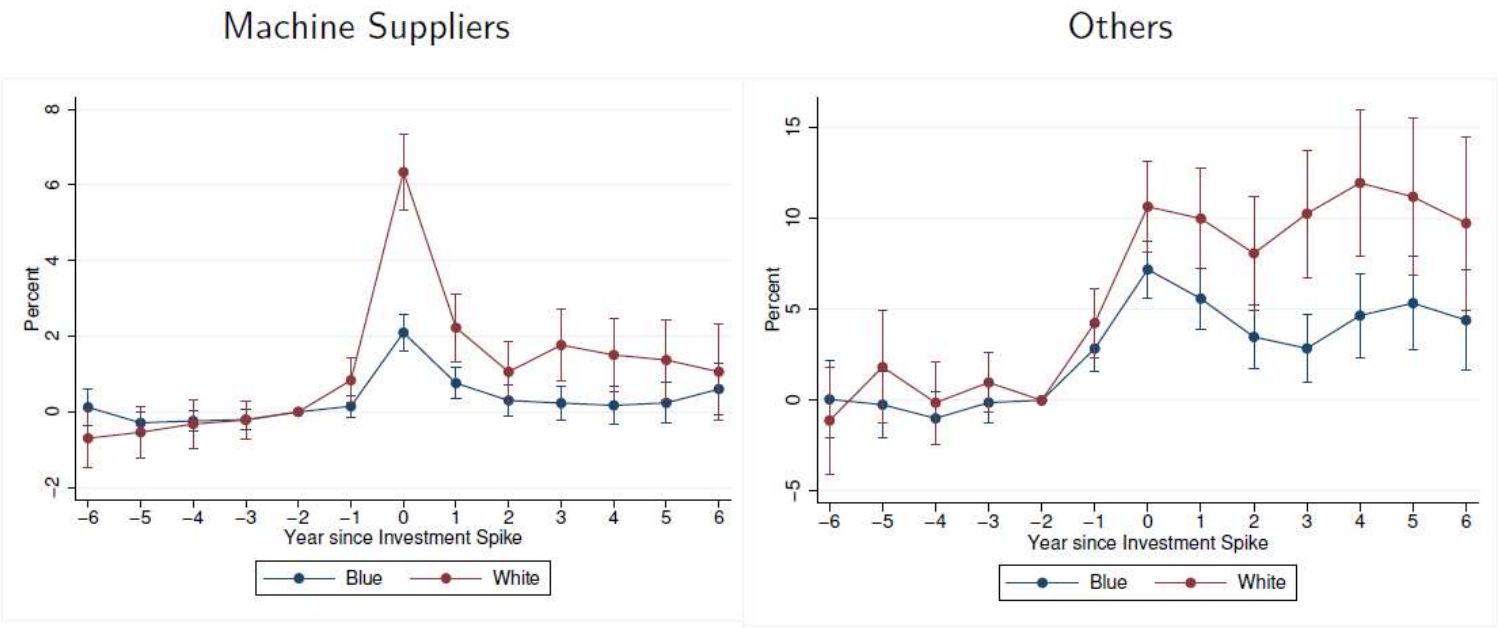
- Bijnens, Humlum and Vanormelingen, (2023) "The Firm Boundaries of Capital-Skill Complementarity" cts
  - External suppliers are critical to capture the skill bias of new machinery as skill bias mainly occurs through *external* suppliers to adopting firms



Bijnens et al, 2023

Using B2B linkages to proxy digitalization / robotisation

- Bijnens, Humlum and Vanormelingen, (2023) "The Firm Boundaries of Capital-Skill Complementarity"
  - Skill bias at machine integration initially; other skilled services eventually



Bijnens et al, 2023

Foreign shock propagation in the production network

- Dhyne et al. (2021) "Trade and domestic production network"

TABLE 4
Firms' response to foreign demand shocks

	(1) Δln Sales	(2) Δln Sales	(3) Δln Sales	(4) Δln Sales
Direct export shock	0.178***			
	(0.0270)			
Total export shock		0.283***	0.311***	0.311***
		(0.0326)	(0.0428)	(0.0261)
N	143,572	143,572	839,881	995,739
Sample	Direct exporter	Direct exporter	Non-direct exporter	All firms
Ind.-Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

Notes: Standard errors are in parentheses. Variables are winsorized at the top and bottom 0.5 percentiles. The total export shock for firm j is defined as $\sum_i \tilde{H}_{ji,t-1} r_{iF,t-1} d\log X^{\text{shock}}_{iF,t}$, and the direct export shock for firm j is defined as $r_{jF,t-1} d\log X^{\text{shock}}_{jF,t}$. The assignment to the direct exporter or non-direct exporter sample is made based on the export status in $t-1$. All specifications include the lagged share of firms' sales exposed to household demand, $\sum_i \tilde{H}_{ji,t-1} r_{iH,t-1}$, as a control, with a time-varying coefficient. Standard errors are clustered at the NACE four-digit level. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Ludwig et al, 2023

Foreign shock propagation in the production network

- Dhyne et al. (2023) "Foreign demand shocks to production network : firm responses and worker impacts"
  - Belgian firms pass on a large share of a foreign demand shock to their domestic suppliers, face upward sloping labor supply and have sizable fixed overhead costs in labor

	(1) Average wage	(2) FTE Employment	(3) Labor cost	(4) Input purchases	(5) Domestic input purchases
Instantaneous response	0.0868***	0.0679**	0.153***	0.946***	0.764***
(γ^0)	(0.0296)	(0.0322)	(0.0368)	(0.0770)	(0.0672)
Cumulative response	0.0915	0.320***	0.412***	0.781***	0.599***
($\sum_{\kappa=0}^{3} \gamma^\kappa$)	(0.0571)	(0.0273)	(0.0698)	(0.120)	(0.104)
Industry-Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes

Notes: This table uses the main estimation sample of 995,739 firm-year observations in Belgium from 2002 to 2014 (see Section 2.3 for details). For each outcome variable, we estimate its elasticity with respect to sales. We run four firm-level 2SLS regressions based on equation (23) for $\kappa \in \{0, 1, 2, 3\}$ and report the instantaneous response (γ^0) as well as the cumulative response (the sum of four coefficients $\{\gamma^\kappa\}_{\kappa=0}^{3}$). The first-stage F-statistics for excluded instruments is 142.3. Variables are winsorized at the top and bottom 0.5 percentiles. Standard errors in parentheses are clustered at the NACE four-digit level, and standard errors of the cumulative responses are computed using the bootstrap method. $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Ludwig et al, 2023

Cost shock propagation in the production network

- Duprez and Magerman (2018, 2023) "Price updating with production networks"
  - How do firms change their prices in production networks ?
  - What is the impact of firm-level price changes on aggregate prices ?
  - Empirical setting : decomposition of price changes in various components

$$d \ln p_{jt} = \beta_{jt} \underbrace{\sum_{i \in \mathcal{S}_{jt}} \omega_{ijt-1} d \ln p_{it}}_{\text{change in input price index}} + \gamma_{jt} d \ln z_{jt} + \delta_{jt} d \ln \mathcal{P}_{-jt} + \eta_{jt} d\xi_{jt}$$

  - Data : B2B + industrial production data (PRODCOM survey : unit value of domestic products) + international trade (unit value of imported inputs) + annual accounts (TFP estimates)

Ludwig et al, 2023

Cost shock propagation in the production network

- Results
  - Passthrough is incomplete (52%)
    - Sectoral heterogeneity
    - Passthrough complete if common shock
  - Strategic complementarity matters ($\delta > 0$)

	IV		
Dep. var.	(iv) $d \ln p_{jt}$	(v) $d \ln p_{jt}$	(vi) $d \ln p_{jt}$
$d \ln P_{jt}$	0.521***	0.524***	0.531***
	(0.063)	(0.063)	(0.062)
$d \ln z_{jt}$	-0.107***	-0.110***	-0.109***
	(0.005)	(0.005)	(0.005)
$d \ln \mathcal{P}_{-jt}$	0.377***	0.368***	0.403***
	(0.090)	(0.090)	(0.098)
FE	year	year + sector	year×sector
N	33,718	33,718	33,718
J-test χ^2	3.70	3.21	4.72
[p-value]	[.30]	[.36]	[.19]

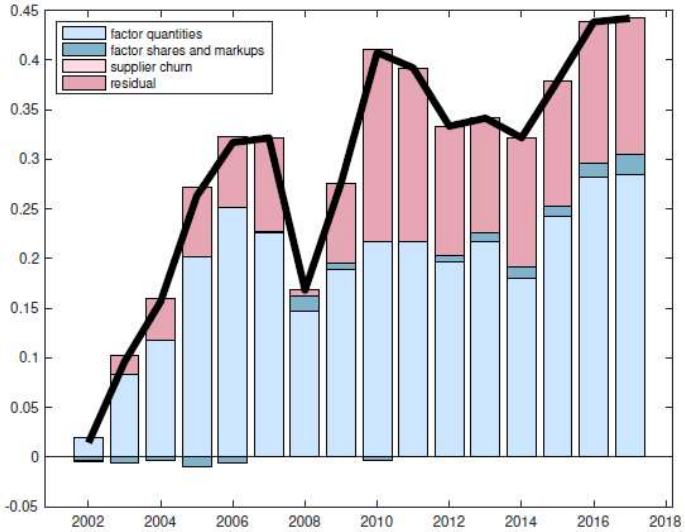
Duprez, Magerman, 2018

Supplier Churn and Growth: A Micro-to-Macro Analysis

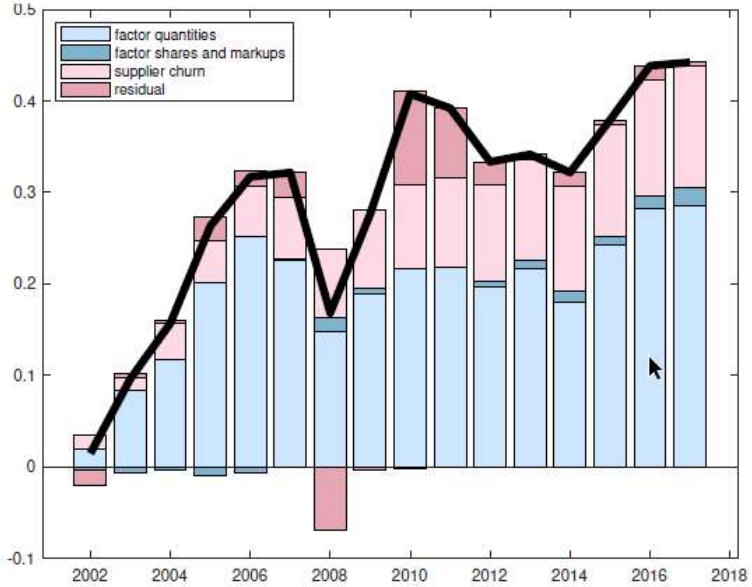
- Baqaee, Burstein, Duprez & Farhi (2024)
- Widely believed: new suppliers create surplus for consumers
- Consumer surplus can drive growth and trade
- Paper seeks to quantify micro & macro importance of this force
- Make progress by focusing on firms as the “consumers”
- Output observable but utility is not

Supplier Churn and Growth: A Micro-to-Macro Analysis

Solow-style growth decomposition



Accounting for supplier addition and separation



Supplier churn can plausibly account for a large portion of aggregate productivity growth

Baqaee, Burstein, Duprez & Farhi (2024) "Supplier Churn and Growth: A Micro-to-Macro Analysis"

ChaMP cross-country projects

- BE, EE, IT, HU, HR, NL, PT
- Compute firm level production network statistics : number of nodes, centrality, upstreamness,
- => sector level indicators
- Relate those indicators to mon. pol. transmission indicators : freq of price changes…
  - For BE : analyse the firm level response to monetary policy shock (using quarterly data) and related those response to network characteristics
  - Countries which similar data are invited to replicate the analysis

Thank you for your attention

List of publications using B2B data

- NBB Economic Review
  - Dhyne, Duprez (2015), "Has the crisis altered the Belgian economy's DNA ?"
  - Dhyne, Duprez (2016), "Three regions, three economies ?"
  - Dhyne, Duprez (2017), "The world is a village: the integration of Belgian firms into the world economy"
  - Cordemans, Duprez, Kikkawa (2018), "America's new trade policy and its impact on the Belgian economy"
  - Duprez, Nautez (2019), "Economic flows between Regions in Belgium"
  - Dhyne, Duprez (2021), "Belgian firms and the COVID-19 crisis"
  - De Mulder, Dhyne (2022), "With a little help from my friends: patents, technological diffusion and firm's productivity"

List of publications using B2B data

- NBB Working Papers
  - Dhyne, Magerman, Rubinova (2015) , "The Belgian production network 2002-2012"
  - Dhyne, Rubinova (2016), "The supplier network of exporters: connecting the dots"
  - Magerman, De Bruyne, Dhyne, Van Hove (2016), "Heterogeneous firms and the micro origins of aggregate fluctuations"
  - Duprez, Magerman (2018), "Price updating in production networks"
  - Mahy, Rycx, Vermeylen, Volral (2018), "Productivity, wages and profits: Does firms' position in the value chain matters ?"
  - Gagliardi, Mahy, Rycx (2018), "Upstreamness, social upgrading and gender: Equal benefits for all ?"
  - Connell Garcia, Dhyne, Vandenbussche (2019), "Learning about demand abroad from wholesalers: a B2B analysis"
  - Dhyne, Kikkawa, Komatsu, Mogstad, Tintelnot (2022), "Foreign demand shocks to production networks: Firm responses and worker impacts"
  - Dhyne, Duprez (2022), "Sourcing of services and total factor productivity"

List of publications using B2B data

- NBB Working Papers
  - Dhyne, Ludwig, Vandenbussche (2023), "Export entry and network interactions: Evidence from the Belgian production network"
  - Amiti, Duprez, Konings, Van Reenen (2023), "FDI and superstar spillovers: Evidence from firm-to-firm transactions"
  - Baqaee, Burstein, Duprez, Farhi (2023), "Input varieties and growth: a micro-to-macro analysis"
  - Dhyne, Duprez, Komatsu (2023), "The Belgian business-to-business transactions dataset 2002-2021"

List of publications using B2B data

- Academic Journals
  - Dhyne, Duprez (2017), "It's a small, small world… A guided tour of the Belgian production network", IPM
  - Dhyne, Konings, Van den Bosch, Vanormelingen (2021), "The return on information technology: who benefits most?", ISR
  - Dhyne, Kikkawa, Mogstad, Tintelnot (2021), "Trade and domestic production network", RESTUD
  - Berns, Kikkawa, (2021), "Measuring trade in value added with firm-level data", JIE
  - Kikkawa, Magerman, Dhyne (2022), "Imperfect competition in Firm-to-firm trade", JEEA
  - Bernard, Dhyne, Magerman, Manova, Moxnes (2022), "The origins of firm heterogeneity: a production network approach", JPE
  - Dhyne, Kikkawa, Kong, Mogstad, Tintelnot (2023), "Endogenous production networks with fixed costs", JIE
  - Dhyne, Kikkawa, Mogstad, Tintelnot (2023), "Measuring the share of imports in final consumption", AEA P&P