TRADE INTERMEDIATION AND RESILIENCE IN GLOBAL SOURCING

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Job Market Paper

MOTIVATION

- Growing concerns on the fragility of global supply chains
  - Firms exposed to frequent and recurrent disruptions in risky locations
  - Provisions like supplier diversification are costly (esp. for small players)
- Trade intermediaries offer alternative technology for input sourcing
  - Specialized distributors that focus on buying and reselling goods
  - Yet little work on intermediated sourcing and impact on resilience
- **This paper:** Role of intermediation services in mitigating disruptions
  - Explore producers' use of intermediaries under supply chain risk
  - Quantify impact of intermediaries on producers' adaptive responses

MOTIVATION

*"**Safety and compliance are the foundation of our supply network.** We pride ourselves on taking measures to reduce supplier risk and ensure continual supply to our customers."*

Univar Solutions – leader intermediary in chemicals

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"***We focus on managing complexity and risk to maximize your profitability.*** *Our global supply chain connects thousands of suppliers and vendors with leading brands."*

Li & Fung – leader intermediary in apparel ▸ more

THIS PAPER

- **Novel facts on the use of intermediaries and their supply networks**
  - Customs and tax data for import transactions in Chile (2005-19)
  - Share of intermediated imports increases with supply chain risk
  - Intermediaries offer more diversified and robust supply networks

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- **Global sourcing model with supply chain risk and trade intermediation**
  - Producers optimally protect from disruptions in risky locations
  - Larger firms pay matching costs to engage with multiple suppliers
  - Smaller firms contract with intermediaries at higher input prices

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  - Producers optimally protect from disruptions in risky locations
  - Larger firms pay matching costs to engage with multiple suppliers
  - Smaller firms contract with intermediaries at higher input prices
- **Quantify role of intermediation services in mitigating disruptions**
  - Sizable profit losses from disruptions: large firms (-16%), mid-size firms (-20%)
  - Intermediation is key for mid-size firms that cannot diversify directly ($-40\% \rightarrow -20\%$)
  - Contribution of intermediaries influenced by brokerage fees ($\pm$ 4 pp)

LITERATURE

1. Global value chains

   Amiti & Konings (2007); Antras et al (2017); Bernard et al (2018, 2019); Blaum et al (2018); Boehm & Oberfield (2020); Bøler et al (2015); Goldberg et al (2010); Halpern et al (2015); Gopinath & Neiman (2014); Huang et al (2024)

   Risk and intermediation shape access to foreign input markets

2. Supply chain resilience

   Balboni et al (2023); Blaum et al (2023); Carvalho et al (2021); Castro-Vincenzi (2022); Castro-Vincenzi et al (2024); Elliott et al (2022); Khanna et al (2022); Kopytov et al (2022); Korovkin et al (2024); Grossman et al (2023, 2024)

   Heterogeneous sourcing responses → not all firms can diversify

3. Trade intermediation

   Ahn et al (2011); Akerman (2018); Antras & Costinot (2011); Bernard et al (2010, 2015); Blum et al (2009, 2024); Crozet et al. (2013); Dhingra & Tenreyro (2022); Ganapati (2024); Grant & Startz (2022); Manova et al (2024)

   Evidence on supply networks → microfoundation + stability gains

→ **Combining (2) and (3): novel adaptation mechanism for smaller firms**

STYLIZED FACTS

DATA

- Chilean Customs Service (2005-19)
  - Universe of international transactions
  - **Buyer-supplier identities**, product (HS6), country, value (USD), quantity
- Chilean Tax Authority (2005-19)
  - **Business activity:** self-reported and tax-validated ($\sim$ISIC4)
  - Firm characteristics: sales, workers, age, location, etc.
- Two types of intermediaries
  - **Wholesalers (firm-to-firm)** and retailers (firm-to-consumer)
  - *"Wholesale is the resale without transformation of new and used goods to industrial, commercial, institutional or professional users..."*

DATA

- 3 measures of supply chain risk
  - **Geopolitical Risk index** (Caldara & Iacoviello 2022)
  - **Economic Policy Uncertainty index** (Baker, Bloom & Davis 2016)
  - **Trade Volatility index** (own construction)

DATA

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  - **Trade Volatility index** (own construction)
    - → **Capture variation within origin-products over time**
    - → Trade flows by product p origin o destination d and year t, exc. Chile (CEPII)
    - → Gravity residualization: $X_{opdt} = \delta_{pdt} + \delta_{odt} + \varepsilon_{opdt}$
    - → Compute standard deviation of residualized flows

WHOLESALERS ARE PROMINENT IN GLOBAL SOURCING

- Wholesalers represent 7% of firms and 14% of exports, but more than **40% of imports**
- Growing evidence on role of intermediated sourcing: Denmark (Utar 2017); US (Ganapati 2024)

	Producers	Wholesalers	Retailers
# firms	528,617	43,084	86,627
% firms	0.81	0.07	0.12
% importers	0.44	0.31	0.26
% imported value	0.45	0.44	0.11
% imported products (HS6)	0.91	0.89	0.75
% links with foreign suppliers	0.45	0.44	0.24
% exporters	0.53	0.37	0.09
% exported value	0.85	0.14	0.01
% exported products (HS6)	0.87	0.72	0.38
% links with foreign buyers	0.68	0.35	0.06

▸ more

FACT 1: INTERMEDIATION INCREASES WITH SUPPLY CHAIN RISK

- % intermediated imports increases with risk within origin-products (1 SD → ∼1 pp)
  - 5-year long differences: exogenous changes to risk factors abroad
  - Robust to changes in origin productivity, trade costs, and industry imports

	Δ % Intermediated Imports					
	Geopolitical Risk		Economic Uncertainty		Trade Volatility	
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Supply Chain Risk	0.010***	0.011***	0.010	0.013**	0.007***	0.005**
	(0.003)	(0.003)	(0.006)	(0.005)	(0.002)	(0.002)
Δ Origin country productivity	No	Yes	No	Yes	No	Yes
Δ Origin country trade costs	No	Yes	No	Yes	No	Yes
Δ Product total imports	No	Yes	No	Yes	No	Yes
Observations	33,074	32,768	23,791	23,791	35,155	34,393

**Results indicate 5-years differences from 2014 to 2019 at the origin country-product level.*

FACT 2: INTERMEDIARIES HAVE MORE DIVERSIFIED SUPPLY NETWORKS

- Intermediaries have more suppliers and less concentrated purchases within origin-products
  - Similar result for *homogeneous* products → more suppliers per input variety ▸ more

	(log) # suppliers		HHI suppliers	
	(1)	(2)	(3)	(4)
Intermediary dummy	0.061***	0.049***	-0.024***	-0.019***
	(0.006)	(0.006)	(0.002)	(0.002)
Firm size (sales bins)	Yes	Yes	Yes	Yes
Imported value	Yes	Yes	Yes	Yes
Product - country FE	No	Yes	No	Yes
Observations	371,200	346,949	371,200	346,949

**Results correspond to cross-sectional data for 2019. The intermediary dummy equals 1 if the importer is a wholesaler and 0 for producers.*

FACT 3: INTERMEDIARIES HAVE MORE STABLE SUPPLY LINKS

- Intermediaries exhibit lower separation rates with suppliers within origin-products
  - Robust to controlling for changes in downstream conditions ▸ more
  - Mechanisms: supplier *screening*, customer importance, product-specific shocks ▸ more

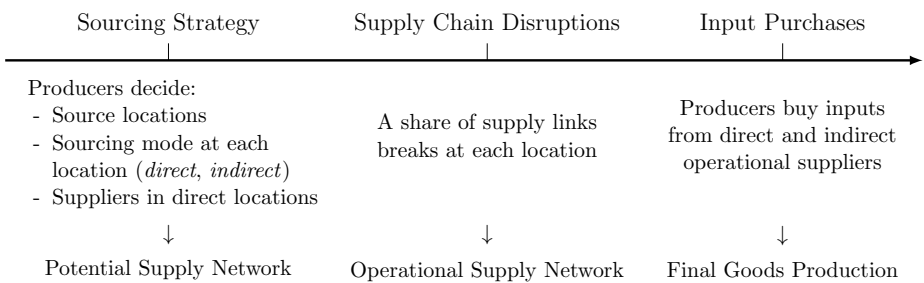
	$\mathbb{D}$(link separation = 1)			
	Firm-product-country		Firm-product-country-supplier	
	(1)	(2)	(3)	(4)
Intermediary dummy	-0.115***	-0.113***	-0.094***	-0.092***
	(0.007)	(0.008)	(0.008)	(0.009)
Firm size (sales bins)	Yes	Yes	Yes	Yes
Imported value	Yes	Yes	Yes	Yes
Number of suppliers	Yes	Yes	No	No
Product - country FE	No	Yes	No	Yes
Observations	312,724	289,355	427,739	352,770

**Separation = supply link active in year t but not in $t+1$. Cross-sectional results for 2018 including importers active in both 2018 and 2019.*

THEORETICAL FRAMEWORK

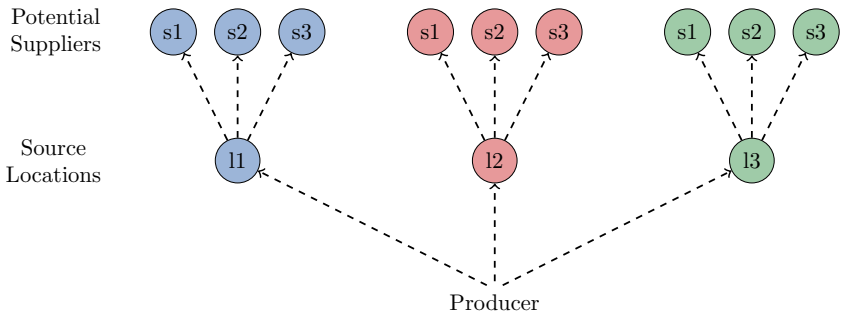
MODEL OVERVIEW

- **Global sourcing model with supply chain risk and trade intermediation**
- Heterogeneous final-good producers assemble inputs under monopolistic competition
- Producers define sourcing strategy in the expectation of disruptions



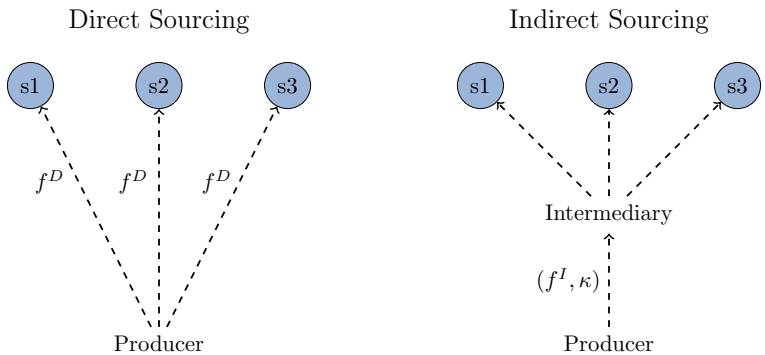
GLOBAL INPUT MARKETS

- Discrete set of source locations $\mathcal{L}$, each populated by a discrete set of suppliers $\mathcal{S}_l$
- Each location offers a differentiated input x_l that can be produced by all suppliers
- Locations differ in input costs ($\tau_l \alpha_l$), disruption probabilities (ζ_l), and fixed sourcing costs (f_l)



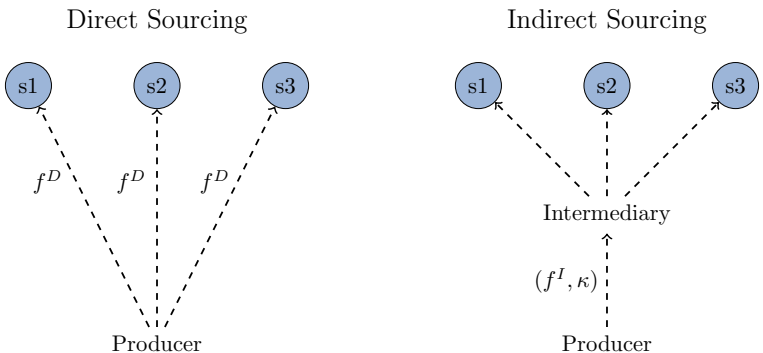
SOURCING MODE AT EACH LOCATION

- **Direct sourcing** → Matching costs $f_l^D(S_l^D)$ for S_l^D suppliers with disruption probability ζ_l^D
- **Indirect sourcing** → Brokerage fee κ on input prices, sourcing technology $\left\{S_l^I \geq S_l^D,\ \zeta_l^I \leq \zeta_l^D\right\}$
  → Low fixed cost of contracting with intermediaries $f_l^I \leq f_l^D(\cdot)$



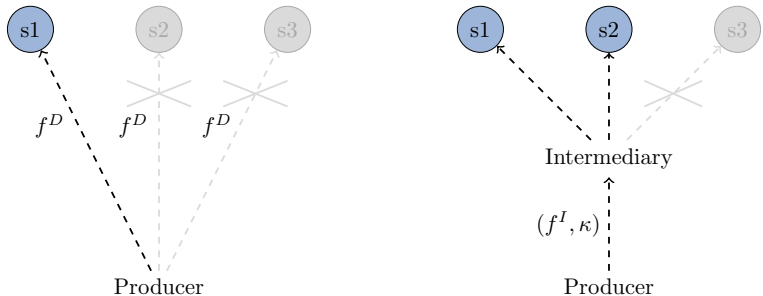
SOURCING MODE AT EACH LOCATION

- **Two mitigation strategies at hand in risky locations:**
  1. Diversification → Multiple direct relationships at higher matching costs
  2. Intermediation → Access to resilient network at higher input prices



SUPPLY CHAIN DISRUPTIONS

- Idiosyncratic disruptions break the supply links established in the first stage
- Discrete shock $Z_l^M = \{disrupted, operational\}$ with exogenous probabilities ζ_l^M and $1 - \zeta_l^M$
- Consistent with low correlation across link breakages ($\rho \approx 0.09$), extension with correlated shocks



FINAL DEMAND

- Consumers in country i have nested Cobb-Douglas/CES preferences over a tradable homogeneous good and non-tradable differentiated varieties

$$U_i = q_{i0}^{1-\beta}\left(\int_{\Omega_i} q_i(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right)^{\beta\sigma/(\sigma-1)}, \quad \sigma > 1$$

- Given expenditure E_i and price index $P_i \equiv \left(\int_{\Omega_i} p(\omega)^{1-\sigma} d\omega\right)^{1/(1-\sigma)}$, demand for variety ω is:

$$q_i(\omega) = p_i(\omega)^{-\sigma} P_i^{\sigma-1} E_i$$

PRODUCTION TECHNOLOGY

- **Producers transform inputs into final goods under constant returns to scale**
  - $\varphi(\omega)$: core productivity drawn from distribution $G(\varphi)$
  - $x_{il}(\omega)$: input purchases from each location in the producer's set

$$q_i(\omega) = \varphi(\omega) X_i(\omega)\,, \qquad X_i(\omega) = \left(\sum_{l \in \mathcal{L}(\omega)} x_{il}(\omega)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \qquad \eta > 1$$

- **Marginal cost depends on producers' productivity and input costs**
  - Input prices vary by sourcing mode at each location: $p_l^{x,I} = \kappa\, p_l^{x,D}$

$$c_i(\omega) = \frac{C_i(\omega)}{\varphi(\omega)}\,, \qquad C_i(\omega) = \left(\sum_{l \in L(\omega)} p_{il}^{x,M}(\omega)^{1-\eta} \right)^{\frac{1}{1-\eta}}$$

OPTIMAL SOURCING

- Optimal sourcing with one location
  - Producers ex-post problem → production decisions after disruptions
  - Producers ex-ante problem → sourcing strategies before disruptions
- Optimal sourcing with multiple locations
  - Embed machinery into global setting *à la* Antràs, Fort & Tintelnot (2017)
- General equilibrium and numerical solution

PRODUCERS EX-POST PROBLEM

- **Producers make input purchases and production decisions conditional on a network**
  - Already selected sourcing mode $M_l(\omega)$ and suppliers $S_l^D(\omega)$ if sourcing directly, and disruptions Z_l materialized

$$\max_{p_i(\omega),\, q_i(\omega),\, x_{il}(\omega)} \pi_i^{\text{ex-post}}\left(\omega \,\middle|\, M_l, S_l^D, Z_l\right) = \left[p_i(\omega) - c_i\left(\omega \,\middle|\, M_l, S_l^D, Z_l\right)\right] q_i(\omega)$$

- **Given CES demand and monopolistic competition, ex-post profits are:**

$$\pi_i^{\text{ex-post}}\left(\omega \,\middle|\, M_l, S_l^D, Z_l\right) = \begin{cases} \varphi(\omega)^{\sigma-1}\left(p_{il}^{x,M}\right)^{1-\sigma} \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} P_i^{\sigma-1} E_i & \text{if operational} \\ 0 & \text{otherwise} \end{cases}$$

EX-POST PROFITS AND SOURCING MODE

Proposition 1

Conditional on network operability, producers' ex-post profits are lower under indirect sourcing, especially for more productive firms.

- **Indirect sourcing raises input costs, reducing market shares downstream**
- **Brokerage fees impose a greater cost on larger firms**

PRODUCERS EX-ANTE PROBLEM

- **Producers define optimal sourcing strategy in the expectation of disruptions**
  - Select sourcing mode $M_l(\omega)$ and suppliers $S_l^D(\omega)$ if sourcing directly

$$\max_{M_l(\omega) \in \{D,I\},\ S_l^D(\omega) \in \mathcal{S}_l} \pi_i^{\text{ex-ante}}\left(\omega, M_l, S_l^D, Z_l\right) = \mathbb{E}_Z\left[\pi_i^{\text{ex-post}}\left(\omega, M_l, S_l^D, Z_l\right)\right]$$

$$- \underbrace{\mathbb{I}_{\{M_l(\omega)=D\}}\, f_l^D\left(S_l^D(\omega)\right)}_{\text{Direct matching costs}} - \underbrace{\mathbb{I}_{\{M_l(\omega)=I\}}\, f_l^I}_{\text{Indirect contracting costs}}$$

  - Expectation over ex-post profits (sunk network investments)
  - Combinatorial discrete choice-problem in expectations (no closed-form solution)
  - Given ex-post solution → characterize producers' ex-ante strategy

DIRECT SOURCING STRATEGY

Proposition 2

Producers' direct sourcing strategy is such that:

1. *Direct supplier diversification increases network operability and reduces expected input costs for producers.*
2. *The optimal number of direct suppliers (weakly) increases with firm productivity:* $S_l^D(\varphi^H) \geq S_l^D(\varphi^L)$ *for* $\varphi^H \geq \varphi^L$.

- **Firms have incentives to diversify but only productive ones can afford it**
  - Network is operational if at least one link remains active ▸ more
  - Complementary between operability and productivity

INDIRECT SOURCING STRATEGY

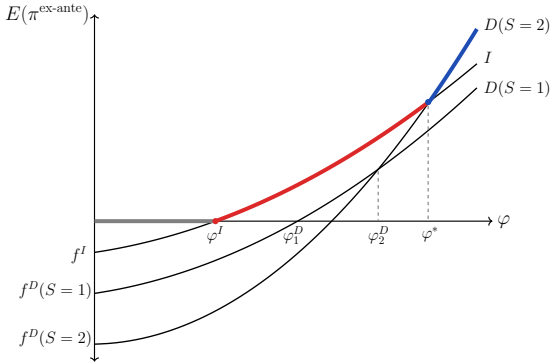
Proposition 3

Producers' use of intermediaries is such that:

1. *Intermediation increases network operability and reduces expected input costs for producers that can match fewer than $\widetilde{S}_l^I\left(S_l^I, \zeta_l^I, \kappa\right)$ suppliers directly.*
2. *There is a productivity threshold φ^* above which producers switch from indirect to direct sourcing.*

- **(Ex-ante) expected input costs can be lower despite brokerage fees**
  - Depends on network that producer could establish directly
- **More productive firms are less likely to use intermediaries**
  - Brokerage fees are more costly (Prop. 1) + smaller resilience advantage (Prop. 2)

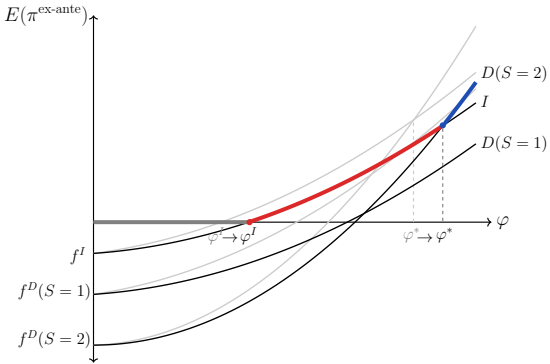
OPTIMAL SOURCING MODE



$$\varphi_l^* = \min_{S_l^D} \left[\frac{f_l^D(S_l^D) - f_l^I}{\left(1 - (\zeta_l^D)^{S_l^D} - \frac{1-(\zeta_l^I)^{S^I}}{\kappa^{\sigma-1}}\right)\left(P_{il}^x\right)^{1-\sigma} B} \right]^{\frac{1}{\sigma-1}}$$

- → Resilience advantage (S^M, ζ^M)
- → Brokerage fees (κ)
- → Matching costs savings

HIGHER SUPPLY CHAIN RISK



→ Smaller direct buyers switch to indirect: $\uparrow \varphi^*$

→ Smaller indirect buyers stop sourcing: $\uparrow \varphi^I$

→ Firms switching modes are more productive

HIGHER SUPPLY CHAIN RISK

Proposition 4

A proportional increase in direct and indirect disruption probabilities:

1. *Induces marginal firms previously sourcing indirectly to stop sourcing from l:* $\varphi^I(\zeta_l') \geq \varphi^I(\zeta_l)$.
2. *Induces marginal firms previously sourcing directly to switch sourcing modes:* $\varphi^*(\zeta_l') \geq \varphi^*(\zeta_l)$.
3. *Induces firms that keep sourcing directly to diversify suppliers:* $\varphi_S^D(\zeta_l') \leq \varphi_S^D(\zeta_l)$ *for* $S \geq 2$.

- **Intermediaries' attributes become more valuable when risk increases**
- **Also greater incentives for direct diversification** (more nuanced with multiple locations)

OPTIMAL SOURCING WITH MULTIPLE LOCATIONS

- **Producers define global sourcing strategy in the expectation of disruptions**
  - Select source locations $L(\omega)$, sourcing modes $M_l(\omega)$, and direct suppliers $S_l^D(\omega)$

$$\max_{\substack{L(\omega)\in\mathcal{L}\\ \{M_l(\omega)\in\{D,I\}\}\\ \{S_l^D(\omega)\in\mathbb{S}_l\}}} \pi_i^{\text{ex-ante}}\left(\omega, L, M_l, S_l^D, Z_l\right) = \mathbb{E}_Z\left[\pi_i^{\text{ex-post}}\left(\omega, L, M_l, S_l^D, Z_l\right)\right] - \sum_{L(\omega)} \mathbb{I}_{\{M_l(\omega)=D\}}\, f_l^D\left(S_l^D(\omega)\right) - \sum_{L(\omega)} \mathbb{I}_{\{M_l(\omega)=I\}}\, f_l^I$$

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- Ex-post profits depend on producers' expected sourcing capability:
  - **Sourcing mode and direct suppliers as in one-location case**
  - Number of locations: input variety gains + network operability
  - Location features: input costs and disruption probabilities

OPTIMAL SOURCING WITH MULTIPLE LOCATIONS

Proposition 5

Producers' global sourcing strategy is such that:

1. *Expected sourcing capability is non-decreasing in firm productivity:* $\mathbb{E}\left[\Theta(\varphi^H)^{\frac{\sigma-1}{\eta-1}}\right] \geq \mathbb{E}\left[\Theta(\varphi^L)^{\frac{\sigma-1}{\eta-1}}\right]$.
2. *If* $\sigma > \eta$, *the optimal sets of locations and direct suppliers per location are non-contracting in firm productivity:* $\mathcal{L}(\varphi^L) \subseteq \mathcal{L}(\varphi^H)$, $S_l^D(\varphi^L) \leq S_l^D(\varphi^H)$.
3. *If* $\sigma > \eta$, *the choice of direct sourcing at each location (weakly) increases with firm productivity:* $\mathbb{I}_{\{M_l=D\}}(\varphi^H) \geq \mathbb{I}_{\{M_l=D\}}(\varphi^L)$.

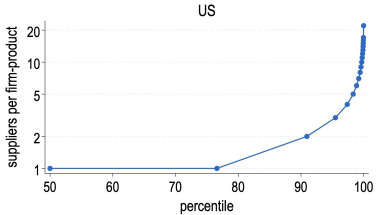
- **Under sourcing complementarities, more productive firms:**
  - Source directly from more locations (Antràs et al. 2017, Bernard et al. 2018)
  - Diversify suppliers in response to risk (Blaum et al. 2023; Castro-Vincenzi et al. 2024)
  - Are less prone to use intermediaries (Ahn et al. 2011; Bernard et al. 2015)

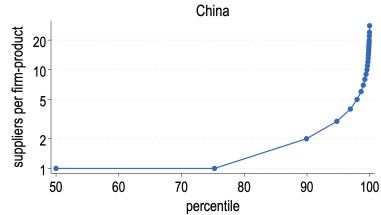
GENERAL EQUILIBRIUM AND NUMERICAL SOLUTION

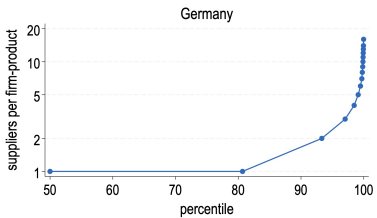
- Imperfect supplier substitution
  - Suppliers produce at location cost $\tau_{il}\alpha_l$ plus a supplier-variety cost $\xi_{sv} \sim$ Fréchet(θ)
  - Optimal sourcing shaped by degree of substitution across suppliers (θ) and across locations (η)
- Free-entry equilibrium implies that: $\int_{\overline{\varphi}_i}^{\infty} \mathbb{E}\left(\pi_i^{\text{ex-ante}}(\varphi)\right) dG_i(\varphi) = w_i f_i^e$
  - Delivers unique demand shifter B; producer's problem has unique solution given B
- Numerical solution has two challenges:
  - High-dimensional choice space → exploit recent methods (Arkolakis et al 2023, Huang et al 2024)
  - High-dimensional expectation → approximate using simulations (Binomial draws)

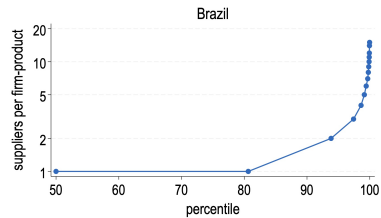
REDUCED-FORM EVIDENCE

ONLY LARGE PRODUCERS TRANSACT DIRECTLY WITH MULTIPLE SUPPLIERS

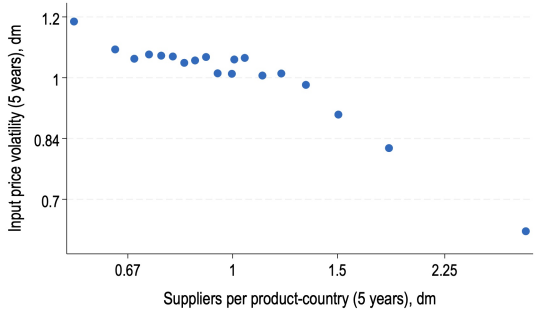








SUPPLIER DIVERSIFICATION REDUCES INPUT COST VOLATILITY



**Input price volatility: standard deviation of the price that firm f pays for product p in origin country c over a 5-year period.*

LARGE PRODUCERS DIVERSIFY IN RESPONSE TO INPUT LOCATION RISK

	(log) # direct suppliers					
	Geopolitical Risk		Economic Uncertainty		Trade Volatility	
	(1)	(2)	(3)	(4)	(5)	(6)
Supply chain risk	-0.058	-0.068	-0.022	-0.019	-0.024***	-0.026***
	(0.049)	(0.047)	(0.025)	(0.024)	(0.005)	(0.005)
× 2nd size tercile	0.041**	0.042**	0.018	0.018	0.025***	0.025***
	(0.018)	(0.018)	(0.025)	(0.025)	(0.004)	(0.004)
× 3rd size tercile	0.069***	0.070***	-0.010	-0.009	0.062***	0.062***
	(0.017)	(0.018)	(0.031)	(0.031)	(0.008)	(0.008)
Origin country - product FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-country productivity	No	Yes	No	Yes	No	Yes
Origin-country trade costs	No	Yes	No	Yes	No	Yes
Product total imports	No	Yes	No	Yes	No	Yes
Observations	269,913	269,251	235,431	235,431	269,958	268,416

NUMBER OF DIRECT BUYERS DECREASES WITH INPUT LOCATION RISK

	Δ (log) # Direct Importers					
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Geopolitical Risk	-0.037***	-0.035***				
	(0.009)	(0.012)				
Δ Economic Policy Uncertainty			-0.041***	-0.044***		
			(0.010)	(0.015)		
Δ Trade Volatility					-0.007**	-0.005*
					(0.003)	(0.003)
Δ Origin-country productivity	No	Yes	No	Yes	No	Yes
Δ Origin-country trade costs	No	Yes	No	Yes	No	Yes
Δ Product total imports	No	Yes	No	Yes	No	Yes
Observations	33,074	32,768	23,791	23,791	35,155	34,393

ESTIMATION

ESTIMATION STRATEGY

Operationalize setting for Chile and 5 source regions ▸ more

- Elasticities: σ, η, θ → model-driven empirical equation
- Location input costs: $\tau_l \alpha_l$ → model-driven empirical equation
- Disruption probabilities: ζ_l^D, ζ_l^I → parameterize link separations
- Suppliers per location: S_l^D, S_l^I → firm-to-firm transactions
- Brokerage fee: κ → export prices within destination-sector
- Matching costs and demand shifter: f_l^D, f_l^I, B → Simulated Method of Moments

ESTIMATED PARAMETERS

Panel A. Elasticities of substitution

σ *(final goods)*	5	η *(input locations)*	1.3	θ *(suppliers)*	3.6

Panel B. Input costs, disruption probabilities, and suppliers per region

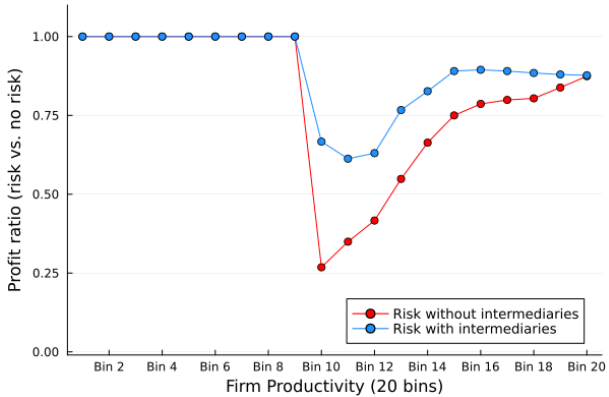
	LAT	CHN	USA	EUR	ROW
$\tau_l \alpha_l$: *trade and production costs*	2.7	3.1	16.1	16.4	10.2
ζ_l^D: *direct disruption probability*	0.23	0.26	0.19	0.18	0.22
ζ_l^I: *indirect disruption probability*	0.17	0.21	0.13	0.13	0.16
$\mathcal{S}_l$: *(potential) direct suppliers*	4	4	4	4	4
S_l^I: *(intermediary) indirect suppliers*	3	4	3	3	3

Panel C. Sourcing costs and demand shifter

κ *(brokerage fee)*	1.2	β^0	1.39	$\beta^{Institutions}$	-2.79
ψ *(indirect contracting)*	0.05	$\beta^{Distance}$	3.07	$\beta^{Suppliers}$	9.49
$\beta^{Dispersion}$	1.02	$\beta^{Language}$	0.96	B *(final demand)*	1.11

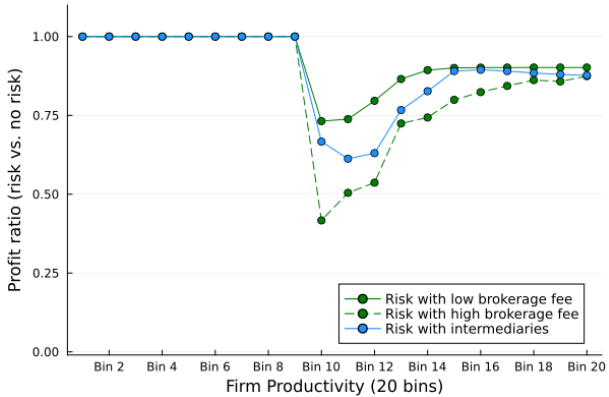
ROLE OF INTERMEDIARIES IN MITIGATING SUPPLY CHAIN RISK

- Intermediaries substantially reduce the impact of disruptions for **mid-size producers**



ROLE OF INTERMEDIARIES IN MITIGATING SUPPLY CHAIN RISK

- **Brokerage fees** are important in determining intermediaries' contribution to resilience



THE EFFECT OF SUPPLY CHAIN DISRUPTIONS

- Disruptions reduce profits by 16% for large firms, regardless of intermediation
- Profit losses for mid-size producers fall from 40% to 20% due to intermediaries

	Baseline (Intermediation)	No Intermediation	Lower Brokerage Fee	Higher Brokerage Fee
Panel A. Profit ratio relative to no-risk scenario				
Mid-size firms	0.799	0.601	0.853	0.778
Large firms	0.836	0.835	0.838	0.835
Panel B. Difference to baseline (pp)				
Mid-size firms	–	-0.199	0.054	-0.022
Large firms	–	-0.001	0.002	-0.001

FINAL REMARKS

- Market responses to risk through trade intermediation
  - Use of intermediation services increases with supply chain risk
  - Intermediaries offer more diversified and stable supply networks
- Firm heterogeneity is important in managing resilience
  - Diversification costs are only affordable for large firms
  - Intermediaries mitigate disruptions for smaller producers
- Potential role for industrial policy in the distribution sector
  - Wholesale markups undermine access to intermediaries
  - *Next*: intermediaries' business model and market power

MOTIVATION

Managing supply through a resilient and reliable network

Looking ahead to a new year

It's hard to believe another year is coming to an end. While 2021 had more than its share of challenges, the growth in our customer and supplier relationships will serve us all well in the new year. We are hopeful we will put many of the supply challenges behind us in 2022.

While many factors have created widespread product availability issues in 2021, the situation allowed our team to work with existing suppliers in creative new ways to ensure supply continuity by securing supply routes and finding new sources to keep customers running. Pairing our domestic and global network of manufacturers with our local sales and technical teams proved invaluable to keeping our customers supplied. We plan to keep those communications channels open in the new year and provide our customers with the products and services needed to help keep our communities healthy, fed, clean, operating and safe.

As your partner, we will continue leveraging our extensive geographic footprint and premier producer partners to give our customers an advantage in situations such as supplying materials that require steel drums. We will also remain vigilant in managing supply through reliable freight deliveries, reliable/sustainable packaging, warehousing/inventory, and secure supply routes from our supplier network.

While no one can fully predict what 2022 will bring, Univar Solutions takes pride and is in a position to help our customers operate, overcome and plan for the challenges that remain in place going into 2022, as well as new challenges that arise to minimize disruptions. We are here for our customers, providing continuity to your business with teams of logistics experts, an extensive distribution network comprised of a significant private truck fleet, account managers, product managers, scientists, chemists and technical advisors to find your next solution.

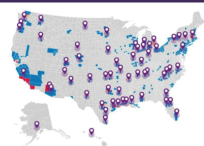
2021 has taught us a lot about the global production base and supply chains. We have been nimble and challenged like most; but we have learned a lot in the process. We are using those learnings and focusing on improving your customer experience.

The new year will start fast as it always does. Your Univar Solutions team will be ready. Please work with your representative early to help you get what you need when you need it.

Thank you for the trust you place in our team every day. We do not take it for granted.

Have a wonderful and safe holiday season!

Largest & Most Local Distribution Network (60 Minutes Away)



Our objectives are focused on customer success and include:

- **Safe handling and on-time delivery**
- **Leverage strong position with local manufacturing and supply chains**
- **Offer technical and application development expertise**
- **Expansion of key supplier relationships**
- **Enabling customers and suppliers ESG objectives**
- **Help customers unlock value using our Solution Centers**
- **Enabling sustainable solutions by offering more sustainably sourced, clean label products**

Our supply chain

We believe in building sustainable supply chains that create value for our customers, factories, workers and communities. We partner with customers and suppliers who share this commitment and collaborate with industry stakeholders to further positive change.

15,000+
SUPPLIERS WORLDWIDE

THREE LARGEST SOURCING MARKETS

1. China
2. Vietnam
3. Bangladesh

At Li & Fung we manage complex and unique supply chains in over 40 economies around the world for our customers. Our global supplier network has been evolving for over 100 years. While over 80% of our sourcing business is with a core group of strategic suppliers, our network also allows us the flexibility to move production across markets, balance capacity constraints and respond to demand, while meeting specific customer needs, such as proximity to the end-consumer or technical expertise and distribution. By sourcing from multiple factories across multiple markets, we can also achieve business contingency plans when unexpected issues occur and continue production for our customers.

Our Vendor Support Services (VSS) unit focuses on the needs of our global supplier base as it addresses the challenges facing the industry. In 2015 we developed services to support suppliers to enhance productivity, operational and resource efficiencies and product testing, and to capture performance data along the supply chain. We want to help suppliers mitigate the increasing costs of labor and other inputs by better managing material and resource usage, production savings, operations and logistics.

Addressing challenges and opportunities in our supply chain is integral to our Sustainability Strategy. Our initiatives focus on three areas:

- Managing risk and furthering compliance in our supply chains
- Sourcing responsibly
- Collaborating with customers and partners to build sustainable supply chains

Supply Chain Compliance

Improving workplace conditions and overall factory management practices brings benefits to workers, suppliers, factories and communities. Each of the locations in our supply chain has a unique set of challenges that we manage through our network of on-the-ground teams and in collaboration with industry and non-profit organizations and local authorities.

Managing our supply chain risk starts with strategic sourcing decisions by our customers and/or sourcing teams and our continuing efforts to direct business to suppliers that share our commitment to compliance and enhancing sustainability performance. Our Vendor Compliance & Sustainability (VCS) team assesses supplier risk and compliance and supports factories to continually improve performance.

MOTIVATION

"Life goes on in these (high-risk) countries despite repeated riots and crises, ***but we don't establish ourselves there*** *and remember to put a buffer on the delivery time."*

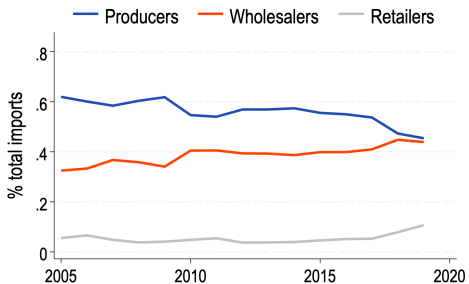
Vedel & Ellegaard (2013) – interviews with clothing firms

"Distributors play a critical role in the economy, and this role was elevated during recent unpredictable demand fueled by COVID ***and the subsequent supply chain disruptions****."*

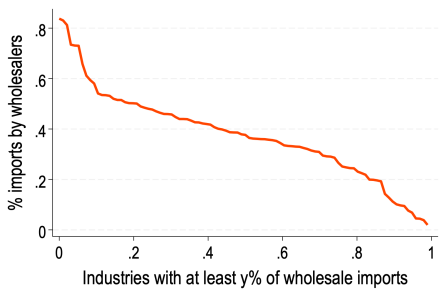
Boston Consulting Group (2023) – Industrial Distributors Value Creators ▸ back

INTERMEDIATED SOURCING OVER TIME AND ACROSS SECTORS

- Wholesalers' share has **increased over time** → similar trend in the US (Ganapati 2024)
- They operate in a **wide range of industries** → at least 20% of imports in 80% of sectors



A. Import shares over time



B. Wholesale imports across HS2-industries

▸ back

FACT 2: INTERMEDIARIES HAVE MORE DIVERSIFIED SUPPLY NETWORKS

- HS6 codes narrowly defined for some products, substantial heterogeneity in others (Grant 2021)
- Restrict analysis to homogeneous goods: organized exchanges, reference prices (Rauch 2007)

	(log) # suppliers		HHI suppliers	
	(1)	(2)	(3)	(4)
Intermediary Dummy	0.044***	0.036***	-0.016***	-0.012***
	(0.007)	(0.008)	(0.002)	(0.003)
Firm size (sales)	Yes	Yes	Yes	Yes
Imported value	Yes	Yes	Yes	Yes
Product - country FE	Yes	Yes	Yes	Yes
Observations	120,930	42,543	120,930	42,543

▸ back

PRODUCERS HAVE MORE SUPPLIERS IN RISKY LOCATIONS

	(log) # suppliers, producers					
	Geopolitical Risk		Economic Uncertainty		Trade Volatility	
	(1)	(2)	(3)	(4)	(5)	(6)
Supply Chain Risk	0.037***	0.043***	0.024***	0.021**	0.046***	0.056***
	(0.005)	(0.009)	(0.007)	(0.009)	(0.002)	(0.002)
Firm size	Yes	Yes	Yes	Yes	Yes	Yes
Imported value	Yes	Yes	Yes	Yes	Yes	Yes
Product FE (HS6)	No	Yes	No	Yes	No	Yes
Origin-country productivity	No	Yes	No	Yes	No	Yes
Origin-country trade costs	No	Yes	No	Yes	No	Yes
Observations	126,671	125,718	108,687	108,088	127,327	125,809

▸ back

INTERMEDIARIES HAVE MORE SUPPLIERS IN RISKY LOCATIONS

	(log) # suppliers, intermediaries					
	Geopolitical Risk		Economic Uncertainty		Trade Volatility	
	(1)	(2)	(3)	(4)	(5)	(6)
Supply Chain Risk	0.040**	0.054***	0.042***	0.032***	0.057***	0.066***
	(0.015)	(0.011)	(0.008)	(0.011)	(0.002)	(0.002)
Firm size	Yes	Yes	Yes	Yes	Yes	Yes
Imported value	Yes	Yes	Yes	Yes	Yes	Yes
Product FE (HS6)	No	Yes	No	Yes	No	Yes
Origin-country productivity	No	Yes	No	Yes	No	Yes
Origin-country trade costs	No	Yes	No	Yes	No	Yes
Observations	190,945	189,323	166,198	165,679	189,742	186,800

▸ back

INTERMEDIARIES HAVE MORE SUPPLIERS THAN PRODUCERS

	(log) # suppliers					
	Geopolitical Risk		Economic Uncertainty		Trade Volatility	
	(1)	(2)	(3)	(4)	(5)	(6)
Intermediary Dummy	0.049**	0.049***	0.055***	0.054***	0.047***	0.048***
	(0.019)	(0.011)	(0.006)	(0.005)	(0.002)	(0.002)
Intermediary × Supply Chain Risk	0.040***	0.003	0.039***	0.015***	0.057***	0.011***
	(0.014)	(0.004)	(0.006)	(0.004)	(0.002)	(0.002)
Firm size (sales)	Yes	Yes	Yes	Yes	Yes	Yes
Imported value	Yes	Yes	Yes	Yes	Yes	Yes
Product FE (HS6)	Yes	No	Yes	No	Yes	No
Product - Country FE	No	Yes	No	Yes	No	Yes
Observations	317,239	299,476	274,470	264,208	316,783	295,383

▸ back

MORE SUPPLIERS AND LOWER SEPARATION RATES IN RISKY LOCATIONS

	(log) # suppliers			separation rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Geopolitical Risk	0.105***			0.055*		
	(0.018)			(0.029)		
Economic Uncertainty		0.049**			0.067***	
		(0.023)			(0.019)	
Trade Volatility			0.039***			0.010***
			(0.001)			(0.002)
Product FE (HS6)	Yes	Yes	Yes	Yes	Yes	Yes
Origin-country productivity	Yes	Yes	Yes	Yes	Yes	Yes
Origin-country trade costs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	63,025	44,880	66,434	52,799	38,801	54,186

▸ back

FACT 3: INTERMEDIATED SUPPLY LINKS ARE LESS LIKELY TO BREAK

- Control for changes in firm-level outcomes that respond to downstream conditions
- Account for potentially differentiated demand shocks that may induce separations

	Firm-product-country			Firm-product-country-supplier		
	(1)	(2)	(3)	(4)	(5)	(6)
Intermediary dummy	-0.078***	-0.063***	-0.061***	-0.060***	-0.048***	-0.046***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
Δ Firm-level imports	Yes	No	Yes	Yes	No	Yes
Δ Firm-level suppliers	No	Yes	Yes	No	Yes	Yes
Firm size (sales)	Yes	Yes	Yes	Yes	Yes	Yes
Imported value	Yes	Yes	Yes	Yes	Yes	Yes
Number of suppliers	Yes	Yes	Yes	No	No	No
Product - country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	284,115	284,115	284,115	400,938	400,938	400,938

▸ back

FACT 3: INTERMEDIATED SUPPLY LINKS ARE LESS LIKELY TO BREAK

- **Supplier screening, customer importance, product-specific shocks**
  - Each individual channel reduces differences by nearly 3 pp
  - Simultaneously, separation probability is only 2 pp lower

	Firm-product-country-supplier				
	(1)	(2)	(3)	(4)	(5)
Intermediary dummy	-0.092***	-0.060***	-0.068***	-0.069***	-0.024***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
Supplier FE	No	Yes	No	No	Yes
Share in supplier's sales	No	No	Yes	No	Yes
Firm-supplier-product links	No	No	No	Yes	Yes
Firm size (sales)	Yes	Yes	Yes	Yes	Yes
Imported value	Yes	Yes	Yes	Yes	Yes
Product - country FE	Yes	Yes	Yes	Yes	Yes
Observations	406,481	352,770	406,481	406,481	352,770

▸ back

EFFICIENCY-RISK TRADE-OFF

- **Network is operational if at least one link remains active**
  - Given a set of suppliers, the number of active links distributes Binomial
  - Increasing operability is costly: diversification (matching costs), intermediation (markups)

$$\Pr\left(S_l^{M,O}(\omega) \geq 1 \,\middle|\, M_l(\omega), S_l^M(\omega)\right) = 1 - \left(\zeta_l^M\right)^{S_l^M(\omega)}$$

- **Network operability and input prices determine expected input costs**

$$\mathbb{E}_{Z_l}\left[p_{il}^x(\omega)^{1-\sigma} \,\middle|\, M_l(\omega) = D, S_l^M(\omega)\right] = \left(1 - \left(\zeta_l^D\right)^{S_l^D(\omega)}\right)\left(p_{il}^x\right)^{1-\sigma}$$

$$\mathbb{E}_{Z_l}\left[p_{il}^x(\omega)^{1-\sigma} \,\middle|\, M_l(\omega) = I\right] = \frac{\left(1 - \left(\zeta_l^I\right)^{S_l^I}\right)}{\kappa^{\sigma-1}}\left(p_{il}^x\right)^{1-\sigma}$$

▸ back

ELASTICITIES

- **Substitution across final goods (σ)**
  - Median estimate from trade literature (Broda & Weinstein 2006; Feenstra & Romalis 2014; Antràs et al 2017)

- **Substitution across input locations (η)**
  - Price variation across locations within buyers
  - $\log \widetilde{X}_{fl}^{D} = (\sigma-1)\log\varphi_f + (1-\eta)\log p_{fl}^{x,D} + \left(\frac{\sigma-\eta}{\eta-1}\right)\log\Theta_f + \log\left((\sigma-1)B\right.$
    → $\log \widetilde{X}_{flt}^{D} = \delta_{ft} + (1-\eta)\log p_{flt}^{x,D} + u_{flt}$ (Atkeson & Burstein 2008, Edmond et al. 2015)

- **Substitution across suppliers (θ)**
  - Variation in number of (direct) suppliers across firms within origin-product
  - $\log p_{il}^{x,D} = \log\gamma + \log\tau_l\alpha_l - -\frac{1}{\theta}\log S_l^{O,D}(\omega)$
    → $\log p_{flt}^{D} = \delta_{lt} - \frac{1}{\theta}\log S_{flt}^{D} + u_{flt}$ (Huang et al 2024)

▸ back

INPUT COSTS - DISRUPTION PROBABILITIES - BROKERAGE FEE

- **Location-specific input costs**
  - Exploit panel data to separate location and supplier-specific components
    → $\log \bar{p}_{slt} = \delta_{lt} + \delta_{st} + e_{slt}$

- **Disruption probabilities**
  - Parameterize probability that supply links break in a given location (logit)
  - Z_l → supply chain risk measures + income dummies, D_b → demand-side controls
    → $\mathbb{D}(separation)_{bslt} = \dfrac{e^{Z'_{lt}\gamma + D'_{bt}\delta}}{1 + e^{Z'_{lt}\gamma + D'_{bt}\delta}}$

- **Brokerage fee**
  - Export price data: producers vs. intermediaries within destination-sector
  - Evidence from domestic transactions in other countries (Alexander et al 2024, Ganapati 2024)
    → $\log p^{Exp}_{flt} = \delta_{lt} + (\kappa - 1)\, D^{Exp}(Intermediary = 1)_{ft} + \epsilon_{flt}$

▸ back

MATCHING COSTS AND AGGREGATE DEMAND

- **Direct matching costs follow log-normal distribution**

$$\log f_l^D\left(S_l^D\right) \;=\; \log \beta^0 + \beta^{Dist} \log \mathsf{Dist}_l + \mathsf{Lang}_l \cdot \log \beta^{Lang} + \beta^{Inst} \mathsf{Inst}_l + \beta^{Supp} \log S_l^D$$

- **Estimate:** $\Omega \equiv \{B, \psi, \beta_0, \beta^{Dist}, \beta^{Lang}, \beta^{Inst}, \beta^{Supp}, \beta^{Disp}\}$, where $\psi \equiv f_l^I / f_l^D$

Moments	Data	Model
% producers importing directly	0.039	0.057
% producers importing directly per region:		
– Latin America	0.012	0.012
– China	0.020	0.045
– United States	0.014	0.021
– Europe	0.017	0.014
– Rest of the world	0.006	0.004
% producers with multiple suppliers	0.206	0.312
% producers importing indirectly	0.061	0.053

▸ back