Trade Intermediation and Resilience in Global Sourcing

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Abstract

I study the role of trade intermediaries in mitigating supply chain risk. Using Chilean firm-to-firm transactions, I show that intermediated imports rise with origin-product risk as intermediaries maintain larger and more stable supplier networks. Fewer firms source directly from risky markets, but larger producers maintain more suppliers. I develop a quantitative model of global sourcing in which producers choose between direct supplier diversification and intermediation to protect against disruptions. Intermediaries allow smaller producers to access resilient networks in exchange for a brokerage fee on input prices. A 10 percent increase in global risk lowers firm profits by 3.5 percent and raises consumer prices by 0.9 percent. These losses would nearly double without intermediation.

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1. Introduction

Sourcing inputs worldwide is an engine of modern production, but it also exposes firms to disruptions overseas. Although these concerns intensified after the Great Recession and the COVID-19 pandemic, firms report frequent disruptions even outside crisis episodes. Examples range from strikes and industrial accidents to supplier bankruptcies, transportation failures, regulatory changes, cyberattacks, and natural disasters (Baldwin and Freeman 2022; Elliott and Golub 2022). Producers can in principle protect themselves by diversifying their supplier base (Blaum et al. 2023; Castro-Vincenzi et al. 2024). However, maintaining multiple supply relationships is often prohibitive for all but the largest producers (Bernard and Moxnes 2018; Bernard et al. 2018a). Alternative strategies for managing risk are thus central to the productivity gains from global sourcing and to supply chain resilience.

Trade intermediaries offer one such alternative. Instead of purchasing inputs directly from suppliers, firms can rely on wholesalers that specialize in sourcing and distribution. Intermediaries arise in many economic settings and are believed to reduce transaction costs (Antràs and Costinot 2011; Bergquist et al. 2024). Their role in global sourcing has increased sharply in recent years (Ganapati 2024), even as they are blamed for imposing steep markups on producers (Bergquist and Dinerstein 2020; Dhingra and Tenreyro 2020). Yet, we know little about what firms actually buy when paying these premia. Anecdotal evidence suggests that importers favor intermediation in riskier markets, and intermediaries often advertise the reliability of their supply chains.[1] Firms may therefore outsource resilience through intermediation services.

This paper shows that producers use trade intermediaries to mitigate supply chain risk. Using Chilean firm-to-firm import data, I document that intermediaries maintain larger and more stable supplier networks. When origin markets become riskier, the share of intermediated imports rises and fewer producers import directly, while only larger producers diversify suppliers. These facts motivate a model of global sourcing with two mitigation strategies. Producers can either incur matching costs to diversify their supplier base, or pay an intermediary's markup for access to a more resilient network. Smaller importers sort into intermediation, while larger producers may also use intermediaries to open secondary locations. Model estimation reveals that 10% higher risk in all origins lowers aggregate firm profits by 3.5% and increases consumer prices by 0.9%. Trade intermediaries absorb nearly half of these losses.

I first establish four facts on input sourcing and trade intermediation under risk. My analysis combines Chilean customs data on the universe of import transactions from 2005 to 2019 with tax

[1] A leading chemicals intermediary, Univar, claims that *"safety and compliance are the foundation of our supply chain network"*, while Li & Fung in apparel *"focus on managing complexity and risk to maximize profitability"*. Interviews with clothing supply chain actors suggest that firms use intermediaries in riskier markets (Vedel and Ellegaard 2013). As stated by one respondent, *"life goes on in these countries despite repeated riots and crises...but we don't establish ourselves"*. See Appendix A for details.

records that report firms' business activities. These data enable me to distinguish between Chilean producers and intermediaries, and to identify their foreign suppliers for each HS 6-digit product and origin country. I focus on wholesalers that mediate firm-to-firm transactions as opposed to firm-to-consumer retailers. Wholesalers are prominent in global sourcing: they represent 7% of firms but over 40% of imports in Chile, and operate across a wide range of sectors.

Fact 1 shows that the share of intermediated imports by origin country and product increases with supply chain risk. This holds for three indices capturing different risk dimensions: *Geopolitical Risk* (Caldara and Iacoviello 2022) and *Economic Policy Uncertainty* (Baker et al. 2016) across origin countries, and a *Trade Volatility* index that I build by residualizing global trade flows to capture fluctuations within origin-products over time. Analysis of five-year long differences reveals that changes in risk conditions abroad, plausibly exogenous to a small economy like Chile, shape firms' sourcing strategies. A one standard deviation increase in any index raises the intermediation share by nearly one percentage point and reduces the number of firms importing directly from the affected markets.

I next unpack differences in the supply networks of producers and intermediaries that underlie this pattern. Fact 2 documents that intermediaries maintain more suppliers than producers within the same origin country and product. Fact 3 shows that, conditional on the number of suppliers, the supply links of intermediaries are less likely to break. Intermediaries thus offer a more resilient sourcing technology. Fact 4 then turns to firms sourcing directly and shows that only larger producers expand their supplier base when input markets become riskier. Taken together, these findings suggest that producers actively seek protection from disruptions, but direct diversification is costly, so the use of intermediation services rises with risk.

I rationalize these facts in a model of global sourcing with supply chain risk and trade intermediation. Heterogeneous final-good producers face fixed matching costs per supplier, but also the risk of supply links turning inoperable. Disruptions take two forms: idiosyncratic shocks that sever individual links, and location-wide shocks that disable all of a producer's suppliers in an origin.[2] Input costs and disruption probabilities both vary across source locations. At each location, producers can either source directly from one or multiple suppliers, or use intermediaries for a brokerage fee on input prices. Intermediaries provide access to a diversified network of local suppliers with lower disruption probability.

Producers define their sourcing strategy in the expectation of disruptions: the set of source locations, the sourcing mode at each, and the number of suppliers when sourcing directly. They weigh input costs against disruption probabilities across locations and optimally protect against

[2]Idiosyncratic disruptions are the most frequent shocks reported by firms (McKinsey 2020). This is consistent with the low correlation across supplier link breakages in the data, even within the same buyer, product, and origin country ($\rho \approx 0.09$). This correlation helps pin down the relative weights of the idiosyncratic and location-wide components when estimating the model.

disruptions in risky markets. Using intermediaries raises *ex-post* input costs at any given location, but *ex-ante* expected costs can be lower if their resilience advantage over a producer's direct alternative outweighs the brokerage fee. More productive firms engage in diversification, incurring higher matching costs to establish links with multiple suppliers, while less productive firms favor intermediation.

Consistent with the empirical facts, a rise in supply chain risk in any given location induces the least productive importers to exit, marginal direct buyers to switch toward intermediaries, and the most productive direct buyers to add suppliers. The net effect of firms exiting and switching sourcing modes rationalizes the increase in the use of intermediation services under risk.[3] Although larger producers serve their core input markets directly, they may enter secondary locations through intermediaries: avoiding the brokerage fee pays off only where sourced volumes are large. Intermediaries can thus relax the efficiency-risk trade-off for both smaller and larger producers.

I use the model to quantify the role of intermediation services in mitigating supply chain disruptions. The producer's problem can be stated as a two-step maximization: the *ex-ante* sourcing strategy is a combinatorial discrete-choice problem, given *ex-post* production decisions conditional on an operational network. I solve this problem numerically, using recent computational methods to tackle the dimensionality of the choice set (Arkolakis et al. 2023) and Monte Carlo simulations to approximate complex expectations at each choice. I then operationalize this setting for Chile and five source regions: Latin America, China, the United States, Europe, and Rest of the World.

The estimation strategy leverages the microdata for Chilean firms and their foreign suppliers. Using model-implied equations, I exploit variation in input prices across locations within firms and in the number of suppliers across firms within locations to recover elasticities of substitution. These estimates indicate greater substitution within than across locations, so that local suppliers offer more scope for diversification. I use the panel data to isolate location-specific costs from input prices, and parameterize supply link breaks with risk measures to estimate disruption probabilities. Regions with lower input costs exhibit more frequent disruptions, reflecting an efficiency-risk trade-off in global sourcing. I infer brokerage fees by comparing export prices between producers and intermediaries, and from recent evidence on wholesale markups (Alexander et al. 2024; Ganapati 2024), with a midpoint markup of 25%. Finally, the simulated method of moments delivers matching costs that are convex in the number of suppliers, suggesting high diversification costs.

Trade intermediaries substantially reduce the aggregate impact of disruptions. A 10% rise in disruption risk across all origins lowers aggregate firm profits by 3.5% and raises consumer prices by 0.9%. Absent intermediation, the same shock would cut profits by 6.5% and raise prices by 1.7%,

[3]Risk shocks in one location affect decisions elsewhere, as they jointly determine producers' marginal costs. Under sourcing complementarities, these interdependencies amplify the responses observed in a single-location setting, driving more buyers to switch modes or stop sourcing altogether. The extent of these responses also depends on the substitutability across input locations and among suppliers within locations.

so intermediaries absorb nearly half of the loss. Intermediaries offset a similar share of the losses at higher risk levels. In absolute terms, however, the losses mitigated grow with risk, so the value of intermediation increases when disruptions are more likely.

The resilience advantage of intermediaries comes mostly from diversification rather than network stability. A decomposition of the intermediation technology attributes two-thirds of its mitigation role to its larger supplier networks, and only a tenth to its more stable supplier links. The two channels are nonetheless complements, jointly absorbing more than the sum of their individual contributions. Intermediaries are also more effective against some risks than others. They offset half of the losses from idiosyncratic disruptions, but only about one-fifth against location-wide shocks that hit an entire region at once. Brokerage fees shape but do not overturn this protection: lower and higher markups change the mitigation only modestly relative to a scenario without intermediation.

Related Literature. This paper bridges and advances three strands of literature. First, I contribute to emerging work on supply chain resilience, exploring the aggregate effects of disruptions (Carvalho et al. 2021; Elliott et al. 2022; Kopytov et al. 2022; Alessandria et al. 2023; Acemoglu and Tahbaz-Salehi 2024; Korovkin et al. 2024), optimal resilience policies (Grossman et al. 2023, 2024), inventory responses to supply risk (Carreras-Valle 2024; Ferrari 2025), and firms' adaptation through production and sourcing decisions (Castro-Vincenzi 2022; Khanna et al. 2022; Balboni et al. 2023; Blaum et al. 2023; Castro-Vincenzi et al. 2024; Bourany et al. 2026).[4] My paper is most closely related to Blaum et al. (2023) and Castro-Vincenzi et al. (2024), which respectively study how firms diversify suppliers in response to shipping and climate risks. Relative to these studies, I introduce matching costs that generate heterogeneous sourcing responses across producers, and indirect diversification through intermediaries. Direct diversification is thus affordable only for the largest producers, while intermediation extends protection to smaller ones.

A second line of research explores the role of intermediaries in trade and development. Intermediaries handle a significant share of trade across and within countries (Bernard et al. 2010; Abel-Koch 2013; Crozet et al. 2013; Bernard et al. 2015; Utar 2017). They are believed to reduce transaction costs (Antràs and Costinot 2011; Bergquist et al. 2024), but also to generate price wedges that can harm local producers (Bergquist and Dinerstein 2020; Dhingra and Tenreyro 2020). While canonical models focused on intermediaries' role in facilitating exporting (Blum et al. 2009; Antràs and Costinot 2011; Ahn et al. 2011; Akerman 2018), recent work highlights how they exploit economies of scale in input sourcing (Grant and Startz 2022; Ganapati 2024). This paper provides the first evidence on the supply networks of intermediaries, and therefore on the sourcing technology

[4]Other bodies of literature study how risk shapes export and FDI decisions (Ramondo et al. 2013; Fillat and Garetto 2015; Esposito 2022), how trade policy uncertainty affects firms' exports and input mix (Handley 2014; Handley and Limão 2017; Handley et al. 2024), and how macroeconomic uncertainty affects the formation of buyer-supplier relationships and aggregate trade flows (Novy and Taylor 2020; Martin et al. 2026).

to which firms gain indirect access. I show that the resilience advantage of this technology can relax the efficiency-risk trade-off despite the markups intermediaries charge.

My paper also contributes to the literature on global value chains. These works have shown that access to foreign inputs enhances firm productivity (Amiti and Konings 2007; Goldberg et al. 2010; Gopinath and Neiman 2014; Bøler et al. 2015; Halpern et al. 2015; Blaum et al. 2018; Boehm and Oberfield 2020). The sourcing problem of producers follows Antràs et al. (2017), where firms choose their set of origin countries, and Huang et al. (2024), where they choose among heterogeneous suppliers within origins. However, these papers study input sourcing in an environment without supply chain risk and where firms transact only directly with suppliers. Here, instead, firms balance efficiency and risk in their sourcing decisions and can outsource network investments to intermediaries. Supply chain risk and intermediation thus jointly shape sourcing patterns, respectively hindering and facilitating firms' access to foreign inputs.

Related studies examine the formation of production networks under search and matching frictions (Chaney 2014; Carballo et al. 2018; Bernard et al. 2018b, 2019; Eaton et al. 2022; Dhyne et al. 2023; Lenoir et al. 2023). Consistent with costly link formation, many firms rely on foreign inputs indirectly (Dhyne et al. 2021). Intermediaries, in particular, increase network connectivity by enabling more buyer-supplier matches (Blum et al. 2024; Manova et al. 2024). This paper shows that intermediaries also generate large resilience gains under disruption risk.

The rest of the paper is organized as follows. Section 2 describes the data and presents stylized facts on input sourcing under risk. Section 3 develops the global sourcing model with supply chain risk and trade intermediation. Section 4 estimates the model and quantifies the role of intermediaries in supply chain resilience. The final section concludes.

2. Stylized Facts

2.1. Data

Firm-to-Firm Trade and Intermediaries. I exploit data for Chile that include the universe of firm-to-firm international transactions and detailed information on the business activity of domestic firms. First, the Chilean Customs Service provides the value, quantity, and unit values for all trade flows from 2005 to 2019, reporting origin country, HS 6-digit product, and buyer-seller identities for each transaction. Second, the Chilean Tax Authority provides data on the primary industry, sub-industry, and activity of Chilean firms over the same period, along with additional firm-level characteristics such as sales and number of employees. I match these datasets using a unique firm tax identifier (RUT).

I classify Chilean firms into three types based on their main industry: producers, wholesalers,

and retailers. At this level, the Chilean Tax Authority closely follows the International Standard Industrial Classification (ISIC, rev. 4). Wholesalers specialize in the *"resale without transformation of new and used goods to retailers, to industrial, commercial, institutional or professional users, or to other wholesalers"*, and their operations may include trade-related services such as sorting, packaging, or storage. Retailers, on the other hand, specialize in the resale of goods for personal or household consumption. Wholesalers thus focus on firm-to-firm transactions, while retailers carry out firm-to-consumer trade.

Table 1 presents summary statistics for trade activity by firm type. Producers are the largest group in number (80%) and contribute nearly half of all imports (45%) and the majority of exports (85%). Wholesalers represent only 7% of firms and 14% of exports, but they are prominent in global sourcing and account for 44% of imports.[5] Notably, 89% of imported products pass through wholesalers, indicating a significant overlap with producers in the types of goods sourced. Moreover, they engage with 45% of all foreign suppliers selling to Chile and conduct 41% of import transactions at the buyer-product-supplier level. Retailers, on the other hand, make up 13% of firms but are less relevant for international trade, accounting for 11% of imports and under 1% of exports.

TABLE 1. Trade Activity by Firm Type

	Producers	Wholesalers	Retailers
# firms	528,617	43,084	86,627
% firms	0.803	0.065	0.132
% importers	0.439	0.302	0.259
% imported value	0.454	0.439	0.107
% imported products (HS6)	0.909	0.889	0.747
% foreign suppliers	0.448	0.446	0.242
% import transactions	0.331	0.405	0.264
% exporters	0.527	0.372	0.101
% exported value	0.852	0.141	0.008
% exported products (HS6)	0.874	0.722	0.382
% foreign customers	0.682	0.352	0.058
% export transactions	0.566	0.382	0.052

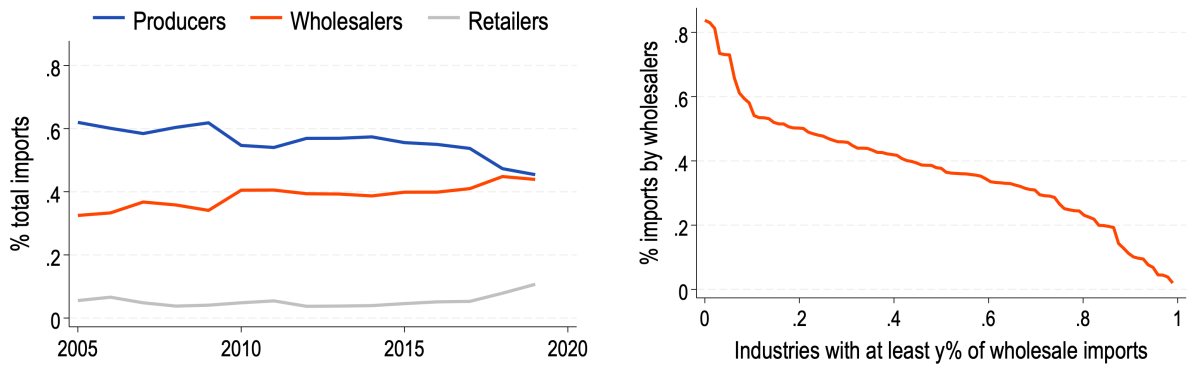
Notes: Summary statistics are reported for the universe of Chilean firms with positive sales in 2019. Firms are classified by their main business activity according to the Tax Authority of Chile (SII), closely following ISIC, rev. 4. International transactions are defined at the buyer-product (HS6)-supplier level.

Figure 1 shows firms' import shares over time in Panel A and the share of wholesale imports across broadly defined sectors in Panel B. The role of wholesalers has increased over the past

[5]The relative importance of wholesalers in input sourcing aligns with recent evidence from developed countries. Utar (2017) documents that wholesalers account for over 50% of Danish imports. Ganapati (2024) reports that the share of US manufactured goods distributed by wholesalers rose from 32% in 1992 to 47% in 2012, driven by their global sourcing activities and technological advancements.

decades, particularly since the Great Recession, with their import share rising from 33% in 2005 to 44% in 2019. Conversely, the import share of producers has steadily declined over the same period. Wholesalers account for at least 20% of imports in 85% of all HS 2-digit sectors active in Chile, and for at least 40% in nearly half of these sectors, indicating that their sourcing activities are spread across the economy. Since I study the use of intermediaries to mitigate disruptions in production, I restrict the analysis to producers and wholesalers, excluding retailers. Therefore, I use the terms 'wholesaler' and 'intermediary' interchangeably hereafter.

FIGURE 1. Import Shares Over Time and Across Sectors



A. Import shares over time

B. Wholesale imports across HS2-sectors

Notes: Panel A displays import shares for producers, wholesalers and retailers from 2005 to 2019. Panel B considers data across HS 2-digit sectors for 2019, showing the share of sectors where wholesalers comprise at least y% of imports on the x-axis and the corresponding share of imports on the y-axis.

Supply Chain Risk. My analysis relies on three risk measures that proxy for the probability of disruptions in origin markets. The *Geopolitical Risk* (GPR) index developed by Caldara and Iacoviello (2022) provides a news-based measure of adverse events and threats associated with political tensions. This indicator has been linked to lower investment at the firm and industry levels, but its relevance for sourcing decisions remains unexplored. The *Economic Policy Uncertainty* (EPU) index developed by Baker et al. (2016) follows a similar methodology to assess economic uncertainty and issues related to legislation and regulations. Both indices capture variation across origin countries and over time. In terms of coverage, the GPR spans 44 economies, representing 92% of Chilean imports in 2019, while the EPU includes 29 countries, accounting for 78% of imports.

I also build a measure of *Trade Volatility* that isolates variation within origin-products over time and covers the universe of Chilean imports. Specifically, I use global trade flows for 2010–2019 from the *CEPII* database (Gaulier and Zignago 2010), considering exports X_{opdt} of HS 6-digit product p from origin country o to destination d in year t, excluding Chile. I residualize using

product-destination-year fixed effects to account for shocks affecting buyer demand, and origin-destination-year fixed effects to absorb changes in bilateral trade costs, thus capturing supply-side volatility. I then compute the (log) standard deviation of residualized flows within origin-products over 5-year windows, as indicated below.

$$X_{opdt} = \delta_{pdt} + \delta_{odt} + \varepsilon_{opdt}\,, \qquad Risk_{opt} = \log\left(SD_{[t-4,t]}\left(\hat{\varepsilon}\right)\right) \tag{1}$$

To validate these risk measures, Table 2 correlates each with separation rates between producers and suppliers across origin-product markets. Supply link separations are more frequent under all three measures. Moreover, the measures are positively correlated but not collinear: the correlation between economic policy uncertainty and geopolitical risk is around 0.4, while the correlation between geopolitical risk and trade volatility is 0.35 (Table A1). Each indicator thus captures different risk dimensions.[6]

TABLE 2. Supplier Separation Rate and Risk Measures

	Supplier separation rate		
	(1)	(2)	(3)
Geopolitical Risk	0.055*		
	(0.029)		
Economic Policy Uncertainty		0.067***	
		(0.019)	
Trade Volatility			0.010***
			(0.002)
Product FE (HS6)	Yes	Yes	Yes
Origin-country productivity	Yes	Yes	Yes
Origin-country trade costs	Yes	Yes	Yes
Observations	52,799	38,801	54,186

Notes: This table examines how the average separation rate between producers and suppliers varies with the risk measures at the origin country-product (HS6) level. Geopolitical Risk and Economic Policy Uncertainty are at the origin-country level, and Trade Volatility at the origin country-product level. All columns include product fixed effects and control for origin country's total factor productivity and trade procedures. The sample includes all Chilean import transactions for 2019. Standard errors are clustered at the level of the risk measure.

2.2. Facts on Input Sourcing under Risk

I establish four facts on input sourcing under supply chain risk. First, the share of intermediated imports for a given product and origin country rises with several measures of risk, while fewer

[6]Figures A3, A4, and A5 display heat maps for each risk measure across origin countries for 2019. For comparison, the trade volatility index built within origin-product pairs is aggregated at the origin-country level.

producers import directly from riskier markets. Second, intermediaries are more diversified than producers, maintaining a larger number of suppliers within origin-products. Third, conditional on the number of suppliers, intermediaries also have more stable supply links than producers. Fourth, among the producers sourcing directly, only the largest expand their supplier base when risk increases. These facts suggest that producers seek protection from disruptions, but direct diversification is costly, and that intermediaries offer a more resilient sourcing technology in the face of risk.

Stylized Fact 1: *The aggregate share of intermediated imports increases with supply chain risk within an origin country and product, and fewer producers source directly from riskier markets.*

I use specification (2) to explore how the use of intermediaries varies with supply chain risk. Y_{opt} denotes the share of intermediated imports for a given origin country o and HS 6-digit product p in year t, while $Risk_{opt}$ is a time-varying measure of supply chain risk. I estimate this equation in long differences, considering the 5-year period from 2014 to 2019. Identification then comes from risk changes within origin country-product pairs, which are plausibly orthogonal to economic conditions in a small economy like Chile. This approach also rules out the effect of time-constant origin country and product characteristics that may confound the relationship between risk and intermediation, since riskier markets can differ systematically from safer ones. Moreover, Z_{opt} controls for time-varying covariates that may affect firms' sourcing strategies.

$$\Delta_{t,t+5} Y_{op} = \alpha \left(\Delta_{t,t+5} Risk_{op} \right) + \Delta_{t,t+5} Z'_{op} \gamma + \epsilon_{op} \tag{2}$$

Table 3 shows that the share of intermediated imports increases with all risk measures described in Section 2.1: the *Geopolitical Risk* and *Economic Policy Uncertainty* indices across input origins, and the *Trade Volatility* index at the origin-product level. The coefficients are normalized to reflect the effect of one standard deviation in each measure. Column (1) reports that an increase in *Geopolitical Risk* expands the intermediation share by one percentage point. Column (2) confirms this result when controlling for changes in origin-country productivity and trade costs, as well as changes in total imports by product to account for industry conditions.[7] Columns (3) to (6) display similar results for changes in *Economic Policy Uncertainty* and *Trade Volatility*, with effects ranging from 0.5 to 1.3 percentage points.

Consistent with this shift toward intermediation, fewer producers import directly from the affected markets when risk increases. Table 4 examines this margin using the same long-differences specification (2) at the origin country-product level, where the dependent variable is the change in

[7] I control for changes in total factor productivity (*Penn World Table 9.1*) and the number of trade procedures (*World Development Indicators*) as a proxy for trade costs. Note that there are virtually no changes in Chilean import tariffs during the period of analysis. On the other hand, time-constant trade barriers, such as distance or cultural differences, are subsumed under the long-differences approach.

TABLE 3. Trade Intermediation and Supply Chain Risk

	Δ % Intermediated imports					
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Geopolitical risk	0.010***	0.011***				
	(0.003)	(0.003)				
Δ Economic policy uncertainty			0.010	0.013**		
			(0.006)	(0.005)		
Δ Trade volatility					0.007***	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

Notes: This table examines how changes in the share of intermediated imports at the origin country-product (HS6) level vary with changes in supply chain risk over a 5-year period. Supply chain risk is measured by Geopolitical Risk and Economic Policy Uncertainty at the origin-country level, and by Trade Volatility at the origin country-product level. The coefficients are normalized to reflect the effect of one standard deviation. Controls include changes in origin country's total factor productivity and trade procedures, and changes in total imports by product. The sample includes all Chilean import transactions for 2014 and 2019. Standard errors are clustered at the level of the risk measure.

the (log) number of producers importing directly from a given origin-product market. The count of direct importers systematically decreases with all measures of supply chain risk: a one standard deviation increase in *Geopolitical Risk* or *Economic Policy Uncertainty* lowers the number of direct importers by 3.5 to 4.4 log points, while the effect for *Trade Volatility* is smaller but still significant.

Overall, these results suggest that risk factors abroad shape firms' sourcing strategies, with intermediaries playing a greater role and fewer producers sourcing directly when risk increases. The next fact unpacks differences in the supply networks of producers and intermediaries that inform this pattern.

Stylized Fact 2: *Intermediaries transact with more suppliers and have less concentrated input purchases across suppliers within origin-products compared to producers.*

I compare the supply networks of producers and intermediaries. Table 5 considers the (log) number of suppliers that firms have per origin-product (HS 6-digit), and a Herfindahl-Hirschman index (HHI) for the concentration of input purchases across suppliers. I regress these variables on a dummy indicating whether the firm is an intermediary. Columns (1) to (3) show that intermediaries systematically source from more suppliers than producers, while columns (4) to (6) indicate less concentrated input purchases. On average, intermediaries have about 5% more suppliers and a 2

TABLE 4. Direct Importers and Supply Chain 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

Notes: This table examines how changes in the (log) number of producers importing directly at the origin country-product (HS6) level vary with changes in supply chain risk over a 5-year period. Supply chain risk is measured by Geopolitical Risk and Economic Policy Uncertainty at the origin-country level, and by Trade Volatility at the origin country-product level. The coefficients are normalized to reflect the effect of one standard deviation. Controls include changes in origin country's total factor productivity and trade procedures, and changes in total imports by product. The sample includes all Chilean import transactions for 2014 and 2019. Standard errors are clustered at the level of the risk measure.

percentage point lower HHI within origin-products.[8] Since wholesalers may operate at a larger scale, I control for buyer size by including 10 bins based on total sales. I also control for imports per buyer-origin-product, ensuring that supplier differences are not driven by wholesalers purchasing larger amounts. Product and country fixed effects account for the possibility of intermediaries specializing in different input markets.

In principle, intermediaries might be sourcing different input varieties from different suppliers: while HS 6-digit codes are narrowly defined for some goods, they allow for substantial heterogeneity within others. Table A2 addresses this possibility by restricting the sample to homogeneous goods according to the Rauch classification (i.e., goods traded in organized exchanges or with reference prices), reducing the scope for differentiation within product codes. This analysis confirms that intermediaries source from more suppliers than producers, even for the same variety.[9]

Fact 2 indicates that producers can access a more diversified supply network by contracting with intermediaries. The next fact shows that, conditional on the number of suppliers, the stability of

[8]Figure A6 displays the average number of suppliers per origin-product for producers and intermediaries of different sizes, along with their Herfindahl-Hirschman index, with observations weighted by import value. While the median firm sources from a single supplier, larger firms tend to multi-source, and the differences between producers and intermediaries persist across the distribution.

[9]See Grant (2021) for a discussion on how heterogeneous goods are grouped in standard classifications, and how this process may ultimately reflect policy motives. The Rauch classification was originally proposed in Rauch (1999) and then updated in 2007, which is the version used in this study.

TABLE 5. Number of Suppliers and Concentration of Input Purchases

	(log) # suppliers			HHI suppliers		
	(1)	(2)	(3)	(4)	(5)	(6)
Intermediary dummy	0.062***	0.045***	0.049***	-0.023***	-0.017***	-0.018***
	(0.007)	(0.006)	(0.007)	(0.002)	(0.002)	(0.003)
Firm size (sales)	Yes	Yes	Yes	Yes	Yes	Yes
Imported value	Yes	Yes	Yes	Yes	Yes	Yes
Product FE (HS6)	No	Yes	No	No	Yes	No
Country FE	No	Yes	No	No	Yes	No
Product - country FE	No	No	Yes	No	No	Yes
Observations	330,973	330,602	307,450	330,973	330,602	307,450

Notes: This table compares the supply networks of producers and intermediaries. All regressions are at the firm-HS6 product-origin country level. The dependent variable in columns (1) - (3) is the (log) number of suppliers, and in columns (4) - (6) is a Herfindahl-Hirschman index (HHI) across suppliers. The independent variable is a dummy indicating whether the firm is a wholesaler. Controls include firm sales (10 bins) and imports per buyer-origin-product. The sample includes all import transactions by Chilean producers and wholesalers in 2019. Standard errors are clustered at the firm level.

supply links also differs systematically between producers and intermediaries.

Stylized Fact 3: *Intermediaries have more stable supply links within origin-products compared to producers.*

Table 6 compares the stability of links established by producers and intermediaries with foreign suppliers. The dependent variable is a dummy indicating whether supply links active in period t break in $t+1$, while the independent variable indicates whether the firm is an intermediary.[10] Columns (1) to (3) perform the analysis at the firm-origin-product (HS6) level, controlling for the initial number of suppliers, so that the dependent variable captures the probability that a firm loses any supplier link in an origin-product. Columns (4) to (6) repeat the analysis at the firm-origin-product-supplier level and thus capture the probability that a specific supplier link breaks. In both cases, I control for firm size and imported value, and include fixed effects to compare supply links within origin-products.

My results indicate significant differences between producers and intermediaries, with intermediated links being around 10 percentage points less likely to break. These patterns are consistent with intermediaries having more robust supply networks. However, separations can also be demand-driven due to changes in downstream conditions that induce firms to stop sourcing from their suppliers. This

[10]Similar patterns emerge when considering supply link breaks over longer intervals (t to $t+k$ with $k = 2, 3, 4$), although the sample shrinks substantially. A potential concern is that some products, such as capital goods, are not sourced every year and may appear as link separations in the data. This should not affect my results because the comparison between producers and intermediaries is made within the same product.

TABLE 6. Probability of Supply Link Separations

	$\mathbb{D}$(separation = 1)					
	Firm-product-country			Firm-product-country-supplier		
	(1)	(2)	(3)	(4)	(5)	(6)
Intermediary dummy	-0.115***	-0.114***	-0.113***	-0.094***	-0.095***	-0.092***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
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 FE (HS6)	No	Yes	No	No	Yes	No
Country FE	No	Yes	No	No	Yes	No
Product - country FE	No	No	Yes	No	No	Yes
Observations	312,724	312,346	289,355	427,739	427,390	406,481

Notes: This table compares the probability of a separation with foreign suppliers for producers and intermediaries. The dependent variable is a dummy indicating whether supply links break from period t to $t+1$, and the independent variable is a dummy indicating whether the firm is an intermediary. Columns (1) - (3) perform the analysis at the firm-HS6 product-origin country level, controlling for the log-number of suppliers. Columns (4) - (6) are at the firm-HS6 product-origin country-supplier level. The sample considers all import transactions in 2018 for firms active in 2018 and 2019. Standard errors are clustered at the firm level.

would affect my results if such changes differ systematically between producers and intermediaries, as would be the case, for example, if intermediaries hold more diversified customer portfolios. To address this possibility, I control for changes in outcomes that respond to downstream conditions: firms' total imports and number of suppliers, as well as sector-level (HS 4-digit) imports. Table A3 shows that the differences between producers and intermediaries are smaller but remain significant.[11]

The lower separation rates of intermediaries can be microfounded in several ways that, while not explicitly modeled, are supported by the data. One possibility is that intermediaries match with safer suppliers due to better *screening* capabilities, which I explore by introducing supplier fixed effects. Another option is that intermediaries are more important customers, and can *monitor* suppliers more closely or be placed *first in line* during disruptions. I assess this by controlling for the share of buyers in suppliers' total sales. Furthermore, intermediaries may source multiple products from the same supplier, maintaining relationships during *product-specific shocks*, which I test by defining links at the supplier-product level. Table A4 shows that each channel individually reduces the gap in separation rates by roughly 3 percentage points. When all three are considered simultaneously, separation rates are only 2 percentage points lower for intermediaries.

[11] Similar demand controls are included when estimating disruption probabilities across input locations for model quantification (Section 4). The estimated probabilities increase with all three risk measures: *Geopolitical Risk*, *Economic Policy Uncertainty*, and *Trade Volatility*.

Stylized Fact 4: *Among producers sourcing directly, only larger firms expand their supplier base in riskier markets.*

Fact 1 established that fewer producers source directly when input markets are riskier. I now examine whether producers that source directly diversify suppliers in response to risk. The number of direct suppliers is positively correlated with all risk measures across origin countries and products (Table A5). However, most Chilean producers source from a single supplier within an origin-product: only about one-fifth multi-source, and these firms are larger, accounting for two-thirds of direct imports (Figure A7).[12] Risk responses are therefore likely to differ across producers.

Table 7 examines how producers adjust the (log) number of direct suppliers for a given origin country and product (HS6) when risk increases over time. The specification stacks observations for 2014 and 2019 and includes origin country-product fixed effects, so that responses are identified from changes in risk within input locations.[13] Firm-year fixed effects absorb time-varying producer characteristics, and I control for changes in origin-country productivity, trade costs, and product-level imports. To capture heterogeneous responses across producers, I interact each risk measure with an indicator for above-median producer size, defined by total imports in the initial period.

Direct-supplier responses differ by producer size. For producers below the median, an increase in *Trade Volatility* reduces the number of direct suppliers, while *Geopolitical Risk* and *Economic Policy Uncertainty* show no significant effects. Producers above the median respond differently: the interactions with firm size are positive and significant for *Geopolitical Risk* and *Trade Volatility*, and the point estimates imply that larger producers expand their supplier base. Similar results are obtained when interacting risk measures with size terciles, with the largest responses in the top tercile (Table A6). This suggests that direct diversification is profitable only for larger firms, as the presence of matching costs with suppliers would imply.

In sum, the documented facts indicate that intermediation rises in riskier markets (Fact 1), that intermediaries maintain more suppliers (Fact 2) and more stable supply links (Fact 3), and that only large producers diversify suppliers directly (Fact 4). These patterns motivate a model in which firms respond to supplier risk either by incurring matching costs for direct diversification or by using intermediaries to access a more resilient sourcing technology.

[12] These figures align with evidence for US manufacturers, where 21% of importers source from multiple suppliers within the same origin and account for three-quarters of imports (Blaum et al. 2023), and for Colombian importers, where around 30% of firms have more than one supplier (Bernard et al. 2018a). Recent studies connect supplier diversification to shipping and climate risk (Blaum et al. 2023; Castro-Vincenzi et al. 2024).

[13] Long-differences at this level of granularity would require that the same firm sources the same input from the same origin country over five years, sharply reducing the number of observations.

TABLE 7. Number of Direct Suppliers by Producer Size

	(log) # direct suppliers					
	Geopolitical Risk		Economic Uncertainty		Trade Volatility	
	(1)	(2)	(3)	(4)	(5)	(6)
Supply chain risk	-0.015	-0.018	-0.009	-0.009	-0.032***	-0.034***
	(0.026)	(0.026)	(0.009)	(0.009)	(0.006)	(0.006)
× Firm size (above median)	0.026***	0.026***	0.003	0.003	0.066***	0.066***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.003)	(0.003)
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
Origin country - product FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm - year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	244,147	243,545	212,957	212,957	244,473	243,068

Notes: All regressions consider the (log) number of direct suppliers at the firm-product-origin country-year level, stacking periods 2014 and 2019. Firm size is measured by total imports in the initial period, and the interaction indicates producers above the median. Supply chain risk is measured by Geopolitical Risk and Economic Policy Uncertainty at the origin country-year level, and by Trade Volatility at the origin country-product-year level. Controls include changes in origin country's total factor productivity and trade costs, and changes in total imports by product. The sample includes Chilean producers active in 2014 and 2019. Standard errors are clustered at the level of the risk measure.

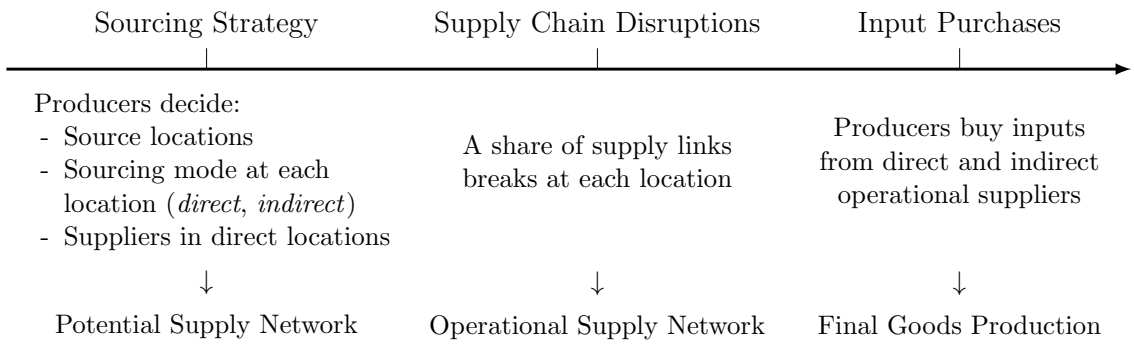
3. Theoretical Framework

I develop a model of global sourcing with supply chain risk and trade intermediation. Heterogeneous final-good producers source inputs from discrete sets of locations and suppliers, and face disruptions that sever individual supply links or all their links at an origin. Producers trade off input costs against disruption probabilities across locations, and have two ways to mitigate risk within them: matching directly with multiple suppliers (*diversification*) or sourcing indirectly (*intermediation*). Intermediaries provide access to networks that can be larger and more stable than producers' direct alternatives in exchange for a brokerage fee on input prices. The model characterizes producers' optimal sourcing strategies and the use of intermediation services under risk.

3.1. Setup

Timing. A producer of final good ω makes decisions in sequential stages. In the first stage, it chooses a sourcing strategy to maximize expected profits. This includes the set of source locations $L(\omega)$, the sourcing mode $M_\ell(\omega)$ at each location (directly from suppliers or through intermediaries), and the number of suppliers $S_\ell^D(\omega)$ when sourcing directly.[14] These choices involve sunk sourcing investments and define a *potential* network of direct and indirect suppliers. Supply chain disruptions are then realized at each location, rendering a share of supply links inoperable. Finally, the producer makes input purchases and production decisions conditional on its *operational* network. Figure 2 summarizes the timing of events.

FIGURE 2. Timeline of Events



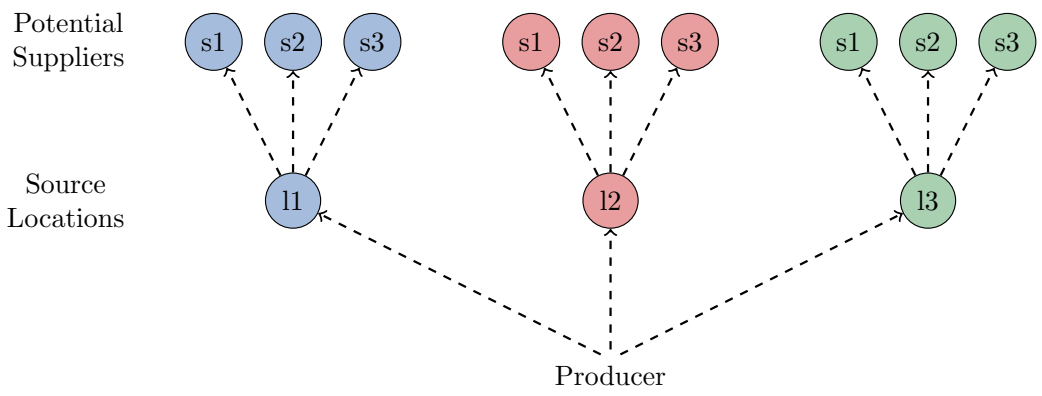
Input Markets. Producers have access to a discrete set of source locations $\mathcal{L}$, each populated by a discrete set of suppliers $\mathcal{S}_\ell$. Locations differ in unit production costs α_ℓ, disruption risk, and sourcing costs that comprise both iceberg trade costs τ_ℓ and fixed matching costs with suppliers f_ℓ. Producers face an efficiency-risk trade-off when cheaper locations are also more exposed to disruptions. Each location offers a differentiated input x_ℓ. I first consider identical suppliers within locations, delivering the local input at the same price $p_{s\ell} = \tau_\ell \alpha_\ell$.[15] This assumption isolates the insurance motive for maintaining multiple supply relationships. Section 3.4 then introduces differences in suppliers' input costs. Figure 3 illustrates the structure of input markets.

Supply Chain Risk. I model disruptions as shocks that break supply links at each location, capturing any failure in production or distribution that prevents suppliers from serving their

[14] The concept of *location* can accommodate different geographic and industry partitions. Here, locations can be thought of as markets defined by the origin country and HS sector of the intermediate goods.

[15] I abstract from a detailed microfoundation of input markets. Under perfect competition, α_ℓ can represent a location-specific wage when input production uses only labor with constant returns to scale. It can also absorb a supplier markup under monopolistic competition.

FIGURE 3. Input Markets with Discrete Locations and Suppliers



customers.[16] Formally, firms face two types of disruptions: idiosyncratic shocks that independently disable individual links with probability ζ_ℓ^M and location-level shocks that simultaneously disable all of a producer's links at an origin with probability ξ_ℓ^M. The two types of shocks are independent across producers and locations, and their probabilities may vary with the sourcing mode M. Changes in risk at a location are modeled as increases in ζ_ℓ^M or ξ_ℓ^M.[17]

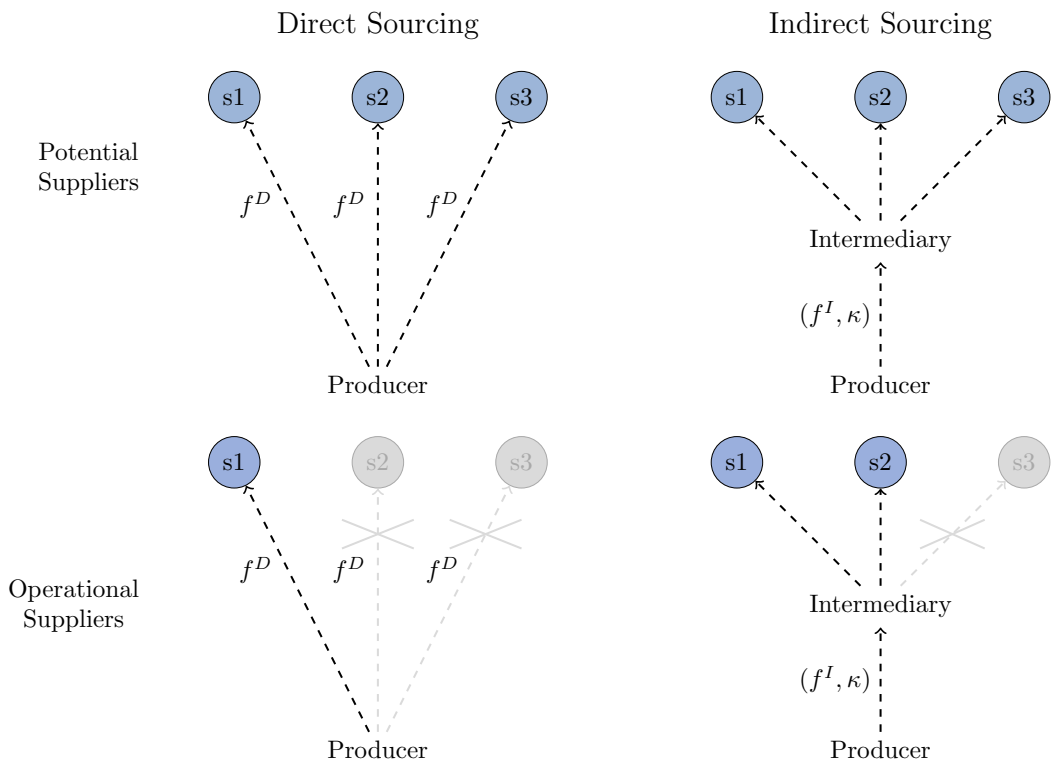
Sourcing Modes. Producers can access each input location through two modes. Under direct sourcing, they select a number of suppliers $S_\ell^D \in \{1, \ldots, |\mathcal{S}_\ell|\}$ and incur strictly increasing matching costs $f_\ell^D(S_\ell^D)$. Under indirect sourcing, they contract with an intermediary at fixed cost f_ℓ^I and access the intermediation technology: a network of $S_\ell^I > 1$ local suppliers and disruption probabilities $\zeta_\ell^I \leq \zeta_\ell^D$ and $\xi_\ell^I \leq \xi_\ell^D$. In return, intermediaries charge a brokerage fee that raises the location input price by a factor κ_ℓ. Producers thus have two ways to mitigate risk at each location: diversify by establishing direct links with multiple suppliers at higher matching costs, or use intermediaries, which can provide access to a diversified and more stable network at higher input prices. Figure 4 illustrates sourcing modes and the realization of disruptions.

Producers. Country i has a continuum of heterogeneous final goods producers. Each producer owns a blueprint for a single variety ω, operates under monopolistic competition, and draws productivity φ from a distribution $G(\varphi)$. The production technology transforms intermediate inputs

[16] This *on-and-off* structure is analogous to percolation analysis in graph theory, where edges are randomly disabled in a network. While my setting features a bipartite supply network, Elliott et al. (2022) apply a similar approach in multi-layer production networks.

[17] In the Chilean data, the correlation across supply-link breakages within the same buyer, product, and origin country is only 0.09 (Table A7). This is consistent with business surveys reporting that idiosyncratic disruptions are the most common (McKinsey 2020). Including location-level shocks allows me to examine how the cost of disruptions and the role of intermediaries depend on the shock structure.

FIGURE 4. Sourcing Modes and Disruptions within Locations



into final goods under constant returns to scale:

$$q_i(\omega) = \varphi(\omega) X_i(\omega) \qquad X_i(\omega) = \left(\sum_{\ell \in L(\omega)} x_{i\ell}(\omega)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}, \tag{3}$$

where $X_i(\omega)$ is a composite intermediate combining inputs from the producer's source locations $L(\omega)$, with elasticity of substitution $\eta > 1$. The producer's marginal cost thus depends on its productivity and the unit cost of its input composite, $C_i(\omega)$, which aggregates the prices $p_{i\ell}^{x,M}(\omega)$ paid for inputs under the sourcing mode chosen at each location:

$$c_i(\omega) = \frac{C_i(\omega)}{\varphi(\omega)} \qquad C_i(\omega) = \left(\sum_{\ell \in L(\omega)} p_{i\ell}^{x,M}(\omega)^{1-\eta} \right)^{\frac{1}{1-\eta}}. \tag{4}$$

These are realized prices conditional on the operational network. With identical suppliers within locations, input prices do not depend on the number of suppliers provided at least one remains operational. Maintaining multiple suppliers within a location therefore serves only to insure against disruptions. Inputs are differentiated across locations, so sourcing from multiple origins generates

variety gains beyond risk protection.

Final Demand. Consumers in country i have Cobb-Douglas preferences over a homogeneous good and differentiated final goods. The homogeneous good is freely traded and produced from labor under constant returns to scale, pinning down wages w_i. Preferences over varieties $\omega \in \Omega_i$ of the non-tradable differentiated good are CES:

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

where β is the expenditure share on differentiated goods, and $\sigma > 1$ is the elasticity of substitution across varieties. Given expenditure E_i on differentiated goods and their price index P_i, demand for variety ω with price $p_i(\omega)$ is:

$$q_i(\omega) = p_i(\omega)^{-\sigma} P_i^{\sigma-1} E_i\,. \tag{5}$$

3.2. Optimal Sourcing with One Location

I first characterize the producer's problem when only one input location is available, and then extend the analysis to multiple locations in Section 3.3. I solve the problem backwards, first deriving optimal input purchases and production conditional on an operational network (ex-post problem), and then determining the sourcing strategy that maximizes expected profits (ex-ante problem).

Ex-Post Problem. Producers have already selected their sourcing mode $M_\ell(\omega)$ and, if sourcing directly, a network of $S_\ell^D(\omega)$ suppliers. After observing the realization Z_ℓ of link and location shocks, they purchase inputs from operational suppliers, set output prices, and choose production to maximize ex-post operating profits:

$$\pi_i^{\text{ex-post}}(\omega \mid M_\ell, S_\ell^D, Z_\ell) = \max_{p_i, q_i, x_{i\ell}} \left[p_i(\omega) - c_i(\omega \mid M_\ell, S_\ell^D, Z_\ell)\right] q_i(\omega).$$

Given CES demand and monopolistic competition, producers set a constant markup such that $p_i(\omega) = \frac{\sigma}{\sigma-1} c_i(\omega \mid M_\ell, S_\ell^D, Z_\ell)$. This determines production from consumer demand (5) and input purchases from the production technology (3). The producer has input access if at least one supplier link survives in its own network under direct sourcing or in the intermediary's network under indirect sourcing. If all links fail, the input is unavailable and the producer cannot operate.[18] Ex-post profits are therefore:

[18]The impact of disruptions is smoother when multiple input locations are available: losing access to one origin raises input costs, but does not necessarily prevent production as long as other locations remain operational. I consider this case in Section 3.3.

$$\pi_i^{\text{ex-post}}(\omega \mid M_\ell, S_\ell^D, Z_\ell) = \begin{cases} B_i \varphi(\omega)^{\sigma-1} (p_{i\ell}^{x,M})^{1-\sigma} & \text{if operational,} \\ 0 & \text{otherwise,} \end{cases} \tag{6}$$

where $B_i \equiv \sigma^{-1}[\sigma/(\sigma-1)]^{1-\sigma} P_i^{\sigma-1} E_i$ summarizes final demand.

Producers pay the supplier price when sourcing directly, which is augmented by the brokerage fee when using intermediaries:

$$p_{i\ell}^{x,D} = \tau_\ell \alpha_\ell, \qquad p_{i\ell}^{x,I} = \kappa_\ell p_{i\ell}^{x,D}, \qquad \kappa_\ell > 1, \tag{7}$$

Conditional on input access, the brokerage fee raises marginal costs and final-good prices, reducing producers' market shares and operating profits by a factor $\kappa_\ell^{1-\sigma}$. This profit loss is larger for more productive firms, which purchase more inputs. The advantage of intermediation must therefore come from more secure access to inputs or lower network investments.

Ex-Ante Problem. Before disruptions materialize, producers choose their sourcing mode and, under direct sourcing, their number of suppliers to maximize expected operating profits net of network investments. Using the ex-post profit function in (6), their problem is:

$$\pi_i^{\text{ex-ante}}(\omega; \zeta_\ell^D, \xi_\ell^D, \zeta_\ell^I, \xi_\ell^I) = \max_{M_\ell, S_\ell^D} \Big\{ 0, \mathbb{E}_{Z_\ell}\big[\pi_i^{\text{ex-post}}(\omega \mid M_\ell, S_\ell^D, Z_\ell)\big] - \mathbb{1}_{\{M_\ell = D\}} f_\ell^D(S_\ell^D) - \mathbb{1}_{\{M_\ell = I\}} f_\ell^I \Big\}.$$

The expectation is over link and location shocks under the chosen sourcing strategy. The fixed costs of matching with direct suppliers or contracting with an intermediary are paid before disruptions and are nonrecoverable.

With S potential suppliers under sourcing mode M, the number that remain operational, $S_\ell^{O,M}$, follows a zero-inflated binomial distribution (Appendix C.10). The probability of input access is therefore:

$$\rho_\ell^M(S) \equiv \Pr(S_\ell^{O,M} \geq 1 \mid S) = (1 - \xi_\ell^M)\big[1 - (\zeta_\ell^M)^S\big]. \tag{8}$$

The probabilities of input access and the input prices in (7) determine expected operating profits.

In particular, the expected input costs under direct and indirect sourcing are:[19]

$$\mathbb{E}_{Z_\ell}\left[(p_{i\ell}^{x,D})^{1-\sigma} \mid S_\ell^D\right] = (1-\xi_\ell^D)\left[1-(\zeta_\ell^D)^{S_\ell^D}\right](\tau_\ell\alpha_\ell)^{1-\sigma}, \tag{9}$$

$$\mathbb{E}_{Z_\ell}\left[(p_{i\ell}^{x,I})^{1-\sigma}\right] = \kappa_\ell^{1-\sigma}(1-\xi_\ell^I)\left[1-(\zeta_\ell^I)^{S_\ell^I}\right](\tau_\ell\alpha_\ell)^{1-\sigma}. \tag{10}$$

Access to a larger or more stable supplier network can offset the higher ex-post input prices paid with intermediation. The comparison of expected input costs across sourcing modes thus depends on the network a producer could build directly.

Using (8)–(10), each strategy's expected profits can be written as an operating return net of its fixed network investment. The producer's ex-ante problem is then to compare expected profits without sourcing, under intermediation, and with its best direct network:

$$\max\left\{0,\ A_{i\ell}\varphi^{\sigma-1}\kappa_\ell^{1-\sigma}\rho_\ell^I(S_\ell^I) - f_\ell^I,\ \max_S\left[A_{i\ell}\varphi^{\sigma-1}\rho_\ell^D(S) - f_\ell^D(S)\right]\right\}, \tag{11}$$

where $A_{i\ell} \equiv B_i(\tau_\ell\alpha_\ell)^{1-\sigma}$. Firm productivity determines whether the expected operating gains from a sourcing strategy justify its fixed network investment.

Sourcing Strategies. I first consider the producer's choice of direct suppliers. Equation (11) exhibits complementarity between firm productivity and network reliability: the expected return from adding a supplier rises with productivity, while its matching cost does not. More productive firms therefore have stronger incentives to diversify suppliers.

Proposition 1. (direct diversification) *Conditional on direct sourcing, more productive firms choose weakly larger supplier networks to insure against disruptions.*

Proof. *See Appendix C.1.*

To compare intermediation with direct diversification, let $\widetilde{S}_\ell^I$ denote the *equivalent* number of direct suppliers that delivers the same expected operating profits as the intermediation technology (Appendix C.8). Formally:

$$\widetilde{S}_\ell^I = \frac{\log\left[1-\dfrac{\kappa_\ell^{1-\sigma}\rho_\ell^I(S_\ell^I)}{1-\xi_\ell^D}\right]}{\log\zeta_\ell^D}.$$

A more resilient intermediary network, as indicated by higher $\rho_\ell^I(S_\ell^I)$, or a lower brokerage fee raises the number of direct suppliers needed to match the intermediation technology. For producers whose

[19]With heterogeneous suppliers, the set of suppliers can affect input costs beyond insure against disruptions. Expected input costs thus depend on the entire distribution of operational suppliers, rather than only on the probability that at least one link remains operational.

direct alternative has fewer than $\widetilde{S}_\ell^I$ suppliers, the reliability advantage of intermediation outweighs its brokerage fee, lowering expected input costs.[20]

The sourcing mode also depends on network investments. I consider the case in which contracting with an intermediary costs less than establishing a direct link with a supplier, $f_\ell^I < f_\ell^D(1)$.[21] This fixed-cost advantage grows as producers add direct suppliers to insure against disruptions. Even for networks above the equivalent supplier count $\widetilde{S}_\ell^I$, where direct sourcing offers higher expected operating profits, only sufficiently productive firms can justify the larger sourcing investments.

Proposition 2. (intermediation)

a. *Intermediation provides more reliable input access and lower expected input costs for producers that could match fewer than $\widetilde{S}_\ell^I$ suppliers directly, despite the brokerage fee.*
b. *There exists a productivity cutoff φ_ℓ^* below which buyers use intermediaries and above which they source directly.*

Proof. *See Appendix C.2.*

In the one-location problem, this productivity cutoff can be characterized explicitly:

$$\varphi_\ell^* = \min_{S \in \{1,\ldots,|\mathcal{S}_\ell|\}} \left[\frac{f_\ell^D(S) - f_\ell^I}{A_{i\ell}\left[\rho_\ell^D(S) - \kappa_\ell^{1-\sigma}\rho_\ell^I(S_\ell^I)\right]} \right]^{\frac{1}{\sigma-1}} \quad \text{for } S > \widetilde{S}_\ell^I.$$

For each number of direct suppliers S greater than $\widetilde{S}_\ell^I$, the expression indicates the productivity level at which direct sourcing and intermediation yield the same expected profits net of network investments. The switching point is the lowest of these productivity thresholds, and rises with a more resilient intermediation technology, lower brokerage fees, or greater fixed-cost savings from intermediation. Figure 5 illustrates the case in which both sourcing modes are used. Indirect sourcing becomes profitable first at φ_ℓ^I and producers use intermediation until φ_ℓ^*, above which sourcing directly from two suppliers is optimal.

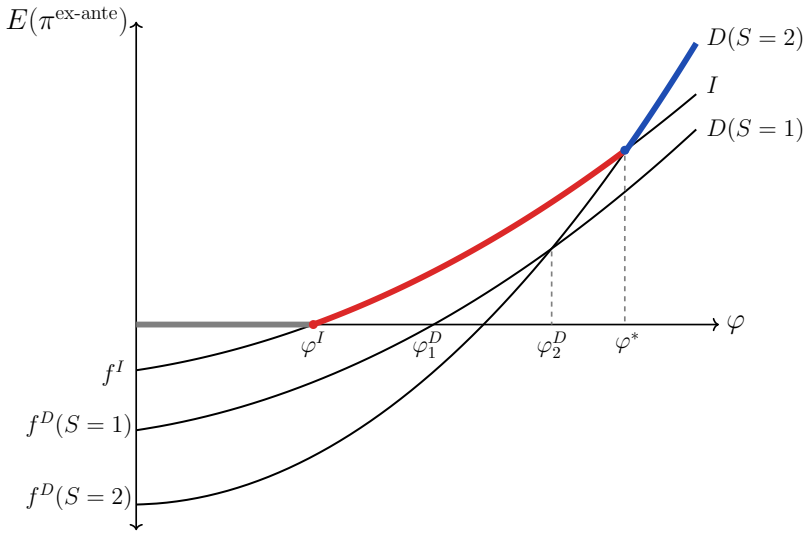
Supply Chain Risk. I next analyze how producers adapt to changes in supply chain risk. I consider a proportional increase in link disruption probabilities under both sourcing modes, holding location-level disruption probabilities fixed.[22]

[20] Appendix Figure A8 compares producers' optimal number of direct suppliers with the equivalent supplier count $\widetilde{S}_\ell^I$.

[21] The notion that intermediaries reduce fixed costs in exchange for a markup is standard in the trade literature (Ahn et al. 2011; Bernard et al. 2015) and underlies recent work on production networks (Blum et al. 2024; Manova et al. 2024). I build on this insight but emphasize the role of intermediaries' network characteristics under supply chain risk.

[22] The intermediation technology reduces link disruption probabilities by a factor μ_ℓ, so that $\zeta_\ell^I = \mu_\ell \zeta_\ell^D$, with $0 < \mu_\ell \leq 1$. I increase ζ_ℓ^D holding μ_ℓ fixed.

FIGURE 5. Optimal Sourcing Strategy



Notes: This figure illustrates sourcing modes from a given location ℓ. Each curve displays expected *ex-ante* profits under a given strategy: sourcing directly from one $(D(S=1))$ or two $(D(S=2))$ suppliers, or sourcing indirectly (I). Firms are sorted by productivity on the x-axis. Firms on the gray segment do not source from ℓ, those on the red segment source indirectly, and those on the blue segment source directly.

PROPOSITION 3. (RISK AND INTERMEDIATION) *Suppose both sourcing modes are used and intermediaries have at least as many suppliers as marginal direct buyers. For moderate link disruption probabilities, a small proportional increase in ζ_ℓ^D and ζ_ℓ^I has three effects:*[23]

a. *Marginal indirect buyers stop sourcing.*
b. *Marginal direct buyers switch to intermediation.*
c. *Continuing direct buyers weakly expand their supplier networks.*

Proof. *See Appendix C.3.*

For any given sourcing strategy in (11), higher risk lowers expected operating profits without changing its fixed network investment. The least productive buyers can no longer cover the intermediary's contracting cost and stop sourcing, raising the minimum productivity required to source, φ_ℓ^I.

An additional direct supplier provides insurance when all existing links fail and the new link survives. From (8), the probability of input access increases by

$$\rho_\ell^D(S+1) - \rho_\ell^D(S) = (1-\xi_\ell^D)(\zeta_\ell^D)^S(1-\zeta_\ell^D).$$

[23]A sufficient bound is $\zeta_\ell^D < 1/2$. This bound and the network-size condition are sufficient, not necessary. Appendix C.3 gives the more general conditions governing the diversification and switching responses.

Higher link risk makes the backup more likely to be needed, but also more likely to fail. For moderate link risk, the first effect dominates. Since matching costs are unchanged, continuing direct buyers have stronger incentives to diversify suppliers.

As risk rises, the intermediation technology becomes more valuable relative to marginal buyers' direct alternatives. Producers can obtain its protection without financing additional direct matches. Higher risk flattens the expected-profit curves under both modes, but more strongly for the direct networks at the mode cutoff. The expected operating-profit advantage of direct sourcing therefore shrinks, reducing the denominator in the expression for φ_ℓ^*. Since the difference in fixed investments is unchanged, direct sourcing requires higher productivity. The cutoff shifts to the right, inducing marginal direct buyers to switch to intermediation.

Appendix Figure A9 illustrates the three responses. Exit reduces the number of indirect buyers, while switching increases it. Firms switching to intermediation are more productive than those exiting, shifting the composition of indirect buyers toward higher-productivity firms. The overall effect on the share of intermediated purchases also depends on expenditure within each mode and is determined in the quantitative model.

3.3. Optimal Sourcing with Multiple Locations

With multiple locations, producers can protect input access by diversifying across origins as well as suppliers. The cost of establishing direct relationships now matters at each origin. Even a large producer may buy too little from a secondary origin to justify building its own supplier network there. Intermediation can make that origin accessible while the firm sources directly from its primary locations.

A sourcing strategy $\vartheta(\omega) \equiv \{L(\omega), M_\ell(\omega), S_\ell^D(\omega)\}$ specifies the source locations, the mode at each, and the number of direct suppliers. Conditional on this strategy and the realization of disruptions, the producer buys from operational locations and sets its final-good price as before. Operating profits are:

$$\pi_i^{\text{ex-post}}(\omega \mid \vartheta, Z) = B_i \varphi(\omega)^{\sigma-1} \Theta(\omega \mid \vartheta, Z)^{\frac{\sigma-1}{\eta-1}}, \tag{12}$$

where $\Theta \equiv \sum_{\ell \in L(\omega)} (p_{i\ell}^{x,M_\ell})^{1-\eta}$ aggregates the input prices available across locations. An unavailable input contributes zero to this sum, and operating profits are zero if every location is disrupted.

As in Antràs et al. (2017), sourcing capability determines the contribution of the input network to firm profits. Here that contribution depends on which parts of the network survive:

$$\mathbb{E}_Z[\pi_i^{\text{ex-post}}(\omega \mid \vartheta, Z)] = B_i \varphi(\omega)^{\sigma-1} \mathbb{E}_Z\left[\Theta(\omega \mid \vartheta, Z)^{\frac{\sigma-1}{\eta-1}}\right]. \tag{13}$$

The producer chooses its potential network to maximize expected operating profits net of fixed sourcing costs:

$$\max_{\vartheta} \left\{ B_i \varphi(\omega)^{\sigma-1} \mathbb{E}_Z \left[\Theta(\omega \mid \vartheta, Z)^{\frac{\sigma-1}{\eta-1}} \right] - F(\vartheta) \right\}, \tag{14}$$

where $F(\vartheta)$ is the sum of direct matching and indirect contracting costs across chosen locations.[24] The empty network yields zero profits.

Accessing more locations generates input variety gains and reduces the probability that disruptions prevent production altogether. Within a location, a broader or more stable supplier network helps preserve these gains. The two investments are complementary when $\sigma > \eta$: cheaper inputs at one origin expand production and increase purchases from other origins, raising the return to securing those supply relationships. This complementarity gives more productive firms an incentive to invest throughout their networks.

Proposition 4. (global sourcing) *When $\sigma \geq \eta$ and sourcing modes are held fixed, more productive firms source from all the locations used by less productive firms and use at least as many direct suppliers at each location. More generally, expected sourcing capability is non-decreasing in firm productivity.*

Proof. *See Appendix C.4.*

Producers choose locations, modes, and suppliers jointly. With sourcing complementarities, an improvement at one origin expands purchases elsewhere, changing the value of both reliable access and savings on brokerage fees. Sourcing modes therefore depend on the firm's other input sources.

To examine entry into a secondary origin, hold sourcing choices elsewhere fixed and compare the additional expected operating profits with the cost of accessing that origin. I consider an intermediary that requires less fixed investment and offers a higher expected operating return per unit of fixed cost than every direct option. A lower fixed cost by itself is not sufficient if the intermediary's brokerage fee or disruption risk absorbs too much of the operating gain.

Proposition 5. (entry into secondary origins) *Holding sourcing choices elsewhere fixed, intermediation makes an additional location profitable for a range of producers that would otherwise leave it out of their network.*

Proof. *See Appendix C.5.*

The relevant scale is purchases from the additional origin. Even a large producer may buy too little there to justify a direct network, while finding indirect access profitable. Intermediation

[24] Without supply chain risk or trade intermediation, and with one supplier available per location, the sourcing problem in (14) is isomorphic to that in Antràs et al. (2017).

can therefore support entry into secondary origins alongside direct sourcing from the firm's main locations.[25]

A more resilient intermediary increases the expected return from entering an origin and lowers the productivity at which access becomes profitable. It can therefore make a risky secondary origin worth accessing for firms that would otherwise leave it out. Higher risk at that origin lowers the return to entry under both modes, even when it makes intermediation relatively more attractive.

Given an optimal sourcing strategy and a particular realization of disruptions, one can compute producers' input expenditure from each operational location:

$$\widetilde{X}_{i\ell}^{M}(\omega) = \varphi(\omega)^{\sigma-1}\left(p_{i\ell}^{x,M}(\omega)\right)^{1-\eta}\Theta(\omega)^{\frac{\sigma-\eta}{\eta-1}}(\sigma-1)B_i. \tag{15}$$

Total input expenditure is

$$\widetilde{X}_i(\omega) = c_i(\omega)q_i(\omega) = \varphi(\omega)^{\sigma-1}\Theta(\omega)^{\frac{\sigma-1}{\eta-1}}(\sigma-1)B_i. \tag{16}$$

For a given sourcing strategy, more productive firms purchase more from every operational location. Improvements elsewhere reinforce this scale effect when $\sigma > \eta$. Intermediated purchases can therefore reflect both substitution away from direct sourcing and access to origins the firm would otherwise leave out of its network.

3.4. Supplier Heterogeneity

So far, an additional supplier is valuable because it can replace a disrupted link. I now allow suppliers to differ in their production costs. More suppliers then provide both insurance and access to lower input prices, including when the existing links remain operational. This extension separates the two benefits of diversification and provides the specification used in the quantitative analysis.

Each location input x_ℓ is now a CES bundle of a unit continuum of varieties $v \in [0,1]$, with elasticity of substitution $\lambda > 1$. Supplier s produces variety v with efficiency $1/\varepsilon_{s\ell}(v)$, where efficiencies are independent Fréchet draws with distribution $\Pr(1/\varepsilon_{s\ell}(v) \le u) = \exp(-u^{-\theta})$, $u > 0$. These draws are realized after matching and are independent of disruptions, so suppliers remain identical from the producer's perspective when it forms its network. Delivered variety prices are $\tau_\ell \alpha_\ell \varepsilon_{s\ell}(v)$. Producers, or intermediaries acting on their behalf, purchase each variety from the cheapest operational supplier.

[25] When $\sigma = \eta$, expected operating profits are additive across locations and these conditional comparisons give the full location-by-location solution. With complementarities, choices elsewhere also affect the return to entering an origin.

With k operational suppliers, the resulting location input price is:

$$p_{i\ell}^{x,M}(k) = \kappa_\ell^{\mathbb{I}\{M=I\}} \gamma \tau_\ell \alpha_\ell k^{-1/\theta}, \qquad k \geq 1, \tag{17}$$

where $\gamma = \left[\Gamma(1 + (1-\lambda)/\theta)\right]^{1/(1-\lambda)}$ and $\theta > \lambda - 1$. Appendix C.6 derives this expression. A lower θ means greater dispersion in supplier efficiencies and larger price gains from another operational supplier. As $\theta \to \infty$, these gains vanish and the model returns to the identical-supplier benchmark.[26]

Disruptions now hurt a producer even when they leave some suppliers operational, because fewer available cost draws raise the input price. In the one-location problem, the *supplier capability* that determines expected operating profits combines network operability with these cost gains. Let K denote the operational supplier count and $r \equiv (\sigma - 1)/\theta$. Then:

$$\Lambda_\ell^M(S) \equiv \mathbb{E}[K^r] = \underbrace{\rho_\ell^M(S)}_{\text{input access}} + \underbrace{\mathbb{E}\left[(K^r - 1)\mathbb{I}_{\{K \geq 1\}}\right]}_{\text{input-cost gains}}. \tag{18}$$

Expected profits take the same form as in (11), replacing ρ_ℓ^M with Λ_ℓ^M and incorporating γ into the location cost. With multiple locations, expected sourcing capability uses the prices in (17) and the operational-count distribution in Appendix C.10.

Moderate link risk raises the insurance benefit of another supplier: the producer is more likely to need that link when its existing suppliers fail. Higher risk can also reduce expected input-cost gains by making it less likely that several suppliers survive together. When the loss in expected cost savings dominates, the producer may reduce its supplier count even though backup supply has become more valuable.[27]

With multiple origins, the value of preserving local access and obtaining lower prices also depends on the inputs available elsewhere. The balance between these benefits can therefore differ from the one-location case. The quantitative model allows both forces to operate across the firm's entire network.

Intermediaries provide both benefits through their supplier portfolios. A broader network can preserve input access and lower procurement costs, while the brokerage fee raises the price charged to the buyer. As in the benchmark, the appeal of intermediation depends on these gains relative to the direct network that the buyer's purchases can support.

[26] Here, lower prices arise from access to more cost draws at unchanged supplier markups. The set of input varieties is fixed. This mechanism complements models in which buyers' outside options affect suppliers' prices (Alviarez et al. 2023; Huang et al. 2024; Ignatenko 2026). The common factor γ can be absorbed into the location cost scale.

[27] Appendix C.7 decomposes the marginal supplier gain. The insurance component is $(1 - \xi_\ell^D)z^S(1-z)$ and rises for $z < S/(S+1)$, so $z < 1/2$ suffices for every increment from one or more suppliers. In the one-location problem, the optimal direct supplier count weakly falls with link risk when $(\sigma - 1)/\theta \geq 1$. At moderate risk, declining cost gains then outweigh the stronger insurance incentive.

3.5. General Equilibrium

To close the model, prospective producers pay an entry cost $w_i f_i^e$ before drawing productivity from G_i. They then choose their sourcing strategy or exit. Let $V_i(\varphi; B_i)$ denote maximized expected profits after sourcing costs, including the option of not producing. Free entry requires:

$$\int V_i(\varphi; B_i)\, dG_i(\varphi) = w_i f_i^e. \tag{19}$$

This condition determines the demand shifter B_i and hence the productivity cutoff $\overline{\varphi}_i$ below which producers do not undertake sourcing. A better intermediation technology raises the return to entry at a given B_i. Free entry then weakly lowers B_i and the differentiated-goods price index. Appendix C.9 gives the equilibrium derivation and regularity conditions.

With the numeraire sector active, wages remain fixed and expenditure on differentiated goods is $E_i = \beta w_i L_i$.[28] Let N_i^e denote the mass of entrants and $\vartheta_i^*(\varphi)$ their optimal sourcing strategies. Revenues equal σ times operating profits, so goods-market clearing implies:

$$N_i^e = \frac{\beta w_i L_i}{\sigma\left[w_i f_i^e + \int F_i(\vartheta_i^*(\varphi))\, dG_i(\varphi)\right]}, \tag{20}$$

where firms that exit incur no sourcing costs. The mass of producers that undertake sourcing is $N_i = N_i^e[1 - G_i(\overline{\varphi}_i)]$, for a continuous productivity distribution. The differentiated-goods price index follows from the resulting mass of producers and their input costs. With the numeraire price fixed, the ratio of overall consumption price indices across equilibria is $(P_i'/P_i)^\beta$.

Entry and prices therefore adjust alongside firms' sourcing decisions. These equilibrium responses are distinct from the sourcing comparisons above, which hold the demand shifter fixed.

4. Quantitative Analysis

The theory developed in Section 3 allows me to quantify the role of trade intermediation in mitigating supply chain disruptions. Leveraging the detailed microdata at hand, I operationalize this setting for Chile, five source regions (Latin America, China, the United States, Europe, and Rest of the World), and one sector per region. My main result is that intermediaries substantially reduce the aggregate impact of disruptions on operating profits and differentiated-goods prices, absorbing close to half of the loss from a uniform rise in global risk; this insurance value grows with risk and comes mainly

[28] Aggregate expenditure equals labor income because free entry exhausts producers' expected net profits. I assume that input suppliers are price takers and intermediation receipts cover procurement and distribution costs, so there are no additional intermediary profits to rebate. Disruptions are idiosyncratic across producers, although links within a buyer-location network can fail together.

from the broader supplier networks intermediaries provide. I also show that these gains do not hinge on the level of brokerage fees: varying the markup within the empirically relevant range changes the mitigation only modestly.

4.1. Numerical Solution

I solve the sourcing problem in (14) using the heterogeneous-supplier specification in Section 3.4. The first challenge is the dimensionality of the choice set. Because suppliers are identical before matching, a producer chooses their number rather than their identities. Each foreign location offers $|\mathcal{S}_\ell| + 2$ options: no sourcing, intermediation, or direct sourcing from one to $|\mathcal{S}_\ell|$ suppliers. With five foreign regions and four potential suppliers per region, there are $6^5 = 7{,}776$ foreign sourcing strategies. I enumerate these strategies jointly with domestic sourcing choices and compare their expected profits net of fixed costs. This preserves the dependence of each location's sourcing mode on the rest of the network.

The second challenge is to evaluate expected profits before disruptions. For each strategy, I sum over the possible operational supplier counts at every location, using the zero-inflated binomial probabilities in Appendix C.10. Independence across locations gives the joint probabilities in (A18), so expected sourcing capability can be computed exactly and stored before solving producers' choices. Changes in productivity and fixed sourcing costs then require only a new comparison of the strategy-specific profit functions.

The quantitative comparisons hold the demand shifter B and the mass of potential producers fixed, allowing firms to adjust locations, modes, and suppliers. They measure changes in aggregate operating profits and in the price index for differentiated final goods.[29] This isolates how access to intermediation changes firms' sourcing responses and the resulting cost of disruptions.

4.2. Model Estimation

The estimation proceeds in two steps. I first discipline the substitution and supplier-dispersion parameters, regional input costs, disruption probabilities, supplier sets, and brokerage fee using microdata and estimates from the literature. I then use the simulated method of moments to estimate the aggregate demand shifter and the parameters governing fixed sourcing costs, conditional on those first-step objects. Table 8 separates these objects: Panels A and B report substitution and supplier-dispersion parameters and region-level primitives, while Panel C reports the calibrated

[29] The free-entry closure in Section 3.5 also allows demand and entry to adjust. Under the Cobb-Douglas preferences in the model, a change in the differentiated-goods price index translates into a change in the overall consumption price index with expenditure weight β.

brokerage fee and the SMM estimates of demand and sourcing costs.[30]

Elasticities. I calibrate the parameters governing substitution across final goods in consumption (σ), across inputs from different locations in production (η), and dispersion in supplier efficiencies within locations (θ). I take $\hat{\sigma} = 5.0$, close to median estimates in the trade literature (Broda and Weinstein 2006; Feenstra and Romalis 2014; Antràs et al. 2017), and infer η and θ using model-consistent equations.

First, I consider a log-linear version of (15) indicating firm f's input purchases from source location ℓ, conditional on direct sourcing:

$$\log \widetilde{X}^{D}_{f\ell} = (\sigma - 1)\log \varphi_f + (1-\eta)\log p^{x,D}_{f\ell} + \left(\frac{\sigma-\eta}{\eta-1}\right)\log \Theta_f + \log\big[(\sigma-1)B\big]$$

To back out η, I take the following empirical counterpart to the data:

$$\log \widetilde{X}^{D}_{f\ell t} = \delta_{ft} + (1-\eta)\log p^{x,D}_{f\ell t} + u_{f\ell t} \tag{21}$$

where δ_{ft} absorbs differences in producers' marginal costs due to their core productivity and sourcing capability. Identification then comes from price variation across locations for the same firm and year. To address reverse causality concerns, I also estimate (21) for the last sample year (2019) using geographic distance from Chile as an instrument for input prices.[31] As an additional check, I use the full panel and instrument input prices with the interaction of log crude oil prices and log distance. Table A8 reports estimates ranging from 1.2 to 1.5. I use $\eta = 1.3$ for the quantification, close to the $\eta = 1.4$ estimate in Huang et al. (2024) for Chilean global sourcing.

For θ, I consider a log-linear version of (17) that relates input prices to firms' number of suppliers under supplier heterogeneity. Using the number of observed trading partners to measure operational suppliers, the empirical specification is:

$$\log p^{D}_{f\ell t} = \delta_{\ell t} - \frac{1}{\theta}\log S^{D}_{f\ell t} + u_{f\ell t} \tag{22}$$

where $\delta_{\ell t}$ captures location-specific trade and production costs. Identification arises in the first instance from variation in the number of suppliers across firms sourcing from the same location (origin country - HS6 product) and year, and I also include firm-year fixed effects to account for

[30] Following Melitz and Redding (2015), I adopt a Pareto productivity distribution with shape parameter 4.25 and scale parameter 1 for Chilean downstream producers.

[31] In the model, input prices are unaffected by the amount purchased by atomistic producers. In the data, quantity discounts and buyer market power can make prices respond to purchases. Geographic distance shifts trade costs, but its validity as an instrument also requires that it have no direct effect on purchases conditional on the controls. Chile's flat tariff structure limits the use of tariffs as an alternative instrument.

changes in firm-level conditions. A concern is that lower input prices may themselves induce firms to add suppliers. As a check, column (5) of Table A9 instruments the firm's supplier count with the number of distinct foreign exporters selling the same origin-country and HS4 product to Chile in that year. This specification includes origin-country–HS6 and year fixed effects; identification therefore comes from changes in exporter availability within markets.[32] The IV estimate is close to the OLS estimates, which range from 3.4 to 3.9. I retain $\theta = 3.6$, within the range of these estimates, for the quantification.

Panel A of Table 8 summarizes these parameters. The estimates imply $\sigma > \eta$, so sourcing choices across locations are complementary. Within a location, $\theta = 3.6$ means that a 1% increase in operational suppliers lowers the input price by approximately 0.28%. Additional suppliers thus provide cost savings as well as insurance in the quantitative model.

Location Input Costs. Consider the cost structure behind (17), which separates the cost of input varieties into location ($\tau_\ell\, \alpha_\ell$) and supplier-variety multiplicative factors. I assume that the average price charged by a foreign supplier to Chilean buyers follows this structure, and exploit the time dimension of the data to infer the location-specific component. The empirical specification is:

$$\log \bar{p}_{s\ell t} = \delta_{\ell t} + \delta_{st} + e_{s\ell t} \tag{23}$$

where $\delta_{\ell t}$ is interpreted as the average trade and production cost in each location (origin country - HS6 product) and year, which are then aggregated to source regions. The normalized version of these estimates (relative to Chile) is reported in Panel B of Table 8 for the last sample year (2019).[33] As expected, the estimated costs are significantly higher in Europe and the US compared to Latin America and China. Table A10 reports the raw cost estimates in USD and examines a longer time period, revealing similar patterns.

Disruption Probabilities. I parameterize the probability that producer-supplier links break in a given location using a nonlinear (logit) functional form. Specifically, I consider a vector of observable location characteristics, Z_ℓ, which includes the supply chain risk indexes from Section 2 (*Geopolitical Risk*, *Economic Uncertainty*, and *Trade Volatility*), and a set of dummies classifying countries into low-, middle-, and high-income levels. This allows countries at different stages

[32] The exclusion restriction requires these changes to be unrelated to unobserved input-cost or demand shocks after conditioning on the fixed effects. The exporter count is measured from observed trade, so instrument relevance alone does not establish this restriction. Location-year fixed effects would absorb the instrument.

[33] Since domestic input sourcing is not observed, I assume similar production costs in Chile and Latin America, attributing all differences to iceberg trade costs. These costs are estimated to be around a factor of 2.7, following Anderson and Van Wincoop (2004). To facilitate comparisons, I normalize input costs in Chile to 1, such that, by construction, Latin America has an input cost of 2.7 in Table 8.

TABLE 8. Model Parameters

Panel A. Substitution and supplier heterogeneity

σ *(final goods)*	5.0	η *(input locations)*	1.3	θ *(suppliers)*	3.6

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

	LAT	CHN	USA	EUR	ROW
$\tau_\ell \alpha_\ell$: *trade and production costs*	2.7	3.1	16.1	16.4	10.2
$\widehat{p}_\ell^D$: *direct marginal disruption prob.*	0.23	0.26	0.19	0.18	0.22
$\widehat{p}_\ell^I$: *indirect marginal disruption prob.*	0.17	0.21	0.13	0.13	0.16
ζ_ℓ^D: *direct iid disruption prob.*	0.20	0.24	0.16	0.17	0.19
ζ_ℓ^I: *indirect iid disruption prob.*	0.16	0.20	0.12	0.12	0.16
ξ_ℓ^D: *direct location-shock prob.*	0.035	0.021	0.032	0.010	0.034
ξ_ℓ^I: *indirect location-shock prob.*	0.014	0.007	0.010	0.007	0.006
$\lvert\mathcal{S}_\ell\rvert$: *(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)*	1.25	β^0	0.58	$\beta^{Institutions}$	-2.22
ψ *(indirect contracting)*	0.32	$\beta^{Distance}$	2.44	$\beta^{Suppliers}$	4.29
$\beta^{Dispersion}$	6.35	$\beta^{Language}$	0.93	*B (final demand)*	181.3

Notes: This table summarizes the parameters used in the quantification. Panel A presents substitution elasticities and supplier-efficiency dispersion. Panel B reports input costs, disruption probabilities, and supplier sets across regions. Panel C reports the calibrated brokerage fee and the estimated demand and sourcing-cost parameters. The SMM estimates B, ψ, and ($\beta^0, \beta^{Distance}, \beta^{Language}, \beta^{Institutions}, \beta^{Suppliers}, \beta^{Dispersion}$); κ is calibrated from export-price comparisons and varied in the markup counterfactuals. Following Melitz and Redding (2015), producer productivity follows a Pareto distribution with shape parameter 4.25 and scale parameter 1.

of development to differ in baseline probabilities, which then vary based on the risk measures within groups. Additionally, I include a vector D_b to control for changes in buyer-level downstream conditions, which are then excluded from the projected probabilities.[34] The empirical specification is:

$$\Pr(\mathbb{D}(separation)_{bs\ell t} = 1 \mid Z_{\ell t}, D_{bt}) = \frac{e^{Z'_{\ell t}\gamma + D'_{bt}\delta}}{1 + e^{Z'_{\ell t}\gamma + D'_{bt}\delta}} \tag{24}$$

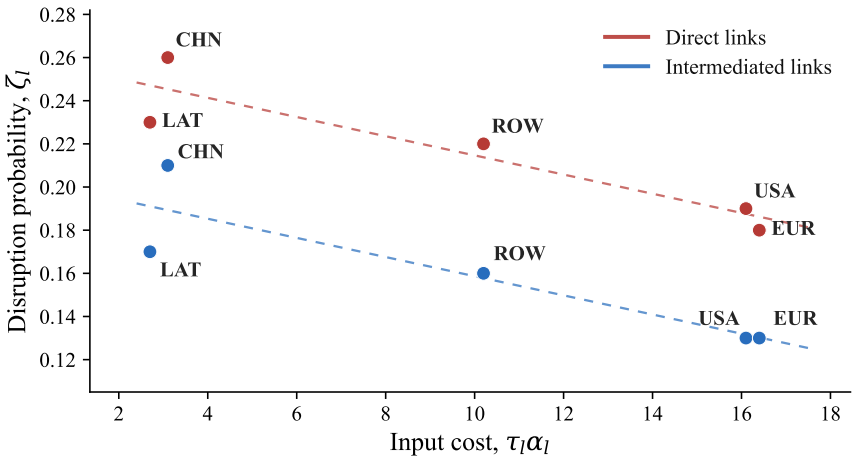
where $\mathbb{D}(separation)_{bs\ell t}$ is a dummy that equals 1 when a bs-link in location ℓ and period t will break in $t+1$.

Table 8 presents the results aggregated at the level of source regions. Direct disruption probabilities

[34] Following the analysis in Section 2, I include the changes in producers' total imports and number of suppliers from period $t-1$ to t. Without controlling for these factors, I find similar relative patterns for disruption probabilities across locations, but the average probability is about 9 pp higher.

range from 0.18 to 0.26, with Europe being the safest region and China the riskiest for Chilean producers. More generally, disruption probabilities are higher in regions with lower input costs, posing an efficiency-risk tradeoff in the choice of source locations.[35] Figure 6 displays this tradeoff directly. Low-cost regions such as Latin America and China expose producers to higher disruption probabilities, while high-cost regions such as the US and Europe are safer. For every region, intermediated links lie below direct links, reflecting the lower separation rates of intermediaries used in the quantification. Table A11 reports the estimates for vectors Z_ℓ and D_b. All coefficients are statistically significant and operate in the expected direction: the frequency of disruptions increases with the risk measures, and decreases in more developed countries or when buyers experience favorable downstream conditions.

FIGURE 6. Input Costs and Disruption Probabilities



Notes: The figure plots the region-level input costs and disruption probabilities reported in Panel B of Table 8. The cost measure is $\tau_\ell \alpha_\ell$, before brokerage fees and supplier-level cost gains. Red points denote direct links and blue points denote intermediated links. Dashed lines show the fitted relationship between input costs and disruption probabilities across source regions.

For indirect disruption probabilities, I compare the supplier separation rates of producers and intermediaries in each source region. As in Section 2, the analysis considers supply links within the same product and origin country (when there is more than one country in the region), while incorporating the demand controls mentioned above. Table A12 reports these results, which are then used to adjust the direct probabilities. As shown in Table 8, indirect disruptions are about 6 pp less likely on average, representing a 25% reduction in the probability of disruptions relative to direct

[35] In the baseline scenario, I consider disruptions in global sourcing but *safe* domestic links. This can be rationalized as producers facing lower matching costs in the home country, allowing them to find replacements within a reasonable time frame. However, it is straightforward to incorporate risk in the home country. The probability of disruptions in Chile could be inferred by extrapolating the coefficients estimated in (24). Alternatively, this probability can be estimated using VAT data on domestic transactions.

sourcing.[36]

I next separate marginal disruption risk into the idiosyncratic and location-level components of the model. A link breaks if a location shock disables all of the buyer's links at that origin, or if the link experiences an individual disruption. Its marginal disruption probability is therefore

$$\widehat{p}_\ell^M = \xi_\ell^M + (1 - \xi_\ell^M)\zeta_\ell^M. \tag{25}$$

To distinguish the two components, I also use the correlation of separations across links within the same buyer, product, and origin. For two distinct links j and k, the shock structure implies

$$\widehat{r}_\ell^M \equiv \text{Corr}(D_j, D_k) = \frac{\xi_\ell^M(1 - \zeta_\ell^M)}{\widehat{p}_\ell^M}.$$

Together, the marginal separation probability and this correlation identify the two disruption probabilities.[37] Panel B of Table 8 reports the resulting probabilities by region and mode. Idiosyncratic disruptions are more frequent than location-level shocks, and both components are lower under indirect sourcing in every region. The distinction matters because additional suppliers insure against individual link failures, while protection against a common location shock requires a safer sourcing mode or access to another origin.

Suppliers per Location. I use import transactions to compute the number of indirect suppliers offered by intermediaries. Specifically, I compute the average number of suppliers that wholesalers have per product (HS6)-region, weighting by wholesalers' import shares. Table 8 reports that the intermediation technology exhibits multisourcing in all regions: when producers source indirectly, they access 4 suppliers per product in China and 3 in the remaining regions. On the other hand, I assume that producers can match with up to 4 suppliers per region when sourcing directly. This corresponds to the 95th percentile in the distribution of direct suppliers per producer, and allows producers to build a diversified network if they can afford the associated matching costs.

Brokerage Fee. In principle, one would like to observe the prices charged by import intermediaries to local producers and compare them to those charged by foreign suppliers in the same industry. I take a similar approach by using customs data on Chilean exports, which allows me to compare the prices charged by producers and export intermediaries for the same destination and sector.[38] I run

[36]These differences are smaller than those reported in Section 2 due to the demand-side controls. However, I consider my approach to be conservative in terms of the resilience advantage of intermediaries, as these buyer-level controls may partially absorb supply-side conditions.

[37]The inversion is $\zeta_\ell^M = \widehat{p}_\ell^M(1 - \widehat{r}_\ell^M)$ and $\xi_\ell^M = \widehat{p}_\ell^M\widehat{r}_\ell^M/[1 - \widehat{p}_\ell^M(1 - \widehat{r}_\ell^M)]$.

[38]Domestic transactions between import intermediaries and producers are recorded in VAT data; here I use export prices as a transparent benchmark and validate the implied markup against external estimates below.

the following empirical specification:

$$\log p_{f\ell t}^{Exp} = \delta_{\ell t} + \log \kappa D^{Exp}(Intermediary = 1)_{ft} + \epsilon_{f\ell t} \tag{26}$$

where $p_{f\ell t}^{\text{Exp}}$ denotes the price charged by firm f in location ℓ (destination-sector), and $D(\text{Intermediary} = 1)_{ft}$ is a dummy indicating whether the exporter is an intermediary. I find an export-price premium of about 11%. This comparison provides a benchmark for the brokerage fee, although export and import intermediaries need not provide the same services. In the United States, Ganapati (2024) reports wholesale sales relative to merchandise purchases of approximately 1.31 to 1.41; Alexander et al. (2024) also documents substantial selling-price premia over purchase prices among Canadian wholesalers.[39] I set the baseline brokerage fee to $\kappa = 1.25$, between the Chilean export premium and the US wholesale price ratios, and examine $\kappa = 1.1$ and 1.4 in the counterfactuals.

Matching Costs and Demand Shifter. The last objects to estimate are the aggregate demand shifter B, the matching costs of sourcing directly in each region $f_\ell^D(S_\ell^D)$, and the costs of contracting with intermediaries f_ℓ^I. For each foreign region, let a_ℓ denote the median cost of establishing one direct link. I parameterize this cost using bilateral distance, common language, and control of corruption:

$$\log a_\ell = \log \beta^0 + \beta^{Dist} \log \text{Dist}_\ell + \text{Lang}_\ell \log \beta^{Lang} + \beta^{Inst} \text{Inst}_\ell \,. \tag{27}$$

Producer f's direct matching costs and the intermediary's contracting cost are

$$f_{f\ell}^D(S) = a_\ell \exp(\beta^{Disp} \varepsilon_{f\ell}) S^{\beta^{Supp}}, \qquad f_\ell^I = \psi a_\ell, \qquad \varepsilon_{f\ell} \sim N(0,1).$$

The cost draw is observed before sourcing and varies across producers and locations. Contracting with an intermediary costs a common share ψ of the region's median one-link direct cost, while direct diversification requires additional matching investments.[40]

I estimate the eight parameters $\Omega \equiv \{B, \psi, \beta^0, \beta^{Dist}, \beta^{Lang}, \beta^{Inst}, \beta^{Supp}, \beta^{Disp}\}$ by simulated method of moments. For each candidate vector, I solve producers' sourcing choices and compare the implied moments with the data. I target the share of firms importing directly, the share of direct imports in input purchases, their geographic composition, the intermediated import share, and the numbers of direct suppliers and source regions per direct importer. These moments jointly discipline the scale of importing, the costs of expanding direct networks, and the relative cost of

[39] The relevant comparison is the selling price relative to the procurement price, which includes the cost of distribution services. It differs from an accounting markup over all operating costs.

[40] Heterogeneous matching costs allow producers with similar productivity to choose different sourcing modes. The cost of the first domestic link is normalized to one, and domestic intermediation is excluded.

using intermediaries.[41]

TABLE 9. Empirical and Simulated Moments

Moment	Data	Model
Import activity		
Share of firms importing directly	0.039	0.037
Share of direct imports in input purchases	0.330	0.297
Import shares by source region		
Latin America	0.340	0.311
China	0.154	0.170
United States	0.218	0.201
Europe	0.150	0.186
Intermediation and diversification		
Share of intermediated imports	0.440	0.491
Number of suppliers per direct importer	1.890	2.374
Number of source regions per direct importer	1.273	1.496

Notes: This table compares empirical and simulated sourcing moments. The saved SMM run uses 0.40 as the target for the intermediated import share, rather than the 0.44 reported here. The procedure estimates the vector Ω containing the final-demand shifter, indirect contracting costs, and the six parameters characterizing direct matching costs. The import-share moments are computed over foreign input purchases by direct importers. The displayed data shares sum to 0.862, with the residual (0.138) corresponding to Rest of the World; the model assigns a comparable share (0.132) to that region.

Panel C of Table 8 reports the estimated demand and sourcing-cost parameters. Matching costs increase with distance and decrease with common language and institutional quality. They rise more than proportionally with the number of direct suppliers, making diversification costly. The estimate $\psi = 0.32$ places the intermediary's contracting cost at roughly one-third of the median cost of establishing a single direct link. Intermediation therefore gives buyers access to several suppliers without incurring the matching costs of building that network themselves.

Table 9 compares the reported empirical and simulated moments. The model assigns too much direct trade to China and Europe and too little to Latin America and the United States. It also overpredicts intermediation and direct diversification: the intermediated share is 49.1% compared with 44.0%, and direct importers use 2.37 suppliers across 1.50 source regions, compared with 1.89 and 1.27 in the data. The overprediction of direct network size matters for assessing how costly it is for producers to build resilience themselves.

[41]The estimation uses 100,000 stratified Pareto productivity draws and averages over 25 fixed-cost draws per producer and location, held fixed across parameter evaluations. The objective is the sum of squared percentage deviations between simulated and empirical moments, with equal weights.

4.3. Counterfactuals

Having estimated the model, I perform counterfactuals to quantify the role of trade intermediation in mitigating disruptions. The exercise follows the narrative suggested by the model and the reduced-form facts. I first quantify how global disruption risk affects aggregate firm profits and consumer prices, with and without intermediaries. I then show how the value of intermediation rises with risk and which features of the intermediation technology drive the resilience gains. I next ask how this value depends on whether disruptions are location-wide or idiosyncratic. Finally, I assess whether these conclusions are sensitive to the level of intermediation markups.

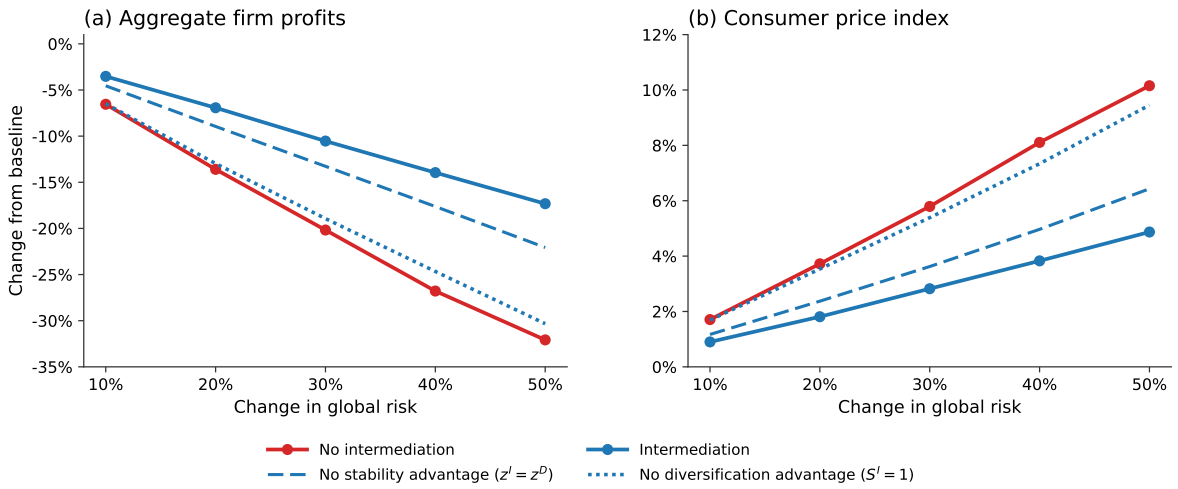
Changes in Global Risk. I begin by quantifying how a uniform increase in foreign disruption risk propagates to aggregate firm profits and consumer prices, comparing the estimated economy with intermediaries to a counterfactual that shuts down intermediation. Each row of Table 10 scales every foreign location's disruption probability by the indicated factor, keeping the home location intact. Disruptions are costly for both firms and consumers. A 10% increase in global risk lowers aggregate firm profits by 3.5% and raises the CPI by 0.9% in the baseline economy. Without intermediaries, the same shock reduces profits by 6.5% and raises the CPI by 1.7%. Intermediaries therefore absorb about 46% of the shock, computed as the reduction in the no-intermediation loss divided by that loss. The mitigation role of intermediaries remains large as risk rises: at a 40% risk increase, profit losses are 14.0% with intermediaries but 26.8% without them, while CPI increases are 3.8% and 8.1%, respectively. The gap between the two economies, the aggregate value of intermediation, widens monotonically with risk (Figure 7), so this insurance value is state dependent: resilient intermediary networks matter most precisely when disruptions are most likely.

TABLE 10. Aggregate effects of higher disruption risk.

	Firm Profits (% change)		Consumer Price Index (% change)	
Risk change	Intermediation	No Intermediation	Intermediation	No Intermediation
+10%	-3.52	-6.55	0.90	1.71
+20%	-6.93	-13.60	1.81	3.72
+30%	-10.53	-20.17	2.82	5.79
+40%	-13.95	-26.79	3.83	8.11

Notes. Each row scales every foreign location's disruption probability by the indicated factor ($\tilde{z}_\ell = 1 - m\,(1 - z_\ell)$ for $\ell \neq 1$). Firm Profits columns report the percent change in aggregate firm variable profits relative to the baseline; Consumer Price Index columns report the percent change in the CPI, with positive values indicating that consumer prices rise. "Intermediation" uses the estimated economy ($\kappa = 1.25$); "No Intermediation" shuts down intermediaries.

FIGURE 7. The Value of Intermediation across Global Risk Levels



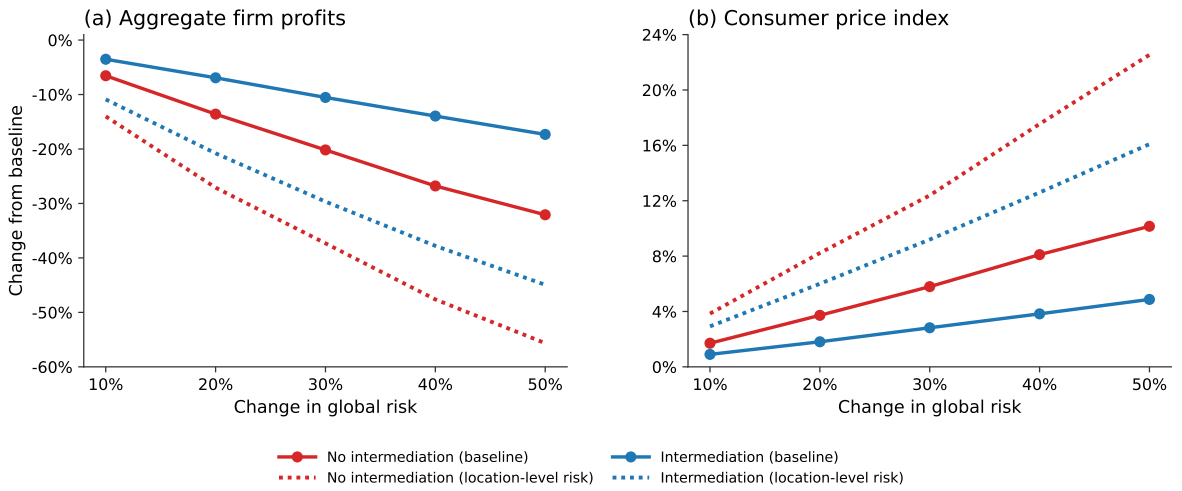
Notes: The solid blue series reports the estimated economy with intermediaries; the solid red series shuts down intermediaries. The dashed blue series removes the intermediary's lower disruption probability relative to direct sourcing ($\zeta_\ell^I = \zeta_\ell^D$) while retaining its broader supplier network ("no stability advantage"). The dotted blue series restricts intermediaries to one supplier per region ($S_\ell^I = 1$) while retaining the lower disruption probability ("no diversification advantage"). Left panel: percent change in aggregate firm variable profits relative to baseline risk. Right panel: percent change in the consumer price index.

Intermediation Advantage. I now decompose where this advantage comes from. Figure 7 plots the estimated economy with intermediaries (blue) and the no-intermediation counterfactual (red) across risk scenarios, together with two partial-intermediation counterfactuals that switch off one component of the intermediary technology at a time.

The intermediary advantage combines two channels. The first is a diversification advantage: intermediaries give producers access to a broader supplier network within each location. The second is a stability advantage: conditional on a location, intermediated links are less likely to be disrupted than direct links. The dashed series removes the stability advantage but keeps the broader network ($\zeta_\ell^I = \zeta_\ell^D$), and the dotted series removes the diversification advantage but keeps the lower disruption probability ($S_\ell^I = 1$). Keeping only the broader network delivers about two-thirds of the aggregate mitigation, while keeping only the more stable links delivers roughly one-tenth. Moreover, the two channels are complementary: their standalone contributions sum to less than the mitigation under full intermediation, so a broader panel of more stable suppliers buffers disruptions by more than the sum of each advantage in isolation. The diversification channel is thus the workhorse of the intermediary advantage, while the stability channel both adds to it directly and amplifies it, especially for consumer prices and at higher risk.

Location-Wide vs. Idiosyncratic Risk. The experiments above scale the total disruption probability at each foreign location. That probability combines a location-wide component that disrupts every

FIGURE 8. Aggregate Effects of Location-Wide versus Idiosyncratic Risk

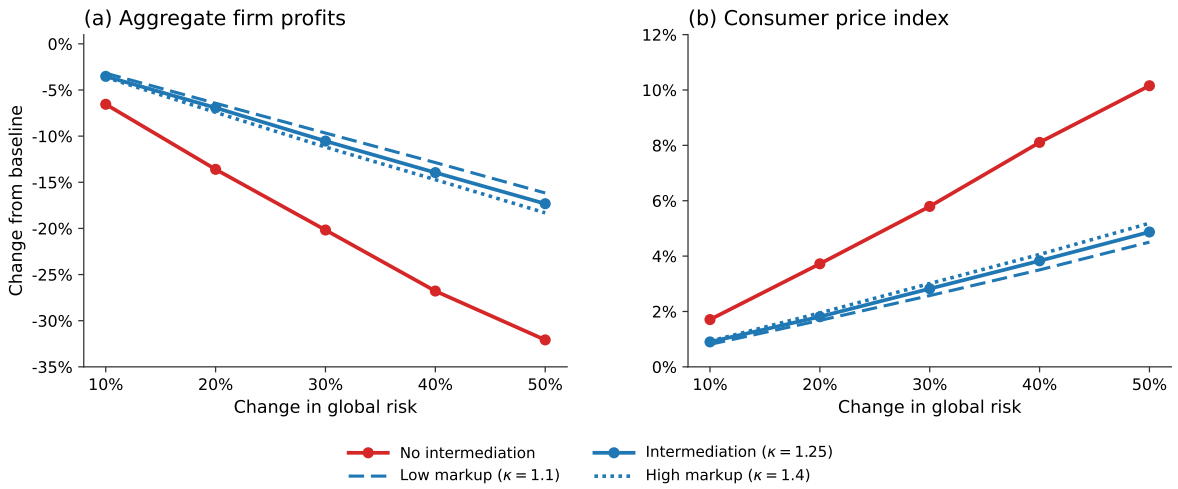


Notes: Each series scales foreign disruption risk by the factor on the horizontal axis. Solid series use the baseline risk structure; dotted series place the entire risk increase on the location-wide component that disrupts every supplier in a region simultaneously, holding the total marginal probability comparable. Blue series use the estimated economy with intermediaries; red series shut down intermediation. Left panel: percent change in aggregate firm variable profits relative to baseline risk. Right panel: percent change in the consumer price index.

supplier in a region at once and an idiosyncratic component that hits individual links independently, and how much of the loss intermediation can offset depends on which component drives the increase. Figure 8 reassigns the entire risk increase to the location-wide component, holding the total marginal probability comparable to the baseline exercise. The mitigation share falls sharply. Under the estimated, idiosyncratic-dominated structure, intermediation absorbs close to half of the profit loss, lowering a 10% shock's loss from 6.5% to 3.5%; under a purely location-wide increase, it absorbs only about one-fifth, from 14.0% to 10.9%. Intermediation is less effective here because its main lever, the within-location diversification advantage, cannot insure against a shock common to an entire region. It still helps, however, through a distinct margin: consistent with Proposition 4, producers spread exposure across source locations, opening additional (often intermediated) locations so that a region-wide disruption in one origin can be partly substituted from another. Location-wide risk is also more damaging in absolute terms, roughly tripling the baseline profit loss at a 40% increase, but the point here is coverage: intermediation offsets a large share of idiosyncratic risk and a smaller yet non-trivial share of systemic risk. Because the estimated cross-link correlation is low ($\widehat{\rho} \approx 0.09$), the economy sits close to the idiosyncratic pole, where intermediation is most effective.

Intermediation Markups. Finally, I assess how the level of intermediation markups shapes resilience. Figure 9 repeats the aggregate risk exercise under three values of the brokerage fee κ:

FIGURE 9. Sensitivity to Intermediation Markups



Notes: The figure reports percent changes in aggregate firm profits (left) and the consumer price index (right) as foreign disruption risk rises. The red line shuts down intermediation. The solid blue line is the estimated economy with $\kappa = 1.25$. The dashed and dotted blue lines re-solve the economy with $\kappa = 1.1$ and $\kappa = 1.4$, respectively, holding other estimated parameters fixed.

the baseline calibration ($\kappa = 1.25$), a low-markup case at $\kappa = 1.1$ (the Chilean export premium), and a high-markup case at $\kappa = 1.4$, close to developed-country wholesale margins (Ganapati 2024; Alexander et al. 2024). These bracket the empirical range discussed above. Changes in κ have small effects relative to shutting down intermediation. Higher markups attenuate this mitigation because intermediation becomes attractive in fewer sourcing states, and the effect is monotone in κ. Even at $\kappa = 1.4$, the economy with intermediaries remains much closer to the baseline economy than to the no-intermediation counterfactual for moderate risk increases. The central conclusion is therefore robust: the resilience value of intermediaries comes primarily from their sourcing technology rather than from assuming particularly low brokerage fees.

5. Conclusion

Global sourcing exposes firms to frequent disruptions abroad, yet diversifying suppliers directly is affordable only for the largest producers. This paper examines how trade intermediaries provide an alternative source of supply chain resilience. Combining Chilean firm-to-firm trade data with a quantitative model of global sourcing, I show that intermediaries maintain larger and more stable supplier networks than producers, and that sourcing shifts toward them where disruption risk is higher.

Three lessons emerge. First, intermediation is a quantitatively important margin of supply chain resilience: intermediaries absorb close to half of the aggregate loss in firm profits and consumer

prices from higher global risk, and this insurance value grows as disruptions become more likely. Second, the gains stem mainly from the breadth of intermediaries' supplier networks rather than from the stability of their individual links, and in the model they reach the producers that could not profitably diversify on their own. Third, the protection that intermediaries offer has clear limits: it is most effective against idiosyncratic, link-level disruptions and considerably weaker against location-wide shocks that strike an entire region at once.

These findings carry implications for policy and future research. The resilience value of intermediation does not depend on assuming low brokerage fees: varying the markup within its empirical range changes the mitigation only modestly relative to removing intermediation altogether. Evaluating policies that target the intermediation sector would require endogenizing brokerage fees and intermediaries' networks, a natural direction for future research, together with how intermediaries interact with inventory management and transportation logistics. More broadly, since the value of each adaptation strategy depends on the nature of the underlying disruptions, a sharper understanding of the risks firms face, and of how they propagate through supply chains, is a first-order input into the design of resilience policy.

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Online Appendix

A. Anecdotal Evidence on Intermediaries

A.1. Selected Quotes

"Our global supply chain connects thousands of suppliers and vendors with leading brands and retailers, all with the goal of meeting consumer demand. We focus on managing complexity and risk to maximize your profitability."

– Li & Fung, leader intermediary in apparel [link]

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

– Univar Solutions, leader intermediary in chemicals [link]

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

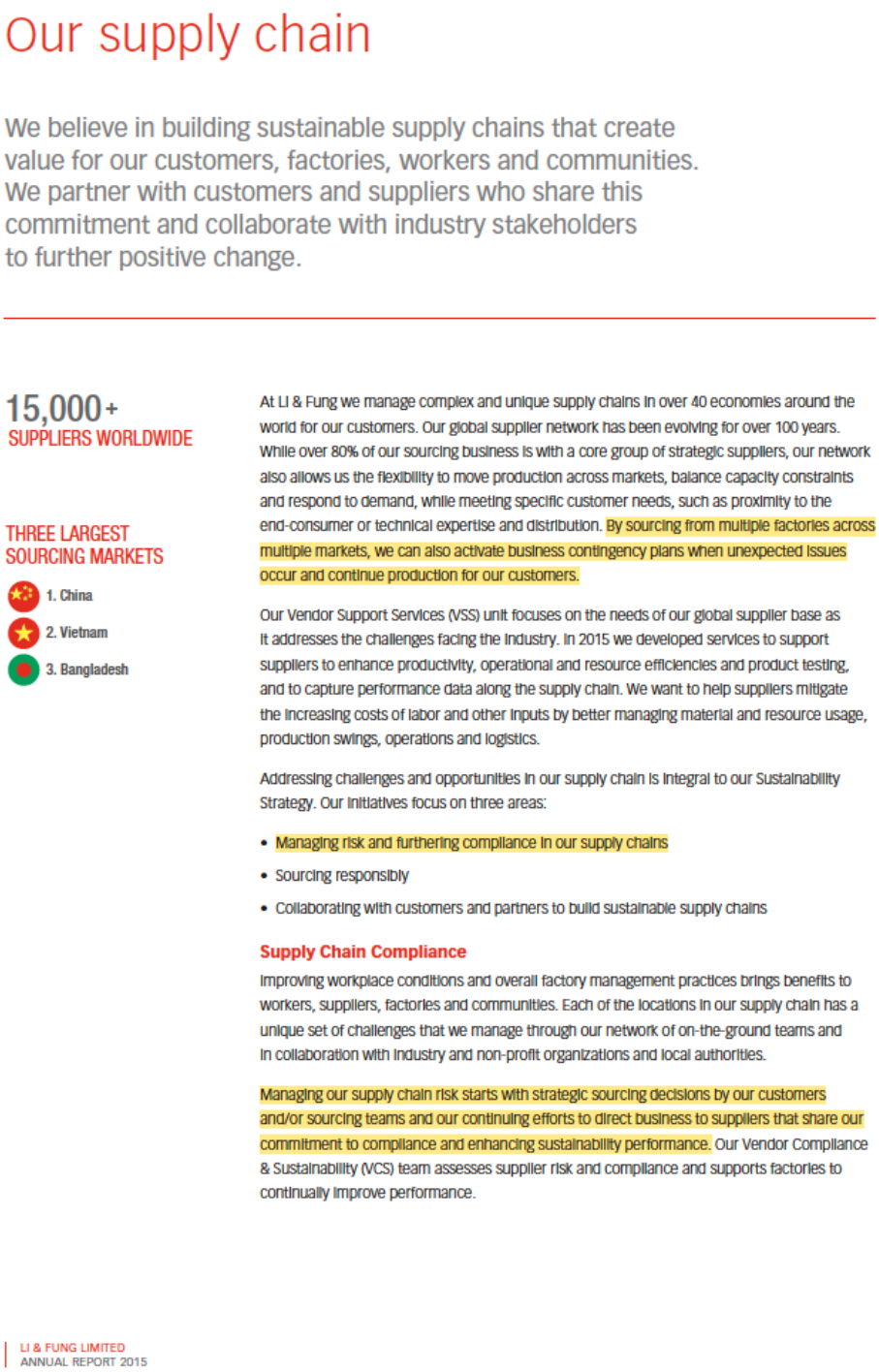
– Interviews with clothing supply chain actors using intermediaries,
Vedel & Ellegaard (2013) [link]

"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."

– Article on industrial intermediaries, Boston Consulting Group (2023) [link]

A.2. Intermediaries' Annual Reports

FIGURE A1. Li & Fung – Annual Report (2015)



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 activate 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 swings, 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.

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ANNUAL REPORT 2015

FIGURE A2. Univar Solutions – End of Year Note to Customers (2021)

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.

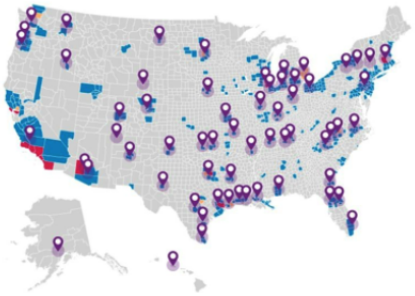
2021 has taught us a lot about the global production base and supply chains. We have been nimble and challenged like most; but we have learned a lot in the process. We are using those learnings and focusing on improving your customer experience.

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**

B. Empirical Appendix

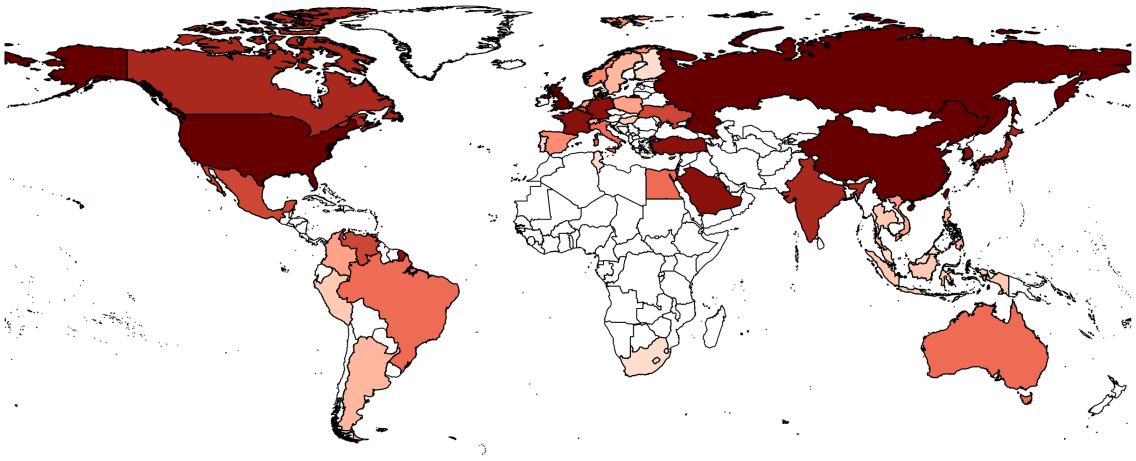
B.1. Comparison of Risk Measures

TABLE A1. Pairwise Correlations across Risk Measures (origin-country level)

	Geopolitical Risk	Economic Uncertainty	Trade Volatility
Geopolitical Risk	1.000	–	–
Economic Uncertainty	0.422	1.000	–
Trade Volatility	0.343	0.401	1.000

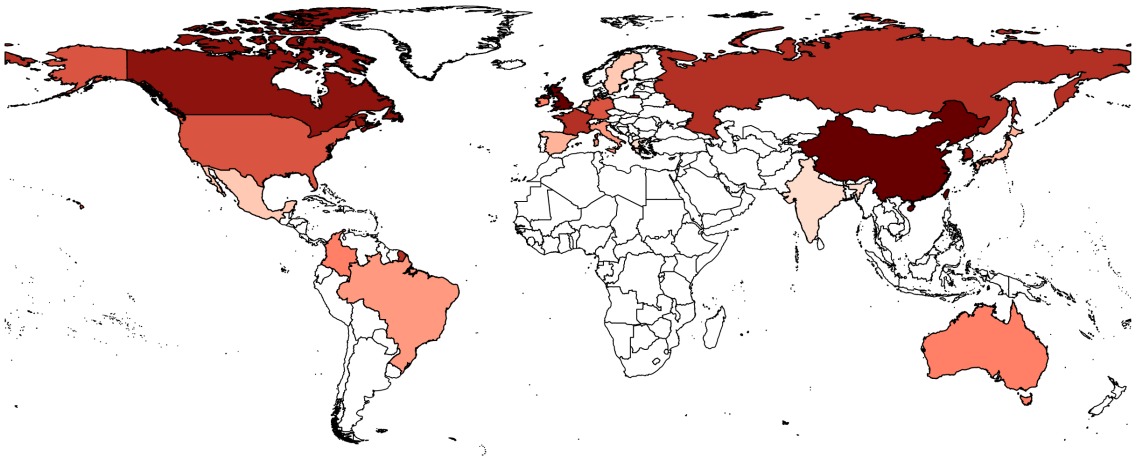
Notes: This table presents pairwise correlations for the three risk measures defined in Section 2.1 in year 2019. The Geopolitical Risk (GPR) and Economic Policy Uncertainty (EPU) indexes are defined at the origin-country level. Trade Volatility is built across origin-products and then aggregated at the country level to compute correlations.

FIGURE A3. Geopolitical Risk Index (GPR)



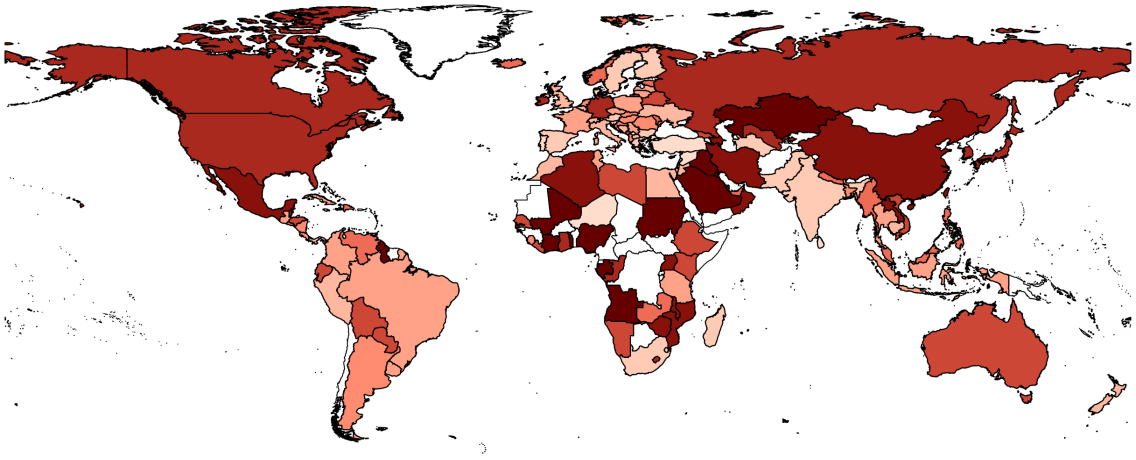
Notes: This figure displays a heat map for the Geopolitical Risk (GPR) index developed by Caldara and Iacoviello (2022), using data for 2019. The index is normalized between 0 and 1, and the map considers 10 levels of intensity.

FIGURE A4. Economic Policy Uncertainty Index (EPU)



Notes: This figure displays a heat map for the Economic Policy Uncertainty (EPU) index developed by Baker et al. (2016), using data for 2019. The index is normalized between 0 and 1, and the map considers 10 levels of intensity.

FIGURE A5. Trade Volatility Index



Notes: This figure displays a heat map for the Trade Volatility index developed in Section 2.1, considering data for 2019. The index is built across origin-products and then aggregated at the origin-country level. The map considers 10 levels of intensity.

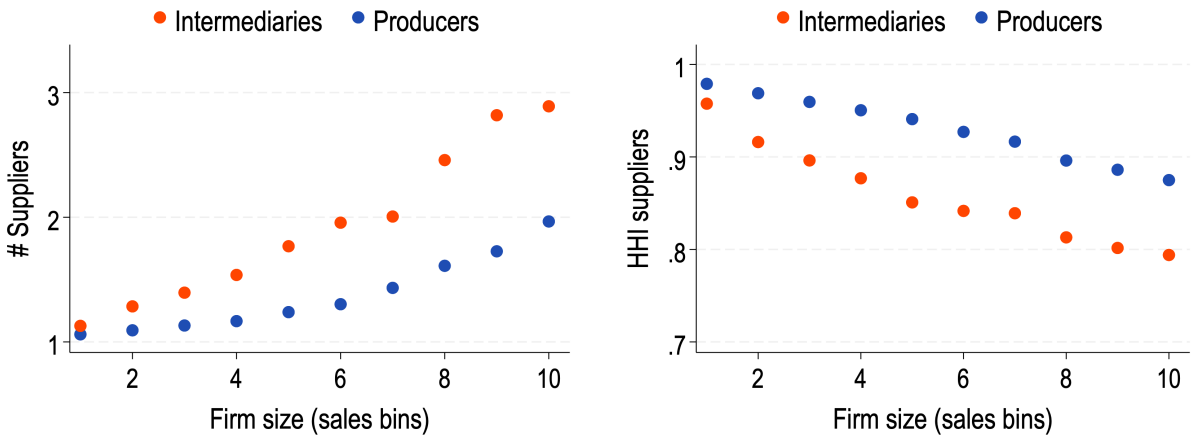
B.2. Additional Evidence on Stylized Facts

TABLE A2. Number and Concentration of Suppliers (homogeneous goods)

	(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

Notes: This table replicates Table 5 for the subsets of homogeneous goods according to the Rauch classification. Columns (1) and (3) exclude products classified as *differentiated* from the sample. Columns (2) and (4) consider only goods classified as *homogeneous* (i.e., goods traded on an organized exchange or where a reference price is available). All regressions are at the firm-product (HS6)-origin country level. The independent variable is a dummy indicating whether the buyer is a wholesaler. The sample includes all import transactions in Chile in 2019. Standard errors are clustered at the firm level.

FIGURE A6. Number and Concentration of Suppliers (weighted average)



A. # suppliers per firm-product-origin

B. Input Concentration across suppliers

Notes: Panel A displays the number of suppliers that a firm has per product (HS6) and origin country. Panel B computes a Herfindahl-Hirschman index (HHI) across suppliers. Each panel groups firms into 10 bins according to total sales (Tax Authority of Chile, SII). Within each bin, a dot represents the mean value of the variable on the y-axis. Since firms source multiple products from multiple countries, I consider the weighted-average across products and origin countries within a firm. Weights are determined by imported values, reducing the influence of peripheral inputs and markets. The figure considers cross-sectional data for year 2019.

TABLE A3. Probability of Supply Link Separations (demand controls)

	Firm-product-country			Firm-product-country-supplier		
	(1)	(2)	(3)	(4)	(5)	(6)
Intermediary dummy	-0.078***	-0.051***	-0.063***	-0.060***	-0.036***	-0.048***
	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
Δ Firm-level imports	Yes	No	No	Yes	No	No
Δ Product-level imports (HS4)	No	Yes	No	No	Yes	No
Δ Firm-level suppliers	No	No	Yes	No	No	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	208,615	284,115	400,938	320,697	400,938

Notes: This table replicates Table 6 including controls for changes in demand conditions across buyers: changes in firm-level imports and suppliers. The dependent variable is a dummy indicating whether supply links break from period t to $t+1$. The independent variable indicates whether the buyer is a wholesaler. The sample considers all import transactions in 2018 for firms active in both 2018 and 2019. Standard errors are clustered at the firm level.

TABLE A4. Potential Mechanisms for Differences in Link Separations

	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
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

Notes: This table explores mechanisms behind the lower supplier separation rates of intermediaries. Column (1) is identical to column (6) in Table 6. Column (2) includes supplier fixed effects to account for the possibility that intermediaries are better at screening suppliers. Column (3) controls for the share of buyers in suppliers' total sales to address whether intermediaries are more important customers. Column (4) defines supply links at the buyer-supplier-product level to assess if differences are driven by intermediaries sourcing multiple products per supplier. Column (5) combines all potential mechanisms.

TABLE A5. Number of Suppliers and Supply Chain Risk (Producers)

	(log) # suppliers					
	Geopolitical Risk		Economic Policy 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 (sales)	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

Notes: This table shows how the number of suppliers of producers varies with supply chain risk. All regressions are at the firm-product (HS6)-origin country level. Geopolitical Risk and Economic Policy Uncertainty are measured at the origin-country level, while Trade Volatility is at the origin country-product level. Controls include firm sales (10 bins), imports per buyer-product-origin, and the origin country's total factor productivity and trade costs. The sample includes all import transactions by Chilean producers in 2019. Standard errors are clustered at the level of the risk measure.

TABLE A6. Number of Direct Suppliers by Producer Size (Terciles)

	(log) # direct suppliers					
	Geopolitical Risk		Economic Uncertainty		Trade Volatility	
	(1)	(2)	(3)	(4)	(5)	(6)
Supply chain risk	-0.057	-0.070	-0.038	-0.040	-0.034***	-0.036***
	(0.074)	(0.078)	(0.038)	(0.039)	(0.005)	(0.005)
× Firm size (2nd tercile)	0.061***	0.059***	0.030	0.030	0.032***	0.032***
	(0.012)	(0.012)	(0.023)	(0.023)	(0.002)	(0.002)
× Firm size (3rd tercile)	0.092***	0.088***	0.001	0.002	0.070***	0.070***
	(0.024)	(0.024)	(0.032)	(0.032)	(0.003)	(0.003)
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
Origin country - product FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm - year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	244,147	240,686	212,957	212,957	244,473	244,211

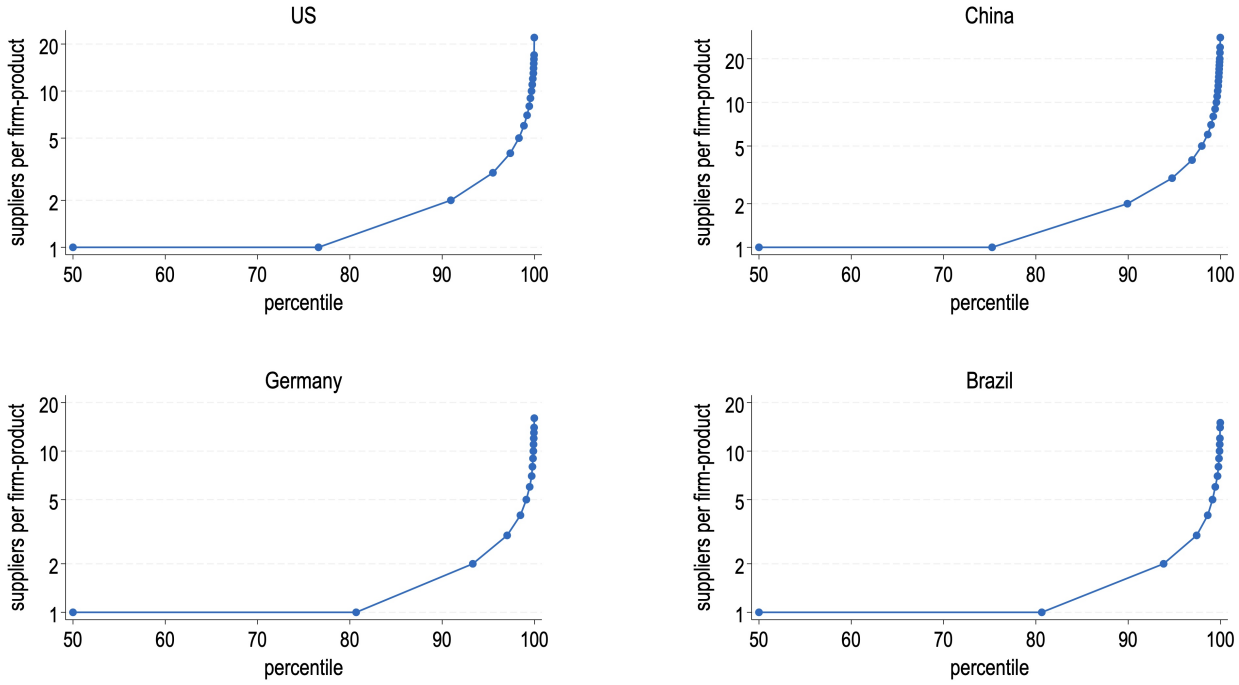
Notes: This table replicates Table 7, interacting each risk measure with indicators for the second and third terciles of producer size instead of an above-median indicator. Producer size is measured by total imports in the initial period. All columns include origin country-product and firm-year fixed effects, and controls for changes in the origin country's total factor productivity and trade costs, and in total imports by product. The sample stacks Chilean producers in 2014 and 2019. Risk measures are standardized. Standard errors are clustered at the level of the risk measure.

TABLE A7. Correlation across Supply Link Separations (firm-origin-product)

	Average correlation (ρ)				
	1 supplier	2 suppliers	3 suppliers	4 suppliers	5 suppliers
All firms	–	0.067	0.090	0.092	0.085
Producers	–	0.093	0.094	0.103	0.109
Wholesalers	–	0.051	0.088	0.085	0.071

Notes: This table reports the average correlation across link separations at the buyer-origin country-product (HS6) level. The analysis is conducted separately for observations with $N = \{2, 3, 4, 5\}$ suppliers. The probabilistic event is represented by a binary variable indicating whether a link active in period t will break in $t + 1$. Pairwise correlations are computed for each combination of links (i, j) given N, such that ρ reports the average across pairs. The sample includes all producers in 2018 that remain active in 2019.

FIGURE A7. Number of Direct Suppliers in Selected Countries



Notes: Each panel plots the number of direct suppliers per firm-product against the within-origin percentile of producers, for a top origin (United States, China, Germany, Brazil), among Chilean producers importing directly in 2019. Most producers source a given product from a single supplier; only a small right tail multi-sources.

C. Theory Appendix

C.1. Proof of Proposition 1

Using the probability of network operability in (8), expected profits net of matching costs under direct sourcing are

$$\pi_i^D(\varphi, S) = A_{i\ell}\varphi^{\sigma-1}\rho_\ell^D(S) - f_\ell^D(S), \qquad A_{i\ell} = B_i(\tau_\ell\alpha_\ell)^{1-\sigma},$$

where $\rho_\ell^D(S) = (1-\xi_\ell^D)[1-(\zeta_\ell^D)^S]$. I hold final demand B_i fixed. Consider two firms with productivity levels $\varphi^H > \varphi^L$ that, conditional on direct sourcing, choose to match with $S^{D,H}$ and $S^{D,L}$ suppliers. These choices are optimal only if

$$A_{i\ell}(\varphi^H)^{\sigma-1}\rho_\ell^D(S^{D,H}) - f_\ell^D(S^{D,H}) \geq A_{i\ell}(\varphi^H)^{\sigma-1}\rho_\ell^D(S^{D,L}) - f_\ell^D(S^{D,L}), \tag{A1}$$

$$A_{i\ell}(\varphi^L)^{\sigma-1}\rho_\ell^D(S^{D,L}) - f_\ell^D(S^{D,L}) \geq A_{i\ell}(\varphi^L)^{\sigma-1}\rho_\ell^D(S^{D,H}) - f_\ell^D(S^{D,H}). \tag{A2}$$

Combining inequalities (A1) and (A2), we obtain

$$A_{i\ell}\big[(\varphi^H)^{\sigma-1} - (\varphi^L)^{\sigma-1}\big]\big[\rho_\ell^D(S^{D,H}) - \rho_\ell^D(S^{D,L})\big] \geq 0.$$

Since $\sigma > 1$, this implies $\rho_\ell^D(S^{D,H}) \geq \rho_\ell^D(S^{D,L})$. Operability is strictly increasing in the number of suppliers when $0 < \zeta_\ell^D < 1$ and $\xi_\ell^D < 1$, so $S^{D,H} \geq S^{D,L}$. At equal productivities, the same ranking follows by selecting the same optimum when firms are indifferent. If there is no link risk, additional suppliers provide no insurance and strictly increasing matching costs select one supplier. If input access is impossible, no producer incurs a positive sourcing investment.

The argument also applies to the supplier-heterogeneity extension in Section 3.4. Replace $\rho_\ell^D(S)$ by $\Lambda_\ell^D(S) = \mathbb{E}[K^{(\sigma-1)/\theta}]$, where K is the operational supplier count, and set $A_{i\ell} = B_i(\gamma\tau_\ell\alpha_\ell)^{1-\sigma}$. An additional potential supplier weakly increases K for every realization of the existing links and strictly increases the capability moment whenever the new link can survive. The same two optimality inequalities therefore imply a weakly larger direct network for more productive firms.

C.2. Proof of Proposition 2

Part (a). Consider expected input costs under the two sourcing modes. With identical suppliers, the inverse-price terms in (9) and (10) are proportional to $\rho_\ell^D(S)$ and $\kappa_\ell^{1-\sigma}\rho_\ell^I(S_\ell^I)$, respectively, where $\rho_\ell^M(S) = (1-\xi_\ell^M)[1-(\zeta_\ell^M)^S]$. The equivalent number of direct suppliers equates these terms:

$$(1-\xi_\ell^D)\big[1-(\zeta_\ell^D)^{\widetilde{S}_\ell^I}\big] = \kappa_\ell^{1-\sigma}(1-\xi_\ell^I)\big[1-(\zeta_\ell^I)^{S_\ell^I}\big].$$

Solving for $\widetilde{S}^I_\ell$ gives

$$\widetilde{S}^I_\ell = \frac{\log\left[1 - \dfrac{\kappa_\ell^{1-\sigma}(1-\xi^I_\ell)[1-(\zeta^I_\ell)^{S^I_\ell}]}{1-\xi^D_\ell}\right]}{\log \zeta^D_\ell}. \tag{A3}$$

Appendix C.8 gives the conditions for a finite equivalent count. Since direct operability increases with S, a network below this count satisfies

$$\rho^D_\ell(S) < \kappa_\ell^{1-\sigma}\rho^I_\ell(S^I_\ell) < \rho^I_\ell(S^I_\ell).$$

The second inequality follows from $\kappa_\ell > 1$ and $\sigma > 1$. Intermediation therefore increases the probability of input access and lowers expected input costs, $\{\mathbb{E}[(p^{x,M}_{i\ell})^{1-\sigma}]\}^{1/(1-\sigma)}$, despite its brokerage fee. This compares operating returns; the choice of sourcing mode also depends on fixed investments.

Part (b). Expected profits net of network investments under the two modes are

$$\pi^D_i(\varphi, S) = A_{i\ell}\varphi^{\sigma-1}\rho^D_\ell(S) - f^D_\ell(S),$$
$$\pi^I_i(\varphi) = A_{i\ell}\varphi^{\sigma-1}\kappa_\ell^{1-\sigma}\rho^I_\ell(S^I_\ell) - f^I_\ell,$$

where $A_{i\ell} = B_i(\tau_\ell\alpha_\ell)^{1-\sigma}$ and final demand B_i is fixed. Consider two firms with productivity levels $\varphi^H > \varphi^L$. I show by contradiction that the more productive firm cannot use intermediation while the less productive firm sources directly. If the latter chooses $S^{D,L}$ suppliers, these choices require

$$A_{i\ell}(\varphi^H)^{\sigma-1}\rho^D_\ell(S^{D,L}) - f^D_\ell(S^{D,L}) \le A_{i\ell}(\varphi^H)^{\sigma-1}\kappa_\ell^{1-\sigma}\rho^I_\ell(S^I_\ell) - f^I_\ell, \tag{A4}$$
$$A_{i\ell}(\varphi^L)^{\sigma-1}\rho^D_\ell(S^{D,L}) - f^D_\ell(S^{D,L}) \ge A_{i\ell}(\varphi^L)^{\sigma-1}\kappa_\ell^{1-\sigma}\rho^I_\ell(S^I_\ell) - f^I_\ell. \tag{A5}$$

The first inequality compares intermediation with the direct network chosen by the less productive firm, which is also available to the more productive firm. Combining the inequalities gives

$$A_{i\ell}\big[(\varphi^H)^{\sigma-1} - (\varphi^L)^{\sigma-1}\big]\big[\kappa_\ell^{1-\sigma}\rho^I_\ell(S^I_\ell) - \rho^D_\ell(S^{D,L})\big] \ge 0.$$

This requires $\kappa_\ell^{1-\sigma}\rho^I_\ell(S^I_\ell) \ge \rho^D_\ell(S^{D,L})$. However, since $f^I_\ell < f^D_\ell(1) \le f^D_\ell(S^{D,L})$, the less productive firm would then earn strictly higher profits under intermediation, contradicting (A5).

I now derive the productivity threshold where producers switch from indirect to direct sourcing. A direct network can cross the indirect profit curve from below only if $\rho^D_\ell(S) > \kappa_\ell^{1-\sigma}\rho^I_\ell(S^I_\ell)$, or

equivalently $S > \widetilde{S}^I_\ell$. For such a network, equating expected profits yields

$$\varphi^*_\ell(S) = \left[\frac{f^D_\ell(S) - f^I_\ell}{A_{i\ell}[\rho^D_\ell(S) - \kappa^{1-\sigma}_\ell \rho^I_\ell(S^I_\ell)]}\right]^{1/(\sigma-1)}. \tag{A6}$$

The switching threshold is the first of these crossings:

$$\varphi^*_\ell = \min_{\substack{S\in\{1,\ldots,|\mathcal{S}_\ell|\} \\ S>\widetilde{S}^I_\ell}} \varphi^*_\ell(S). \tag{A7}$$

A direct option that generates this crossing continues to dominate intermediation at higher productivity. If there is no direct option with a greater operating return, intermediation dominates all direct networks and the cutoff is infinite.

To determine whether producers source at all, consider the productivity levels at which expected profits are zero:

$$\varphi^D_\ell(S) = \left[\frac{f^D_\ell(S)}{A_{i\ell}\rho^D_\ell(S)}\right]^{1/(\sigma-1)}, \tag{A8}$$

$$\varphi^I_\ell = \left[\frac{f^I_\ell}{A_{i\ell}\kappa^{1-\sigma}_\ell \rho^I_\ell(S^I_\ell)}\right]^{1/(\sigma-1)}. \tag{A9}$$

Intermediation is used over a nonempty productivity interval when its profits reach zero before those of every direct alternative. From (A8) and (A9), this requires

$$\frac{\kappa^{1-\sigma}_\ell \rho^I_\ell(S^I_\ell)}{f^I_\ell} > \max_{S\in\{1,\ldots,|\mathcal{S}_\ell|\}} \frac{\rho^D_\ell(S)}{f^D_\ell(S)}. \tag{A10}$$

This is equivalent to $\varphi^I_\ell < \varphi^*_\ell$. It provides a technological condition for intermediation to take place: its resilience and lower contracting costs must compensate for the brokerage fee. Producers below φ^I_ℓ do not source, those between φ^I_ℓ and φ^*_ℓ use intermediaries, and those above a finite φ^*_ℓ source directly. Positive masses in both modes additionally require a productivity distribution with positive mass in the corresponding intervals.

The sorting argument in part (b) extends to heterogeneous suppliers by replacing $\rho^M_\ell(S)$ with $\Lambda^M_\ell(S) = \mathbb{E}[K^{(\sigma-1)/\theta}]$ and $A_{i\ell}$ with $B_i(\gamma\tau_\ell\alpha_\ell)^{1-\sigma}$. The expected-cost comparison then includes gains from supplier cost draws as well as insurance; it need not imply the reliability ranking in part (a).

C.3. Proof of Proposition 3

Part (a). From Proposition 2, the productivity cutoff above which indirect sourcing generates positive expected profits is

$$\varphi_\ell^I(\zeta) = \left[\frac{\kappa_\ell^{\sigma-1} f_\ell^I}{A_{i\ell}(1-\xi_\ell^I)[1-(\mu_\ell\zeta)^{S_\ell^I}]} \right]^{1/(\sigma-1)},$$

where $\zeta \equiv \zeta_\ell^D$, $\zeta_\ell^I = \mu_\ell\zeta$, $0 < \mu_\ell \leq 1$, and $A_{i\ell} = B_i(\tau_\ell\alpha_\ell)^{1-\sigma}$. I increase ζ holding μ_ℓ, location-shock probabilities, final demand, and all other primitives fixed. As stated in the proposition, both modes are initially used: $\varphi_\ell^I < \varphi_\ell^* < \infty$. Condition (A10) gives the technological restriction for the first inequality. I assume positive density of producers around both cutoffs.

Differentiating the indirect participation cutoff gives

$$\frac{d\varphi_\ell^I(\zeta)}{d\zeta} = \frac{\varphi_\ell^I(\zeta)}{\sigma-1} \frac{S_\ell^I \mu_\ell^{S_\ell^I} \zeta^{S_\ell^I-1}}{1-(\mu_\ell\zeta)^{S_\ell^I}} > 0.$$

The minimum productivity required to source indirectly therefore rises. For a sufficiently small increase to $\zeta' > \zeta$, continuity ensures $\varphi_\ell^I(\zeta') < \varphi_\ell^*(\zeta')$. Producers between $\varphi_\ell^I(\zeta)$ and $\varphi_\ell^I(\zeta')$ can no longer cover the intermediary's contracting cost, and direct sourcing is also unprofitable for them. These marginal indirect buyers stop sourcing.

Part (b). Consider now the threshold at which a direct network with S suppliers yields the same expected profits as intermediation. From (A6),

$$\varphi_\ell^*(S,\zeta) = \left[\frac{f_\ell^D(S) - f_\ell^I}{A_{i\ell} g_\ell(S,\zeta)} \right]^{1/(\sigma-1)},$$

where the difference in expected operating returns is

$$g_\ell(S,\zeta) = (1-\xi_\ell^D)(1-\zeta^S) - \kappa_\ell^{1-\sigma}(1-\xi_\ell^I)[1-(\mu_\ell\zeta)^{S_\ell^I}].$$

Only networks with $g_\ell(S,\zeta) > 0$ can define the switching cutoff. Differentiating their crossings gives

$$\frac{\partial\varphi_\ell^*(S,\zeta)}{\partial\zeta} = -\frac{\varphi_\ell^*(S,\zeta)}{\sigma-1} \frac{\partial g_\ell(S,\zeta)/\partial\zeta}{g_\ell(S,\zeta)},$$

with

$$\frac{\partial g_\ell(S,\zeta)}{\partial \zeta} = -(1-\xi_\ell^D)S\zeta^{S-1} + \kappa_\ell^{1-\sigma}(1-\xi_\ell^I)S_\ell^I \mu_\ell^{S_\ell^I}\zeta^{S_\ell^I-1}.$$

Thus the crossing moves to higher productivity when the expected operating-return advantage of direct sourcing falls. Equivalently,

$$\frac{S_\ell^I}{S}\mu_\ell^{S_\ell^I}\zeta^{S_\ell^I-S} < \kappa_\ell^{\sigma-1}\frac{1-\xi_\ell^D}{1-\xi_\ell^I}.$$

This is the more general condition for the switching response. To establish the sufficient conditions in the proposition, consider a network defining the mode cutoff with $S_\ell^I \geq S$. Since $1-(\mu_\ell\zeta)^{S_\ell^I} \geq 1-\zeta^S$, a positive $g_\ell(S,\zeta)$ implies that the right-hand side exceeds one. When $\zeta < 1/2$, the left-hand side is at most one because $(S_\ell^I/S)\zeta^{S_\ell^I-S} \leq 1$ and $\mu_\ell \leq 1$. The crossing therefore increases with risk.

The mode cutoff is the lowest crossing across direct networks. The same argument applies to every network defining that cutoff, including ties, so φ_ℓ^* rises locally. This result continues along a risk interval if the network-size condition remains satisfied at the cutoff. For a sufficiently small increase from ζ to ζ', $\varphi_\ell^I(\zeta') < \varphi_\ell^*(\zeta)$. Producers between $\varphi_\ell^*(\zeta)$ and $\varphi_\ell^*(\zeta')$ therefore switch from direct to indirect sourcing.

Part (c). Consider the productivity cutoff that equates expected profits from S and $S+1$ direct suppliers. The additional link preserves input access when all S existing links fail, the new link survives, and no location shock occurs. The cutoff is therefore

$$\varphi_{\ell,S+1}^D(\zeta) = \left[\frac{f_\ell^D(S+1) - f_\ell^D(S)}{A_{i\ell}(1-\xi_\ell^D)\zeta^S(1-\zeta)}\right]^{1/(\sigma-1)}. \tag{A11}$$

Producers above this cutoff prefer $S+1$ to S suppliers, while the opposite holds below it. Differentiating with respect to link risk gives

$$\frac{d\varphi_{\ell,S+1}^D(\zeta)}{d\zeta} = -\frac{\varphi_{\ell,S+1}^D(\zeta)}{\sigma-1}\frac{S-(S+1)\zeta}{\zeta(1-\zeta)} < 0 \quad \text{for } \zeta < \frac{S}{S+1}.$$

The condition holds for every increment from $S \geq 1$ when $\zeta < 1/2$. Since matching costs are unchanged, every additional supplier becomes more attractive relative to the existing network. Summing these marginal gains gives the same increasing-differences property for nonadjacent supplier counts. Hence continuing direct buyers choose weakly larger networks, even when some counts are never optimal. At indifference, selecting the smallest optimal supplier count throughout the comparison gives this ranking; the same is true for the largest.

C.4. Proof of Proposition 4

I first show that expected sourcing capability is non-decreasing in productivity. From (14), expected profits net of network investments under a sourcing strategy ϑ are

$$\pi_i(\varphi, \vartheta) = B_i \varphi^{\sigma-1} \mathbb{E}_Z\big[\Theta^t \mid \vartheta\big] - F(\vartheta), \qquad t = \frac{\sigma - 1}{\eta - 1} > 0,$$

where $F(\vartheta)$ sums fixed sourcing costs across locations and B_i is held fixed. Consider two firms with productivities $\varphi^H > \varphi^L$. Denote their optimal sourcing strategies by ϑ^H and ϑ^L. Optimality requires

$$\begin{aligned} B_i(\varphi^H)^{\sigma-1}\mathbb{E}_Z[\Theta^t \mid \vartheta^H] - F(\vartheta^H) &\geq B_i(\varphi^H)^{\sigma-1}\mathbb{E}_Z[\Theta^t \mid \vartheta^L] - F(\vartheta^L), \\ B_i(\varphi^L)^{\sigma-1}\mathbb{E}_Z[\Theta^t \mid \vartheta^L] - F(\vartheta^L) &\geq B_i(\varphi^L)^{\sigma-1}\mathbb{E}_Z[\Theta^t \mid \vartheta^H] - F(\vartheta^H). \end{aligned}$$

Combining both inequalities, we obtain

$$B_i\big[(\varphi^H)^{\sigma-1} - (\varphi^L)^{\sigma-1}\big]\big\{\mathbb{E}_Z[\Theta^t \mid \vartheta^H] - \mathbb{E}_Z[\Theta^t \mid \vartheta^L]\big\} \geq 0.$$

Since $\sigma > 1$, more productive firms choose a network with weakly greater $\mathbb{E}_Z[\Theta^t]$, the expected sourcing-capability term entering operating profits. This result allows endogenous sourcing modes and does not require $\sigma \geq \eta$.

I next show that, holding sourcing modes fixed, locations and direct supplier networks expand with productivity when $\sigma \geq \eta$. Fix the mode available at each origin. At a direct origin, the choice is a supplier count in $\{0, 1, \ldots, |\mathcal{S}_\ell|\}$, with zero denoting no sourcing. At an indirect origin, the choice is whether to access the intermediary's network. Compare networks using the same location shocks and the same shocks to links they share. Adding a location or a direct supplier then weakly increases the location's contribution $(p_{i\ell}^{x,M})^{1-\eta}$ in every realization.

Consider increases $u, v \geq 0$ in the contributions of two locations, whose initial contributions are x and y, and let $T \geq 0$ be the contribution of the remaining origins. Increasing differences across the two choices require

$$(T + x + u + y + v)^t - (T + x + y + v)^t \geq (T + x + u + y)^t - (T + x + y)^t.$$

This follows from convexity when $t \geq 1$, or $\sigma \geq \eta$. The inequality holds for every realization of disruptions, so it also holds in expectation. Fixed sourcing costs are additive across locations and cancel from this comparison. Expected profits therefore satisfy increasing differences across local sourcing choices. They also satisfy increasing differences between each choice and firm productivity, because a better network raises $\mathbb{E}_Z[\Theta^t]$ while its fixed investment is independent of productivity.

The feasible choices form a finite product of ordered sets. Applying Topkis's monotonicity theorem, the smallest and largest optimal networks are non-decreasing in productivity. Selecting either consistently at indifference gives $L(\varphi^L) \subseteq L(\varphi^H)$ and $S_\ell^D(\varphi^L) \leq S_\ell^D(\varphi^H)$ at every direct origin. When $\sigma = \eta$, expected profits are additive across locations and the choices are independent across origins. The argument also accommodates heterogeneous suppliers, since an additional operational supplier lowers the local input price in (17).

The qualification on sourcing modes is essential to this argument. Direct sourcing can offer a lower price when operational but a higher probability of failure than intermediation, so the two alternatives need not be ordered across disruption realizations. Equal operating returns in a one-location problem do not imply equal returns when other origins are available. The general capability result therefore does not establish an unconditional sorting of sourcing modes at every location.

C.5. Proof of Proposition 5

Consider a producer's entry into location ℓ, holding its sourcing choices at all other locations fixed at $\vartheta_{-\ell}$. Let $\Theta_{-\ell}$ denote the realized sourcing capability from those origins. An option $a \in \{I, D(S)\}$ adds the local contribution $Y_\ell(a) = (p_{i\ell}^{x,a})^{1-\eta}$, which is zero if the local network is unavailable. Define the increase in expected sourcing capability as

$$H_\ell(a; \vartheta_{-\ell}) = \mathbb{E}_Z\left[(\Theta_{-\ell} + Y_\ell(a))^{\frac{\sigma-1}{\eta-1}} - \Theta_{-\ell}^{\frac{\sigma-1}{\eta-1}}\right]. \tag{A12}$$

The expectation is over disruptions at all locations under the fixed choices elsewhere. For readability, write $H_\ell^I = H_\ell(I; \vartheta_{-\ell})$ and $H_\ell^D(S) = H_\ell(D(S); \vartheta_{-\ell})$, and hold B_i fixed. Subtracting the profits from the existing network, expected profits from adding location ℓ are

$$B_i \varphi^{\sigma-1} H_\ell^I - f_\ell^I \quad \text{or} \quad B_i \varphi^{\sigma-1} H_\ell^D(S) - f_\ell^D(S).$$

As assumed before the proposition, the intermediary requires less fixed investment and offers a higher expected operating return per unit of fixed cost:

$$0 < f_\ell^I < f_\ell^D(1), \qquad \frac{H_\ell^I}{f_\ell^I} > \max_S \frac{H_\ell^D(S)}{f_\ell^D(S)}.$$

Equating the incremental profits to zero gives the productivity thresholds for accessing the origin. The condition above implies

$$\varphi_\ell^I(\vartheta_{-\ell}) = \left(\frac{f_\ell^I}{B_i H_\ell^I}\right)^{1/(\sigma-1)} < \min_S \left(\frac{f_\ell^D(S)}{B_i H_\ell^D(S)}\right)^{1/(\sigma-1)} \equiv \underline{\varphi}_\ell^D(\vartheta_{-\ell}).$$

Producers between these cutoffs earn positive incremental profits from intermediation, while no direct network covers its matching cost. They therefore add the location when indirect sourcing is available and leave it out otherwise. A positive mass of such firms requires positive probability in this productivity interval.

The same expression explains the role of risk in entry. A reduction in the intermediary's disruption probabilities preserves weakly more links for any given realization of the underlying shocks. This weakly raises $Y_\ell(I)$ and hence H_ℓ^I, lowering the indirect entry cutoff. Conversely, an increase in disruption probabilities under both modes reduces the expected return from every local option and weakly raises the entry cutoffs. These comparisons keep choices elsewhere and prices conditional on the operational supplier count fixed.

When $\sigma = \eta$, $H_\ell(a; \vartheta_{-\ell}) = \mathbb{E}_Z[Y_\ell(a)]$, independently of the other source locations. The conditional comparisons then give the full location-by-location solution. With sourcing complementarities, the cutoffs also depend on $\vartheta_{-\ell}$, so the proposition concerns entry holding those choices fixed.

C.6. Input Prices with Heterogeneous Suppliers

At each location, the input bundle is

$$x_{i\ell} = \left(\int_0^1 x_{i\ell}(v)^{(\lambda-1)/\lambda}\, dv\right)^{\lambda/(\lambda-1)}.$$

Suppose $k \geq 1$ suppliers are operational. Their efficiencies are independent Fréchet draws with distribution $\exp(-t^{-\theta})$, so the least unit requirement $\varepsilon_{(1)}(v)$ has survival function $\Pr(\varepsilon_{(1)}(v) > e) = \exp(-ke^\theta)$. Conditional on the operational supplier set, the continuum of independent variety draws gives

$$\int_0^1 \varepsilon_{(1)}(v)^{1-\lambda}\, dv = k^{(\lambda-1)/\theta}\Gamma\left(1 + \frac{1-\lambda}{\theta}\right).$$

The moment is finite when $\theta > \lambda - 1$. Taking the $1/(1-\lambda)$ power and multiplying by delivered unit cost gives

$$p_{i\ell}^{x,M}(k) = \kappa_\ell^{\mathbb{I}\{M=I\}} \gamma \tau_\ell \alpha_\ell k^{-1/\theta}, \qquad \gamma = \left[\Gamma\left(1 + \frac{1-\lambda}{\theta}\right)\right]^{1/(1-\lambda)},$$

as in (17). Independence of disruptions and efficiencies is needed so that surviving suppliers retain

this distribution. If $k = 0$, the location input is unavailable and its inverse-price contribution is zero.

C.7. Insurance and Input-Cost Gains

For one location, let z and ξ be the link and location disruption probabilities, set $r = (\sigma - 1)/\theta > 0$, and let K be the number of operational suppliers among S potential links. Write $\Lambda(S, z) = \mathbb{E}[K^r]$ and $\rho(S, z) = (1 - \xi)(1 - z^S)$. Define $b_r(0) = 0$ and $b_r(k) = k^r - 1$ for $k \geq 1$. Then

$$\Lambda(S, z) = \rho(S, z) + \Psi_r(S, z), \qquad \Psi_r(S, z) = \mathbb{E}[b_r(K)].$$

The marginal supplier gain decomposes exactly as

$$\Lambda(S + 1, z) - \Lambda(S, z) = \underbrace{(1 - \xi)z^S(1 - z)}_{d_0(S,z)} + \underbrace{\Psi_r(S + 1, z) - \Psi_r(S, z)}_{d_{\text{cost}}(S,z)}. \tag{A13}$$

The first term is the insurance gain: the new link preserves input access when all previous links fail. The second is the additional gain from obtaining a lower price when more than one supplier is operational. This comparison holds the one-supplier price fixed; the common price factor multiplies both terms.

To establish the risk response, let $q = 1 - z$ and $K_S \sim \text{Binomial}(S, q)$ conditional on avoiding the location shock. Coupling the first S links of the two networks gives

$$\Lambda(S + 1, z) - \Lambda(S, z) = (1 - \xi)q\,\mathbb{E}\big[(K_S + 1)^r - K_S^r\big].$$

If $r \geq 1$, the increment inside the expectation is non-decreasing in K_S. Both q and the expectation weakly increase with survival probability, and the first factor strictly increases. The total marginal supplier gain therefore strictly decreases with z. Direct profits have decreasing differences in risk and supplier count, so the optimal direct count weakly falls.

The same coupling gives

$$d_{\text{cost}}(S, z) = (1 - \xi)q\,\mathbb{E}[b_r(K_S + 1) - b_r(K_S)].$$

For $r \geq 1$, this increment is zero at $K_S = 0$ and non-decreasing thereafter. Hence the cost component also decreases with risk. When $z < S/(S + 1)$, the insurance component increases, so the fall in the cost component more than offsets it. With $0 < r < 1$, the total marginal gain need not decrease with risk. These statements distinguish the direction of the insurance force from the sign of the overall sourcing response.

For direct numerical evaluation, the derivative of supplier capability is

$$\frac{\partial \Lambda(S,z)}{\partial z} = -(1-\xi)S\,\mathbb{E}[(K_{S-1}+1)^r - K_{S-1}^r], \tag{A14}$$

where $K_{S-1} \sim \text{Binomial}(S-1, 1-z)$. Differencing this expression across network sizes gives the risk derivative of each marginal supplier gain.

Multiple Locations. The insurance decomposition also applies when a producer has other input sources. Hold sourcing choices elsewhere fixed, let T denote their realized inverse-price contribution, and write $c = (\kappa^{\mathbb{I}\{M=I\}}\gamma\tau\alpha)^{1-\eta}$, $b = (\eta-1)/\theta$, and $t = (\sigma-1)/(\eta-1)$. The incremental contribution of k operational local suppliers is

$$h(k,T) = (T + ck^b)^t - T^t.$$

Independence across locations gives

$$\mathbb{E}[h(K,T)] = \rho(S,z)\mathbb{E}[h(1,T)] + \mathbb{E}\big[(h(K,T) - h(1,T))\mathbb{I}_{\{K\geq 1\}}\big].$$

The insurance gain from another local link is therefore

$$(1-\xi)z^S(1-z)\mathbb{E}[h(1,T)],$$

which again increases with moderate local link risk. The contribution of additional cost draws depends on the distribution of T. Thus $r \geq 1$ alone no longer determines the sign of the total marginal supplier response when other locations remain available. If firms also change their networks elsewhere, those adjustments change both components.

C.8. Equivalent Direct Suppliers

The equivalent direct count compares expected operating profits before fixed sourcing costs. In the identical-supplier benchmark, extend the operability function to real counts $s \geq 0$ using $\rho_\ell^D(s) = (1-\xi_\ell^D)[1-(\zeta_\ell^D)^s]$. For $0 < \zeta_\ell^D < 1$ and $\xi_\ell^D < 1$, this function is continuous and strictly increasing from zero. A unique finite equivalent count therefore exists if and only if

$$\kappa_\ell^{1-\sigma}\rho_\ell^I(S_\ell^I) < 1 - \xi_\ell^D.$$

When it exists, its closed form is

$$\widetilde{S}_\ell^I = \frac{\log\left[1 - \kappa_\ell^{1-\sigma}\rho_\ell^I(S_\ell^I)/(1-\xi_\ell^D)\right]}{\log \zeta_\ell^D}.$$

Otherwise set $\widetilde{S}_\ell^I = \infty$: no feasible direct network matches intermediation's expected operating profits. A finite count may lie below one, between integers, or above the number of available suppliers; it is a comparison index, not an available sourcing choice.

Holding direct disruption probabilities and σ fixed, the count increases with the intermediary's operability and decreases with its brokerage fee wherever the solution is finite. Higher direct disruption probabilities increase the count when indirect operability is held fixed. Productivity, final demand, and the common delivered supplier price cancel from the comparison; fixed sourcing costs enter only the subsequent mode choice. If $\widetilde{S}_\ell^I < 1$, even one direct supplier delivers lower effective input costs. If $\widetilde{S}_\ell^I \geq |\mathcal{S}_\ell|$, no direct network strictly improves on the indirect operating return and $f_\ell^I < f_\ell^D(1)$ makes intermediation dominate every direct option.

With heterogeneous suppliers, replace operability by the capability moment in (18). Extend that moment to every nonnegative integer count using the same disruption process, and let $\overline{\Lambda}_\ell^D(s)$ linearly interpolate between those counts, including $\Lambda_\ell^D(0) = 0$. In the identical-supplier benchmark, set $\Lambda_\ell^M(S) = \rho_\ell^M(S)$ and $\overline{\Lambda}_\ell^D(s) = \rho_\ell^D(s)$ as above. Both definitions can then be written as

$$\widetilde{S}_\ell^I = \inf\left\{s \geq 0 : \overline{\Lambda}_\ell^D(s) \geq \kappa_\ell^{1-\sigma}\Lambda_\ell^I(S_\ell^I)\right\}, \tag{A15}$$

with the value set to infinity if the set is empty. Interpolation does not change the comparison at any feasible integer count. Under supplier heterogeneity, this comparison includes both insurance and input-cost gains and need not rank network reliability. It ranks operating profits in the one-location problem; fixed costs also enter the mode decision, and multi-location profits generally depend on the full distribution of local input prices.

C.9. Equilibrium

Let $Q_i(\vartheta) = \mathbb{E}[\Theta(\vartheta)^{(\sigma-1)/(\eta-1)}]$ and let $F_i(\vartheta)$ denote total fixed sourcing costs. The value after drawing productivity is

$$V_i(\varphi; B_i) = \max\{0, \max_\vartheta [B_i \varphi^{\sigma-1} Q_i(\vartheta) - F_i(\vartheta)]\}.$$

The sourcing cutoff is $\overline{\varphi}_i(B_i) = \inf\{\varphi : V_i(\varphi; B_i) > 0\}$. Suppose sourcing costs are nonnegative, the choice set is finite with at least one positive-capability strategy, productivity is positive with

a finite $(\sigma - 1)$ moment, and entry costs are positive. Expected entry value is continuous in B_i, zero at $B_i = 0$, and strictly increasing wherever positive. It becomes arbitrarily large as $B_i \to \infty$. The free-entry equation (19) therefore has a unique solution. An optimal sourcing strategy exists, although there may be ties at productivity cutoffs.

Expected revenues per entrant equal

$$\sigma B_i \int \varphi^{\sigma-1} Q_i(\vartheta_i^*(\varphi))\, dG_i(\varphi) = \sigma\left[w_i f_i^e + \int F_i(\vartheta_i^*(\varphi))\, dG_i(\varphi)\right],$$

using free entry and setting $F_i = Q_i = 0$ for firms that exit. Equating aggregate revenues with $E_i = \beta w_i L_i$ gives (20). Under idiosyncratic shocks across the continuum of firms, the CES price index is

$$P_i^{1-\sigma} = N_i^e \left(\frac{\sigma}{\sigma - 1}\right)^{1-\sigma} \int \varphi^{\sigma-1} Q_i(\vartheta_i^*(\varphi))\, dG_i(\varphi).$$

Together, these equations are consistent with the definition of B_i and determine entry and prices. With a fixed numeraire price, the Cobb-Douglas unit-expenditure function is proportional to P_i^{β}. A weak improvement in intermediation raises V_i at every given B_i, so the equilibrium B_i and price index weakly fall under this closure.

C.10. Network Operability under Link and Location Shocks

The baseline disruption structure combines two independent shocks at every source location ℓ under sourcing mode $M \in \{D, I\}$. A location-level shock $Z_\ell^{L,M}$ occurs with probability ξ_ℓ^M and disables every link the buyer holds at ℓ under mode M simultaneously. Conditional on no location shock, each link is independently disabled with probability ζ_ℓ^M, governed by the iid shock Z_ℓ^M. The two shocks are mutually independent and independent across locations.

Let S_ℓ^O denote the number of operational links given a strategy (M_ℓ, S_ℓ^M). The event $S_\ell^O = 0$ occurs either because the location shock fires (with probability ξ_ℓ^M) or because the location shock does not fire but every link is independently disrupted (with probability $(1 - \xi_\ell^M)(\zeta_\ell^M)^{S_\ell^M}$). For $k \geq 1$, the location shock must not have fired, after which the number of surviving links is Binomial with S_ℓ^M trials and success probability $1 - \zeta_\ell^M$. Combining these cases yields the zero-inflated Binomial distribution:

$$\Pr\left(S_\ell^O = k \,\middle|\, M_\ell, S_\ell^M\right) = \begin{cases} \xi_\ell^M + (1 - \xi_\ell^M)(\zeta_\ell^M)^{S_\ell^M} & \text{if } k = 0, \\ (1 - \xi_\ell^M)\binom{S_\ell^M}{k}\left(1 - \zeta_\ell^M\right)^k \left(\zeta_\ell^M\right)^{S_\ell^M - k} & \text{if } 1 \leq k \leq S_\ell^M. \end{cases}$$

This nests the pure Binomial of the iid-only case when $\xi_\ell^M = 0$. Aggregating over $k \geq 1$ gives the

probability of network operability:

$$\Pr\left(S_\ell^O \geq 1 \,\middle|\, M_\ell, S_\ell^M\right) = (1 - \xi_\ell^M)\left[1 - \left(\zeta_\ell^M\right)^{S_\ell^M}\right]. \tag{A16}$$

With supplier heterogeneity, expected operating profits depend on the full distribution of operational supplier counts, not only on the event $S_\ell^O \geq 1$. In the heterogeneous-supplier case, the relevant capability is

$$\Lambda_\ell^M(S) \equiv (1 - \xi_\ell^M) \sum_{k=1}^{S} \binom{S}{k} (1 - \zeta_\ell^M)^k (\zeta_\ell^M)^{S-k} k^{\frac{\sigma-1}{\theta}}, \tag{A17}$$

The corresponding inverse-price moments are

$$\mathbb{E}[(p_{i\ell}^{x,D})^{1-\sigma} \mid S_\ell^D] = \Lambda_\ell^D(S_\ell^D)(\gamma\tau_\ell\alpha_\ell)^{1-\sigma},$$
$$\mathbb{E}[(p_{i\ell}^{x,I})^{1-\sigma}] = \kappa_\ell^{1-\sigma}\Lambda_\ell^I(S_\ell^I)(\gamma\tau_\ell\alpha_\ell)^{1-\sigma}.$$

These generalize (9)–(10) to heterogeneous suppliers. The homogeneous-supplier case is the limiting case $\theta \to \infty$, where the term $k^{(\sigma-1)/\theta}$ converges to one and $\Lambda_\ell^M(S)$ collapses to the operability probability in (A16).

With independent disruptions across locations, expected sourcing capability in the full model is

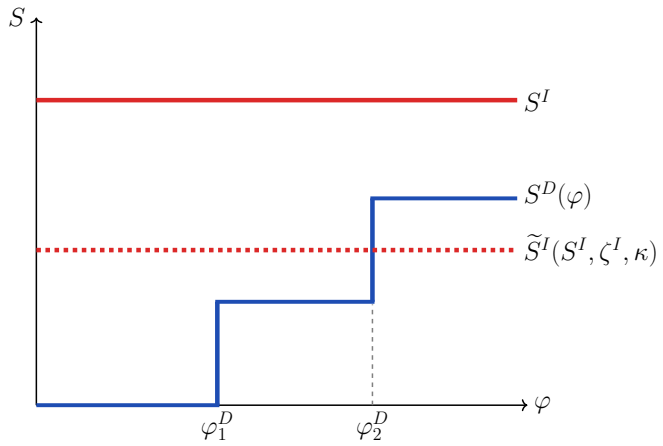
$$\mathbb{E}[\Theta^{\frac{\sigma-1}{\eta-1}}] = \sum_{\{k_\ell\}_{\ell\in L}} \left(\prod_{\ell\in L} \Pr(S_\ell^{O,M_\ell} = k_\ell)\right)\left(\sum_{\ell\in L:\, k_\ell\geq 1} [p_{i\ell}^{x,M_\ell}(k_\ell)]^{1-\eta}\right)^{\frac{\sigma-1}{\eta-1}}. \tag{A18}$$

Each count ranges from zero to the number of contracted suppliers in its location, and the empty operational network contributes zero. In the identical-supplier benchmark, the price is constant whenever $k_\ell \geq 1$, so only operability matters. With heterogeneous suppliers, the number surviving also affects the price. At $\sigma = \eta$, the outer power is one and expected capability is additive across locations.

C.11. Model Figures

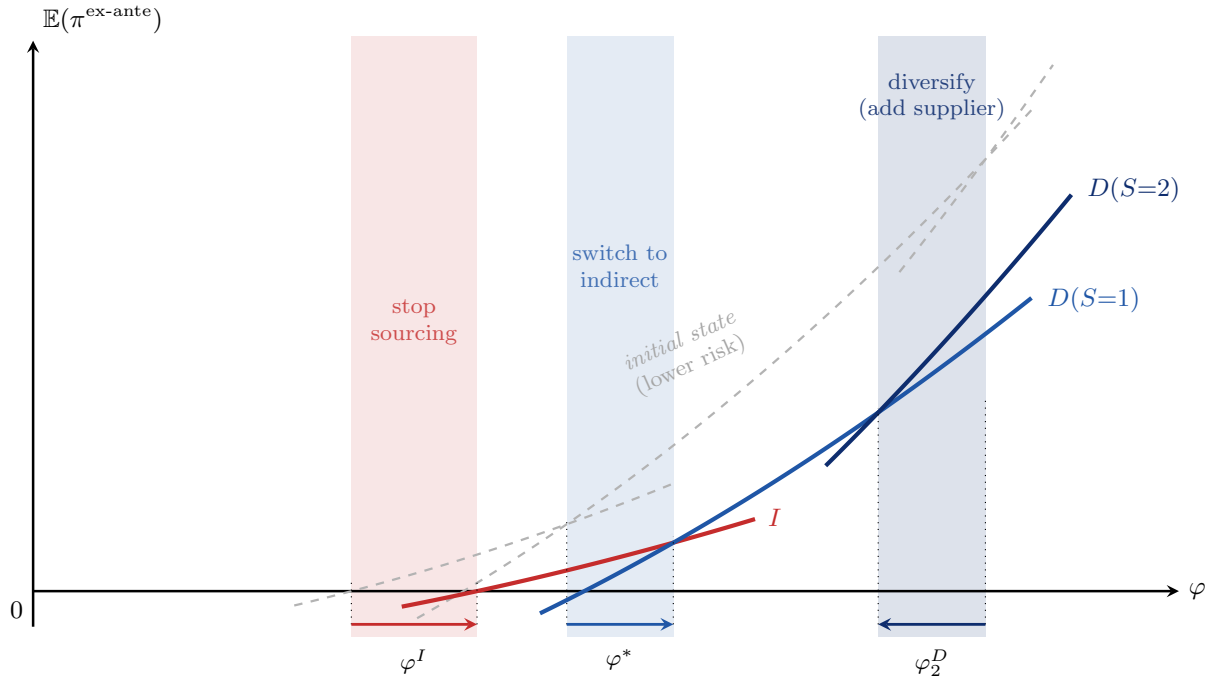
This subsection collects the figures that illustrate producers' optimal sourcing decisions in the one-location case of Section 3.2.

FIGURE A8. Direct and Indirect Suppliers



Notes: The blue line shows the optimal number of suppliers under direct sourcing, $S^D(\varphi)$. The solid red line shows the intermediation technology, which provides access to S^I indirect suppliers. The dashed red line indicates the equivalent direct supplier count $\widetilde{S}^I_\ell$, which matches intermediation's expected operating profits after accounting for network reliability and the brokerage fee. Producers are sorted by productivity on the x-axis.

FIGURE A9. Higher Probability of Disruptions



Notes: The figure illustrates the identical-supplier benchmark under the conditions of Proposition 3. Curves show expected profits under indirect sourcing (I) and direct sourcing with one or two suppliers, before (faint dashed) and after (solid) an increase in link disruption risk. The entry and mode cutoffs move right: marginal indirect buyers stop sourcing, and marginal direct buyers switch to intermediation. The diversification cutoff moves left as backup suppliers become more valuable, inducing some continuing direct buyers to add a second supplier.

D. Estimation Appendix

D.1. Estimation Results

TABLE A8. Elasticity of Substitution across Input Locations

	OLS			IV	
	(1)	(2)	(3)	(4)	(5)
(log) Input prices	-0.248***	-0.224***	-0.251***	-0.378***	-0.514***
	(0.002)	(0.002)	(0.008)	(0.074)	(0.016)
Implied η $(1-\beta)$	1.25	1.22	1.25	1.38	1.51
First-stage F (Kleibergen-Paap)				10.3	15.7
Instrument				Distance	Fuel×Dist
Firm-Year FE	Yes	Yes	No	No	Yes
Firm FE	No	No	Yes	Yes	No
Country-Year FE	No	Yes	No	No	No
Country productivity	No	No	No	Yes	Yes
Sample	2005-19	2005-19	2019	2019	2005-19
Observations	365,505	365,104	22,176	21,805	341,401

Notes: This table uses an empirical counterpart of equation (15) to estimate the elasticity of substitution across input locations (η). The dependent variable is (log) input purchases for a given buyer-origin country-year, the key regressor is (log) input prices, and the estimated coefficients correspond to $1-\eta$. I include firm (firm-year) fixed effects, capturing variation for the same buyer across origins. Columns (1) and (2) use the full panel (2005–2019) and column (3) considers the last year in the sample (2019). Column (4) instruments input prices with geographic distance from Chile (2019), controlling for origin-country productivity. Column (5) uses a time-varying instrument estimated on the full panel, a fuel-cost shifter given by the (log) crude oil price interacted with (log) distance, also controlling for origin-country productivity. The implied $\eta = 1-\beta$ is reported below the coefficients, along with the first-stage Kleibergen–Paap F statistic and the instrument for the IV columns. The table reports robust standard errors; the reported first-stage F statistics are clustered by origin country.

TABLE A9. Supplier Heterogeneity and Input Prices

	OLS				IV
	(1)	(2)	(3)	(4)	(5)
(log) # Suppliers	-0.256***	-0.279***	-0.266***	-0.295***	-0.297***
	(0.003)	(0.003)	(0.011)	(0.012)	(0.083)
Implied θ ($-1/\beta$)	3.90	3.59	3.76	3.39	3.37
First-stage *F* (Kleibergen-Paap)					2,303
Instrument: potential suppliers (origin×HS4)					Yes
Country-Product-Year FE	Yes	Yes	No	No	No
Country-Product FE	No	No	Yes	Yes	Yes
Firm-Year FE	No	Yes	No	No	No
Firm FE	No	No	No	Yes	No
Year FE	No	No	No	No	Yes
Sample	2005-19	2005-19	2019	2019	2005-19
Observations	1,954,843	1,917,790	115,483	112,903	2,200,104

Notes: This table uses an empirical counterpart of equation (17) to estimate the supplier-efficiency dispersion parameter θ. The dependent variable is (log) input prices for a given location (country - HS6 product) and year, the key regressor is the (log) number of suppliers, and the estimated coefficients correspond to $-1/\theta$; the implied θ is reported below the coefficients. Columns (1)–(4) include location or location-year fixed effects, as indicated in the table. Columns (1) and (2) consider the full sample of years, while columns (3) and (4) use the last year available (2019). Column (5) instruments the log supplier count with the log number of distinct foreign exporters selling the same origin-country and HS4 product to Chile in that year. It includes origin-country–HS6 and year fixed effects, and clusters standard errors by origin country and HS4 sector. The Kleibergen–Paap first-stage *F* statistic is reported below the implied θ. The table reports robust standard errors (columns 1–4).

TABLE A10. Location-Specific Trade and Production Unit Costs

	Raw estimates (USD)		Normalized (Chile=1)	
Region	All years (2005-19)	Only 2019	All years (2005-19)	Only 2019
CHN	12.67	17.31	1.93	3.12
EU	74.92	91.03	11.42	16.42
LAT	17.72	14.97	2.70	2.70
ROW	109.46	56.34	16.68	10.16
US	84.74	88.99	12.92	16.05

Notes: This table presents estimates for trade and production costs ($\tau_\ell \alpha_\ell$) across source regions. The raw estimates are in USD, and the normalized version is defined relative to input costs in Chile. Since domestic sourcing is not directly observed, I assume similar production costs in Chile and Latin America, attributing all differences to iceberg trade costs, which are estimated to be around a factor of 2.7 (Anderson and Van Wincoop 2004). Thus, by construction, Latin America has an input cost of 2.7 in the last two columns.

TABLE A11. Estimated Parameters for Link Separation Probabilities

Dep. Variable: $\mathbb{D}(separation)_{bs\ell}$					
Location factors (Z_ℓ)				Demand factors (D_b)	
Geopolitical risk	0.328***	Low-income dummy	-1.817***	Δ firm imports	-0.254***
	(0.033)		(0.066)		(0.066)
Economic uncertainty	0.180***	Mid-income dummy	-1.993***	Δ firm suppliers	-1.057***
	(0.027)		(0.063)		(0.018)
Trade volatility	0.052***	High-income dummy	-2.385***		
	(0.007)		(0.011)		

Notes: This table presents the estimates for vectors Z_ℓ and D_b in the logit model (24) estimating the probability of link separations. The regressions are at the buyer-supplier-location level, where locations are defined at the origin country-HS6 product level. The dependent variable is a dummy that equals 1 when a buyer-supplier link in period t will be inactive in $t+1$. The demand factors are excluded from the projected disruption probabilities. The sample considers all import transactions in 2018 for firms active in 2018 and 2019. The table reports robust standard errors clustered at the location level.

TABLE A12. Differences in Separation Rates by Region (Indirect vs. Direct)

	LAT	CHN	USA	EUR	ROW
	(1)	(2)	(3)	(4)	(5)
Intermediary dummy	-0.060***	-0.055***	-0.070***	-0.050***	-0.064***
	(0.015)	(0.012)	(0.013)	(0.012)	(0.018)
Firm size (sales)	Yes	Yes	Yes	Yes	Yes
Imported value	Yes	Yes	Yes	Yes	Yes
Number of suppliers	Yes	Yes	Yes	Yes	Yes
Product - country FE	Yes	Yes	Yes	Yes	Yes
Δ Firm-level imports	Yes	Yes	Yes	Yes	Yes
Δ Firm-level suppliers	Yes	Yes	Yes	Yes	Yes
Observations	29,694	72,881	49,715	87,922	43,868

Notes: This table compares supplier separation rates for producers and intermediaries in each source region: Latin America, China, the United States, Europe, and Rest of the World. For each group, the regressions are at the buyer-origin country-HS6 product level. The dependent variable is a dummy that equals 1 when the buyer has a separation from period t to $t+1$. The independent variable is a dummy indicating whether the buyer is an intermediary. Controls for changes in demand conditions across buyers are included (firm-level imports and suppliers). The sample includes all import transactions in 2018 for firms active in both 2018 and 2019. Standard errors are clustered at the firm level.