



International Journal of Supply Chain Management and Logistics Research

Journal homepage: <https://trpub.org/journal.php?id=3182Y82Yqi>

TRPub

IJSCMLR

International Journal of
Supply Chain
Management and
Logistics Research

Vol. 1 Issue 1 2026

Review Article

Open Access

Supplier Diversification and Recovery After Port Disruptions in Electronics Supply Chains: A Review of the Evidence

Sigrid Oliveira^{1*}, Nurlan Le², Fernanda Petrovic³

¹Department of Business, Volta Academy of Business, Malaysia

²Department of Business, Yangtze Institute of Business, Czech Republic

³Department of Business, Carpathian School of Business, Slovakia

Article Info

Volume 1, Issue 1, 2026

doi: [10.62715/ijscmlr.2026.v1.i1.pp1-7](https://doi.org/10.62715/ijscmlr.2026.v1.i1.pp1-7)

Received: 10 April 2026

Accepted: 11 June 2026

Published: 28 July 2026

Abstract

Electronics manufacturers depend on components that cross oceans several times before a product is finished, and most of that freight passes through a small number of container ports. When one of those ports closes or congests, the usual advice is to have more than one supplier. This narrative review asks what the published literature actually says about that advice. It brings together four bodies of work: analytical models of dual and multiple sourcing, conceptual and empirical research on supply chain resilience, studies of how shocks spread through production networks, and the maritime and regional economics literature on port closures. The models show that a second source shortens recovery only when its failures are not tied to those of the first, and a port closure ties together every supplier that ships through it. Empirical studies of earthquakes, floods and factory fires indicate that firms with geographically spread partners recover sooner, but that specific, hard-to-substitute inputs transmit disruption whatever the number of suppliers on the approved list. Direct evidence on port disruptions in electronics is thin. The review sets out the conditions under which diversification can be expected to speed recovery and identifies the studies that are still missing.

Keywords: *Supplier diversification, Dual sourcing, Port disruption, Supply chain resilience, Electronics industry, Time to recover*

© 2026 Sigrid Oliveira et al. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

1. Introduction

A smartphone, a server board or an automotive control unit is assembled from several hundred to several thousand parts, and the supply base behind those parts is concentrated in East and Southeast Asia. Wafers are fabricated in one country, packaged and tested in another, mounted on boards in a third and shipped to final assembly in a fourth. Nearly all of the heavier and cheaper items, and a good share of the rest, move by container ship. The gateway ports of southern China, the Yangtze delta, Taiwan, South Korea, Singapore, California and north-west Europe are therefore shared infrastructure for the whole industry.

* Corresponding author: Sigrid Oliveira, Department of Business, Volta Academy of Business, Malaysia. E-mail: sigrid.oliveira@volta.edu

Ports stop working for many reasons. Labour disputes closed the West Coast ports of the United States in 2002 and slowed them again in later contract rounds. Public health controls shut terminals at Yantian and Ningbo in 2021, typhoons close the Pearl River delta ports most summers, and the grounding of a container ship in the Suez Canal in March 2021 showed that a blocked route has much the same effect as a blocked port. Cyber incidents at terminal operators and carriers have been added to the list.

The stock answer to supply risk is diversification: qualify a second supplier, split the volume, and a problem at one source becomes a problem for part of the flow only. The answer is intuitive and is repeated in most practitioner guidance ([Chopra and Sodhi, 2004](#); [Sheffi, 2005](#)). Whether it holds for port disruptions in particular is less obvious, because a port is a common point through which several suppliers may ship. This article reviews what the literature says on that question and on the speed of recovery, as distinct from the avoidance of loss.

2. Scope and Approach

This is a narrative review of the published literature. It draws on four strands that are seldom read together: operations research models of sourcing under supply risk, the conceptual and survey-based literature on supply chain resilience, econometric studies of how disruptions propagate between firms, and maritime and regional economics work on port closures. Sources were chosen for their influence on later work and their relevance to the question, with no claim to exhaustive coverage. Electronics is the focus throughout, though much of the best evidence comes from neighbouring sectors such as automotive, and is read here for what it implies about component supply. Table 1 summarises the strands and what each contributes.

3. What Diversification Means for an Electronic Component

The term covers several different things. A buyer may hold two approved suppliers for a part and split orders between them, which is dual sourcing in the strict sense. It may buy from one supplier that makes the part in two plants. It may keep a second supplier qualified but dormant, to be activated in an emergency. Or it may simply buy standard parts through distributors who themselves draw on several makers. The early comparison of single and multiple sourcing by [Treleven and Schweikhart \(1988\)](#) already separated the risks these arrangements address: disruption of supply, price escalation, quality and technology access.

Table 1: Strands of literature bearing on supplier diversification and recovery from port disruptions			
Strand	Central question	Implication for port disruptions	Representative sources
Sourcing models	When does a second source pay?	Value falls as supplier failures become correlated	Tomlin, 2006 ; Dada et al., 2007
Resilience frameworks	Which capabilities shorten recovery?	Redundancy and flexibility both matter; visibility comes first	Christopher and Peck, 2004 ; Pettit et al., 2010
Disruption severity	What makes a disruption severe?	Density and node criticality raise severity	Craighead et al., 2007
Network propagation	How do shocks spread between firms?	Specific inputs transmit shocks; dispersed partners aid recovery	Barrot and Sauvagnat, 2016 ; Todo et al., 2015
Port economics	What does a closure cost, and to whom?	Rerouting and inventories absorb much of a short closure	Hall, 2004 ; Rose and Wei, 2013
Risk exposure metrics	Where is the chain most exposed?	Compare time to recover with time to survive at each node	Simchi-Levi et al., 2015

Electronics adds two complications. Many of the parts that matter most are custom: an application-specific integrated circuit, a display panel, a camera module built to one product's

dimensions. Qualifying a second maker for such a part takes months and engineering effort, and for the most advanced semiconductors there may be no second maker at all. The other complication is depth. A buyer with two board assemblers may find that both buy the same capacitor from the same factory. [Choi and Krause \(2006\)](#) describe the supply base in terms of the number of suppliers, their differentiation and their interrelationships, and argue that reducing or enlarging it changes risk in ways a simple supplier count does not capture.

4. What the Sourcing Models Predict

Analytical work treats diversification as one of several ways to manage an unreliable source. [Tomlin \(2006\)](#) compares mitigation tactics, which are paid for in advance, such as inventory and routine dual sourcing, with contingency tactics that are invoked only after a disruption, such as rerouting or asking a reliable supplier to raise output. The preferred mix depends on how often disruptions occur, how long they last and how quickly the back-up supplier can add volume. Long, rare disruptions favour a second source over inventory, because stock sized for a long outage is expensive to carry for years.

Models with several unreliable suppliers reach a consistent conclusion about correlation. In the newsvendor setting of [Dada et al. \(2007\)](#), cost generally takes precedence over reliability when suppliers are selected, and reliability affects how much is ordered from those chosen. [Babich et al. \(2007\)](#) show that when supplier defaults are correlated the insurance value of a second source shrinks, although competition between the suppliers may still lower prices. The lesson carries over directly: two suppliers that ship from the same port have highly correlated delivery failures during a closure, whatever their independence as businesses.

A third line of modelling looks below the first tier. [Ang et al. \(2017\)](#) study a manufacturer with two first-tier suppliers who may share a second-tier source, and show that the manufacturer's best sourcing strategy depends on that overlap, which it often cannot observe. The broader review by [Tang \(2006\)](#) observes that most models assume the buyer knows the failure probabilities and how they depend on one another, an assumption that fits port risk poorly.

5. Port Disruptions as a Distinct Kind of Shock

A fire in a supplier's plant removes capacity. A port closure removes nothing: the factories keep producing and the goods accumulate on the wrong side of the quay. This has three consequences for recovery. The shock is common to every shipper using the port, so competitors and other suppliers are hit together and alternative capacity on air freight or through neighbouring ports is bid for by all of them at once. Recovery of the port is not recovery of the flow, because the backlog of vessels and containers takes far longer to clear than the closure lasted and liner schedules stay unreliable for weeks ([Notteboom, 2006](#)). And goods already in transit are a buffer that a plant fire does not provide.

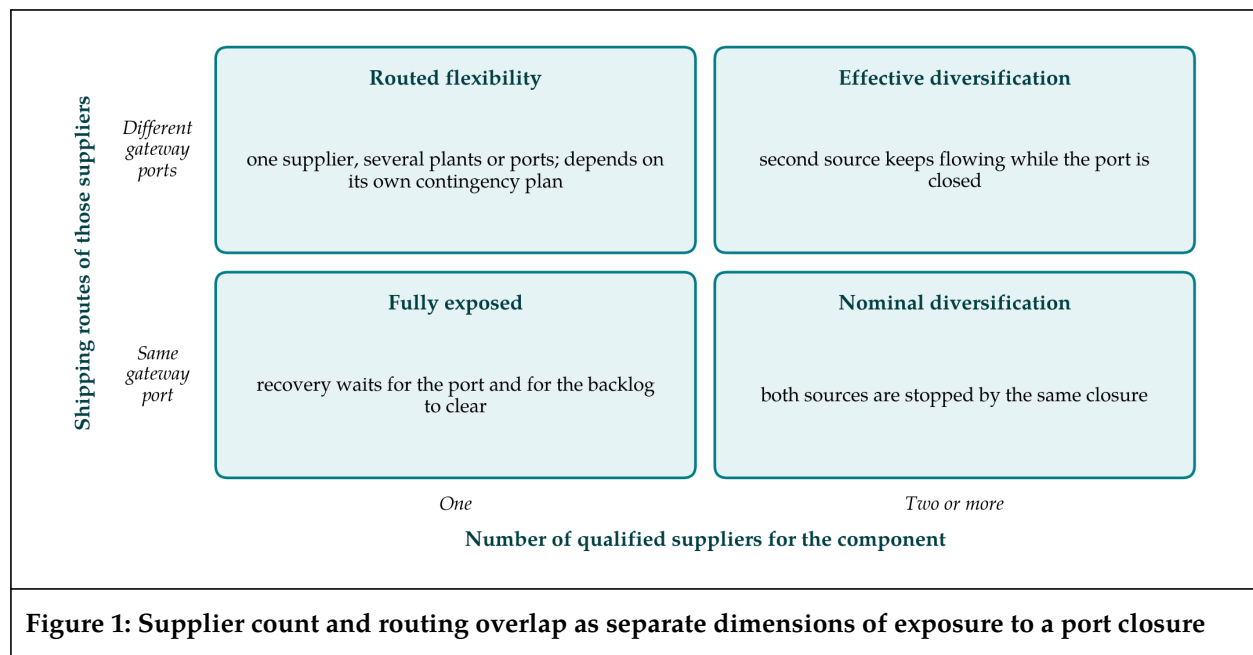
[Craighead et al. \(2007\)](#) relate the severity of a disruption to the density of the supply chain, its complexity and the criticality of the affected node, and to the firm's capabilities for warning and recovery. A gateway port scores high on density and criticality by construction. Figure 1 sets out the resulting distinction between having several suppliers and having several routes. Only the upper right cell offers protection that does not depend on a contingency plan being improvised under pressure.

The economics literature on port closures supports a cautious reading of headline loss figures. [Hall \(2004\)](#) examined the impact studies published around the 2002 West Coast lockout and argued that they overstated losses by ignoring the ways shippers adapt. [Rose and Wei \(2013\)](#) build the adaptations into an input-output analysis of a port shutdown: ship rerouting, use of inventories, diversion of exports to other uses and rescheduling of production. They find that such measures offset a large share of the potential loss. The adaptations they list are forms of flexibility. Supplier diversification appears only indirectly, through the ability to draw on inputs that do not pass through the closed port.

6. Empirical Evidence on Recovery

No body of studies measures recovery speed after port closures for electronics firms with and without diversified suppliers. The evidence has to be assembled from studies of other shocks and other outcomes,

and it should be read with that limitation in view.



6.1. Evidence from natural disasters and plant failures

The best documented single episode in electronics is the fire at a semiconductor plant in New Mexico in 2000, which supplied radio-frequency chips to two handset makers. The account by [Norrman and Jansson \(2004\)](#) describes how one of them, having no alternative source for the affected parts, suffered a large loss and subsequently rebuilt its risk management process around mapping of sub-suppliers. The episode is usually told as a lesson in speed of response, yet the underlying asymmetry was one of sourcing: the firm that recovered quickly could shift demand to other plants and suppliers.

The Great East Japan Earthquake of 2011 produced the most rigorous evidence. [Todo et al. \(2015\)](#) found that firms in the affected area with suppliers and customers outside it resumed operations sooner, which they attribute to support and substitution from intact partners, while dependence on partners inside the area delayed recovery. [Carvalho et al. \(2021\)](#) traced the shock through the national firm network and showed losses reaching firms several links away from the damage. [Barrot and Sauvagnat \(2016\)](#), using natural disasters in the United States, found that customers of a struck supplier lose sales chiefly when the input is specific, and that the loss spills over to the customer's other suppliers. The floods in Thailand in the same year closed a large share of the world's hard disk drive capacity at once and are a reminder that several suppliers in one river basin are one risk ([Haraguchi and Lall, 2015](#)).

6.2. Evidence on complexity and its costs

Diversification is not free of risk of its own. [Bode and Wagner \(2015\)](#) find that horizontal, vertical and spatial complexity of the upstream chain each raise the frequency of disruptions a firm experiences, and that the three amplify one another. More suppliers in more places mean more things that can go wrong, and more ports in use. The financial stakes are large either way: [Hendricks and Singhal \(2005\)](#) documented substantial and lasting underperformance in the share prices of firms that announced supply chain disruptions, with no quick rebound.

7. Conditions Under Which Diversification Speeds Recovery

Read together, the strands point to conditions and not to a general rule. The first is route independence: the alternative source must reach the buyer without passing through the affected gateway, or must be able to switch mode. The second is readiness. A supplier that is approved on paper but has never run volume cannot fill a gap within the weeks that matter, which is why [Sheffi and Rice \(2005\)](#) stress that redundancy must be paired with flexibility that is exercised in normal times. The third is spare capacity at

the alternative source at the moment when every other buyer is asking for it.

Electronics has one advantage over most sectors in meeting these conditions. Many components are small and valuable in relation to their weight, so that air freight, ruinous for steel or furniture, is a tolerable emergency measure for integrated circuits and modules. A second source reachable by air, or a primary source able to switch mode, can therefore stand in for route independence by sea for part of the bill of materials. The advantage does not extend to bulky, low-value items such as enclosures, packaging and passive components bought by the reel, and a finished product cannot ship without them. Recovery is set by the slowest part to arrive.

The fourth condition is knowledge. The exposure measures developed by [Simchi-Levi et al. \(2015\)](#) compare, for each node, the time it would take to recover with the time the buyer could survive on stock and alternatives. Their application to an automotive supply chain showed that large exposures can sit with inexpensive parts from suppliers that receive little management attention. Applying the same logic to ports requires knowing which gateway each part uses, a fact rarely held in procurement records. Resilience frameworks have long listed visibility beside redundancy for this reason ([Christopher and Peck, 2004](#); [Pettit et al., 2010](#)).

8. Gaps and Directions for Research

The clearest gap is direct measurement. Customs and bill-of-lading records identify the port of loading for individual shipments and could be joined to firm-level output or sales to compare recovery paths after a dated closure. The research design of the earthquake studies is transferable, with the port closure as the shock and the pre-existing spread of a firm's suppliers across gateways as the source of variation. Until such work is done, statements about recovery speed rest on analogy.

Three further questions follow. One is how diversification compares with its substitutes for port risk specifically: buffer stock held on the destination side, standing air freight arrangements and contractual rights to reroute. A second concerns systemic effects. If every electronics firm adds a second source in the same alternative region, the industry has moved its common exposure and not removed it, a point raised in the discussion of intertwined supply networks by [Ivanov and Dolgui \(2020\)](#). The third is cost: the recurring expense of qualification, split volumes and added complexity is seldom set against the infrequent benefit in a form that managers can use when budgets are decided.

9. Conclusion

The literature gives qualified support to the view that supplier diversification shortens recovery after a port disruption. Models establish that a second source is valuable to the extent that its failures are independent of the first, and studies of earthquakes and fires show that geographically separate partners help firms restart. The same work shows that the number of approved suppliers is a poor guide: what matters is whether the alternatives use different gateways, are ready to run, have capacity to spare, and are known to the buyer down to the lower tiers. For electronics, where critical parts are specific and production is regionally clustered, those conditions are demanding. Direct evidence on port closures remains to be gathered.

Conflict of interest

To be declared by the author(s) before publication.

Funding

To be declared by the author(s) before publication.

References

- Ang, E., Iancu, D.A. and Swinney, R. (2017). [Disruption risk and optimal sourcing in multitier supply networks. *Management Science*, 63\(8\): 2397-2419. <https://doi.org/10.1287/mnsc.2016.2471>](#)
- Babich, V., Burnetas, A.N. and Ritchken, P.H. (2007). [Competition and diversification effects in supply](#)

- chains with supplier default risk. *Manufacturing & Service Operations Management*, 9(2): 123-146.
- Barrot, J.-N. and Sauvagnat, J. (2016). Input specificity and the propagation of idiosyncratic shocks in production networks. *Quarterly Journal of Economics*, 131(3): 1543-1592.
<https://doi.org/10.1093/qje/qjw018>
- Bode, C. and Wagner, S.M. (2015). Structural drivers of upstream supply chain complexity and the frequency of supply chain disruptions. *Journal of Operations Management*, 36: 215-228.
<https://doi.org/10.1016/j.jom.2014.12.004>
- Carvalho, V.M., Nirei, M., Saito, Y.U. and Tahbaz-Salehi, A. (2021). Supply chain disruptions: Evidence from the Great East Japan Earthquake. *Quarterly Journal of Economics*, 136(2): 1255-1321.
<https://doi.org/10.1093/qje/qjaa044>
- Choi, T.Y. and Krause, D.R. (2006). The supply base and its complexity: Implications for transaction costs, risks, responsiveness, and innovation. *Journal of Operations Management*, 24(5): 637-652.
<https://doi.org/10.1016/j.jom.2005.07.002>
- Chopra, S. and Sodhi, M.S. (2004). Managing risk to avoid supply-chain breakdown. *MIT Sloan Management Review*, 46(1): 53-61.
- Christopher, M. and Peck, H. (2004). Building the resilient supply chain. *International Journal of Logistics Management*, 15(2): 1-14. <https://doi.org/10.1108/09574090410700275>
- Craighead, C.W., Blackhurst, J., Rungtusanatham, M.J. and Handfield, R.B. (2007). The severity of supply chain disruptions: Design characteristics and mitigation capabilities. *Decision Sciences*, 38(1): 131-156.
<https://doi.org/10.1111/j.1540-5915.2007.00151.x>
- Dada, M., Petruzzzi, N.C. and Schwarz, L.B. (2007). A newsvendor's procurement problem when suppliers are unreliable. *Manufacturing & Service Operations Management*, 9(1): 9-32.
- Hall, P.V. (2004). "We'd have to sink the ships": Impact studies and the 2002 West Coast port lockout. *Economic Development Quarterly*, 18(4): 354-367.
- Haraguchi, M. and Lall, U. (2015). Flood risks and impacts: A case study of Thailand's floods in 2011 and research questions for supply chain decision making. *International Journal of Disaster Risk Reduction*, 14: 256-272.
- Hendricks, K.B. and Singhal, V.R. (2005). An empirical analysis of the effect of supply chain disruptions on long-run stock price performance and equity risk of the firm. *Production and Operations Management*, 14(1): 35-52.
- Ivanov, D. and Dolgui, A. (2020). Viability of intertwined supply networks: Extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research*, 58(10): 2904-2915.
<https://doi.org/10.1080/00207543.2020.1750727>
- Norrman, A. and Jansson, U. (2004). Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident. *International Journal of Physical Distribution & Logistics Management*, 34(5): 434-456. <https://doi.org/10.1108/09600030410545463>
- Notteboom, T.E. (2006). The time factor in liner shipping services. *Maritime Economics & Logistics*, 8(1): 19-39.
- Pettit, T.J., Fiksel, J. and Croxton, K.L. (2010). Ensuring supply chain resilience: Development of a conceptual framework. *Journal of Business Logistics*, 31(1): 1-21.
- Rose, A. and Wei, D. (2013). Estimating the economic consequences of a port shutdown: The special role of resilience. *Economic Systems Research*, 25(2): 212-232.
- Sheffi, Y. (2005). *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage*. MIT Press, Cambridge, MA.
- Sheffi, Y. and Rice, J.B. (2005). A supply chain view of the resilient enterprise. *MIT Sloan Management Review*, 47(1): 41-48.

- Simchi-Levi, D., Schmidt, W., Wei, Y., Zhang, P.Y., Combs, K., Ge, Y., Gusikhin, O., Sanders, M. and Zhang, D. (2015). [Identifying risks and mitigating disruptions in the automotive supply chain.](#) *Interfaces*, 45(5): 375-390. <https://doi.org/10.1287/inte.2015.0804>
- Tang, C.S. (2006). [Perspectives in supply chain risk management.](#) *International Journal of Production Economics*, 103(2): 451-488. <https://doi.org/10.1016/j.ijpe.2005.12.006>
- Todo, Y., Nakajima, K. and Matous, P. (2015). [How do supply chain networks affect the resilience of firms to natural disasters? Evidence from the Great East Japan Earthquake.](#) *Journal of Regional Science*, 55(2): 209-229. <https://doi.org/10.1111/jors.12119>
- Tomlin, B. (2006). [On the value of mitigation and contingency strategies for managing supply chain disruption risks.](#) *Management Science*, 52(5): 639-657. <https://doi.org/10.1287/mnsc.1060.0515>
- Treleven, M. and Schweikhart, S.B. (1988). [A risk/benefit analysis of sourcing strategies: Single vs. multiple sourcing.](#) *Journal of Operations Management*, 7(3-4): 93-114.