

# Are you Resilient? Hidden Risks in the Sub-Tier Supply Network

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In the past decade, firms have encountered an ever-increasing number of supply chain disruptions, triggered by a wide range of natural and man-made causes, such as earthquakes, floods, fires, labor strikes, financial crises, and social unrest. These events have caused substantial short-term losses (e.g., production delays and increased labor and supply costs) as well as long-term losses (e.g., market share erosion and bankruptcy).

You may think that appropriate risk mitigation actions by your direct suppliers sufficiently buffer your company from more wide-ranging disruptions in the extended network. However, evidence indicates otherwise. According to the [Supply Chain Resilience Report 2015 \[1\]](#), more than a quarter (29 percent) of supply chain disruptions originate from two or more tiers deep in the supply chain; this estimate is based on responses from 537 firms in 67 countries spanning 14 SIC<sup>1</sup> sectors. The same report also found that a strikingly high 31 percent of organizations do not know the origin of a disruption. These findings underscore the importance of developing visibility into the sub-tier supply network to manage a company's supply chain risk. Unfortunately, because manufacturers (nodal firms) rarely have direct relationships with their sub-tier suppliers, identifying sub-tier suppliers is not always an easy undertaking. Not only is it important to know who the sub-tier suppliers are, the structure of the network that binds them together could also be important. For example, when many tier-1 suppliers share a common tier-2 supplier, the supply base contains a single-point of failure. The Japanese earthquake and tsunami in 2011 created a shortage of components from the shared sub-tier suppliers such as Renesas (a chip supplier) and Merck (a paint pigment supplier), causing month-long production delays for automotive manufacturers [2][3].

A recent study [4] completed by researchers at the University of Michigan's Ross School of Business found that such single points of failure are indeed quite prevalent in the global high-tech industry. Using Bloomberg's Supply Chain Function, <sup>2</sup>the study identified 13,670 supplier-customer relationships among 4,538 global firms either belonging to the high-tech sector or supplying firms in the high-tech sector. The researchers found that, on average, 20 percent of a nodal firm's tier-2 suppliers are shared by two or more tier-1 suppliers, and 2.3 percent of tier-2 suppliers are shared by at least five tier-1 suppliers in the global supply network of high-tech industry.

For example, Advanced Semiconductor Engineering Inc., Amkor Technology Inc., Taiwan Semiconductor Ltd., ARM Holdings plc, and STATS ChipPAC Ltd. are shared by at least 20 tier-1 suppliers in a number of nodal firm's networks. Most of these heavily *shared* tier-2 suppliers are semiconductor companies. The researchers also indicate that these tier-2 suppliers are not necessarily tier-1 suppliers of the associated nodal firms, implying that without sub-tier visibility, nodal firms may not realize that they rely on a particular set of sub-tier suppliers. For instance, 20 of Dell's tier-1 suppliers and 21 of Sony's tier-1 suppliers source from STATS ChipPAC Ltd., which does not directly supply to any of the hardware manufacturers listed in the S&P500.

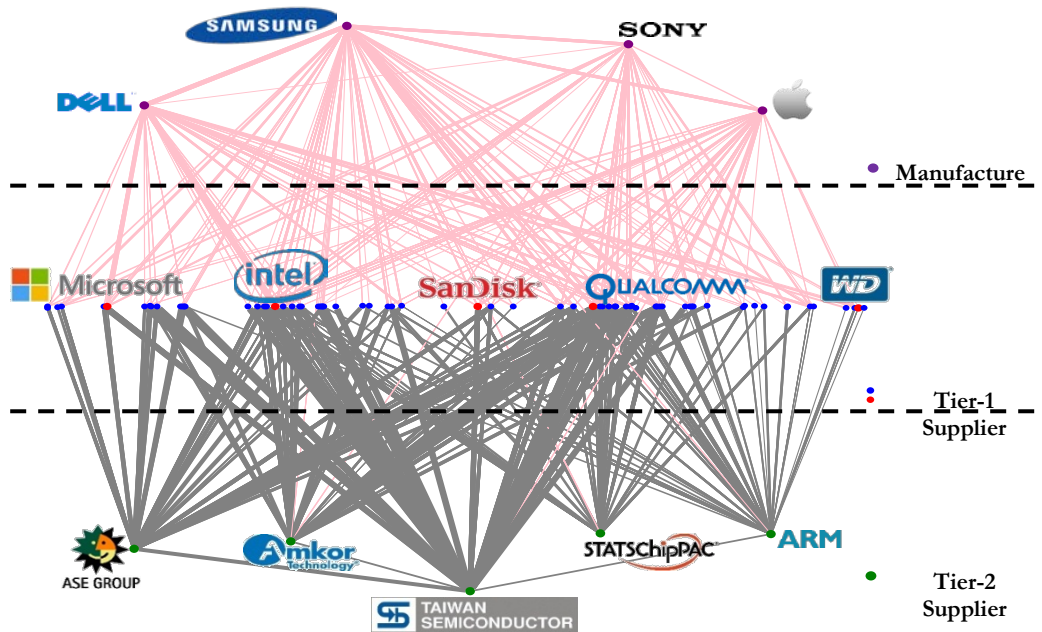
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<sup>1</sup> Standard Industrial Classification.

<sup>2</sup> Bloomberg's Supply Chain Function maps 35,000 firms with their suppliers and customers.

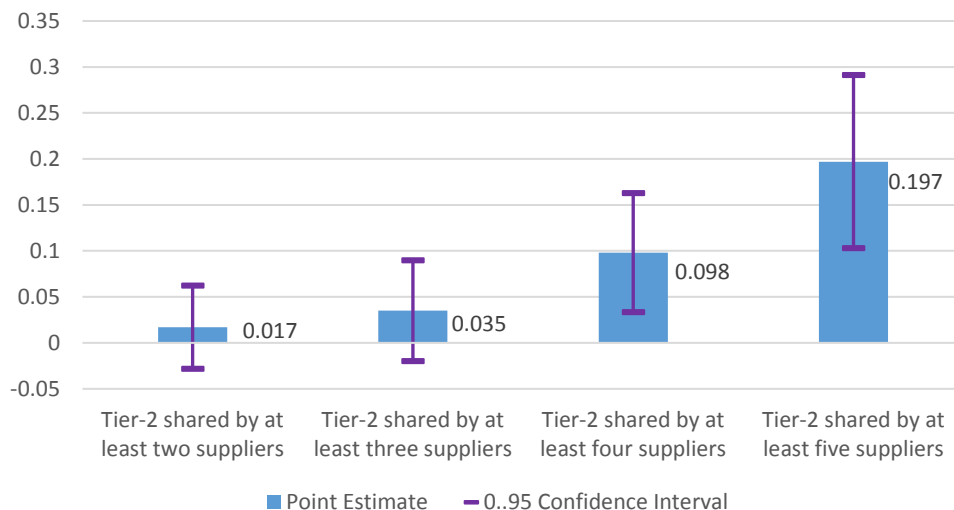
Such tier-2 supplier commonality gives rise to a network structure that takes the shape of a diamond, as shown in Figure 1. Our study proposed several intuitive measures that can be used to index the degree of sub-tier commonality in a firm's supply network.

**Figure 1: High-tech firm's supply network**



*Note. This figure is a sub-network of the high-tech supply network and is displayed to highlight the tier-2 sharing pattern. Every pink link connects the manufacturer with its suppliers, and every gray link connects the tier-1 suppliers with their suppliers. Each link is weighted by cost, which specifies the percentage of a firm's procurement cost that a supplier represents.*

We found that nodal firms with more heavily *shared* tier-2 suppliers also exhibit higher stock return volatilities. A 10 percent increase in stock return volatility of common tier-2 suppliers shared by at least five tier-1 suppliers is associated with 1.97 percent increase in the stock return volatility of the nodal firm—the effect is more than ten times larger than that when the tier-2 suppliers are shared by only (at least) two tier-1 suppliers, as shown in Figure 2.



## Figure 2: Association of stock return volatilities between manufacturers and tier-2 suppliers

We conclude that sub-tier sharing contributes to substantial unmanaged supply chain risks, which highlights the need for firms to increase visibility into their extended supply network. In particular, firms should focus their efforts on identifying *critical* sub-tier suppliers that are shared by multiple immediate suppliers and manage their risks effectively.

### References

- [1] Business Continuity Institute. Supply Chain Resilience Report 2015.
- [2] Kyodo. 2011. Manufacturers expect lasting quake impact. *The Japanese Times*.
- [3] Sedgwick, David. 2014. Toyota asks suppliers for disaster plans. *Automotive News*.
- [4] Wang, Iris, Li, Jun, and Anupindi, Ravi. 2015. "Risky Suppliers or Risky Supply Chains? An Empirical Analysis of Sub-Tier Supply Network Structure on Firm Performance in the High-Tech Sector," Ross School of Business, University of Michigan, Ann Arbor. Available at [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2705654](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2705654)