

Supply Networks

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August 2019

- Buyer-Supplier Relationships and Supplier-Supplier Relationships
- Dyads, Triads, and maybe Tetrads
- Multi-Tier Supply Chains
- Supply Networks
 - Network Mapping and Structure
 - Complex Adaptive Systems
- Major Outlets
 - Academic: *JOM*, *JSCM*, and others
 - Practitioner: *HBR*, *SCMR*, and others

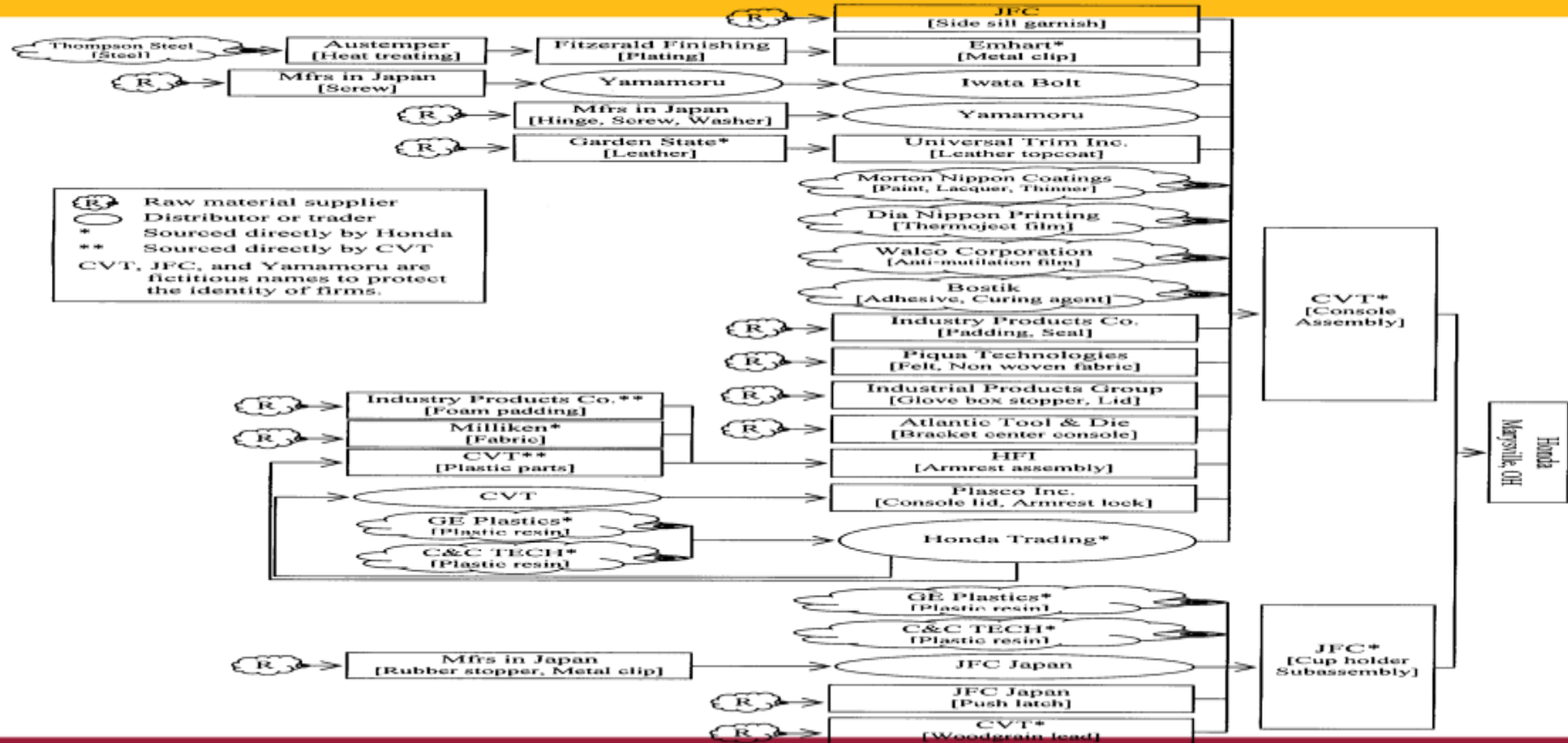
In This Presentation

- Supply chain as a complex adaptive system
- Honda case study in the 90's
- And beyond...

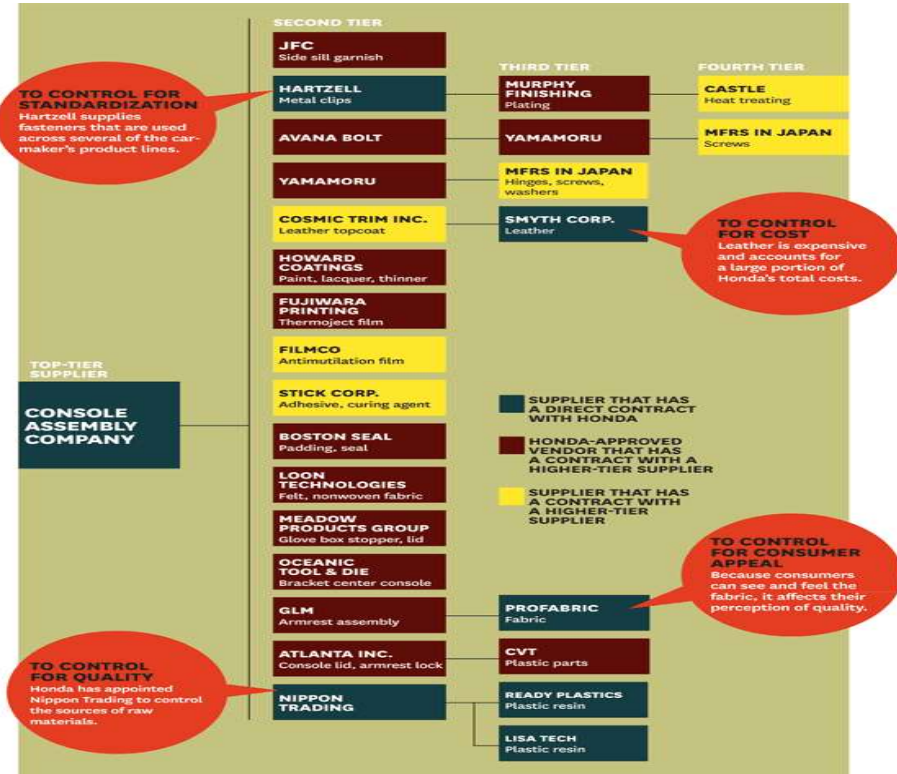
SC as a CAS



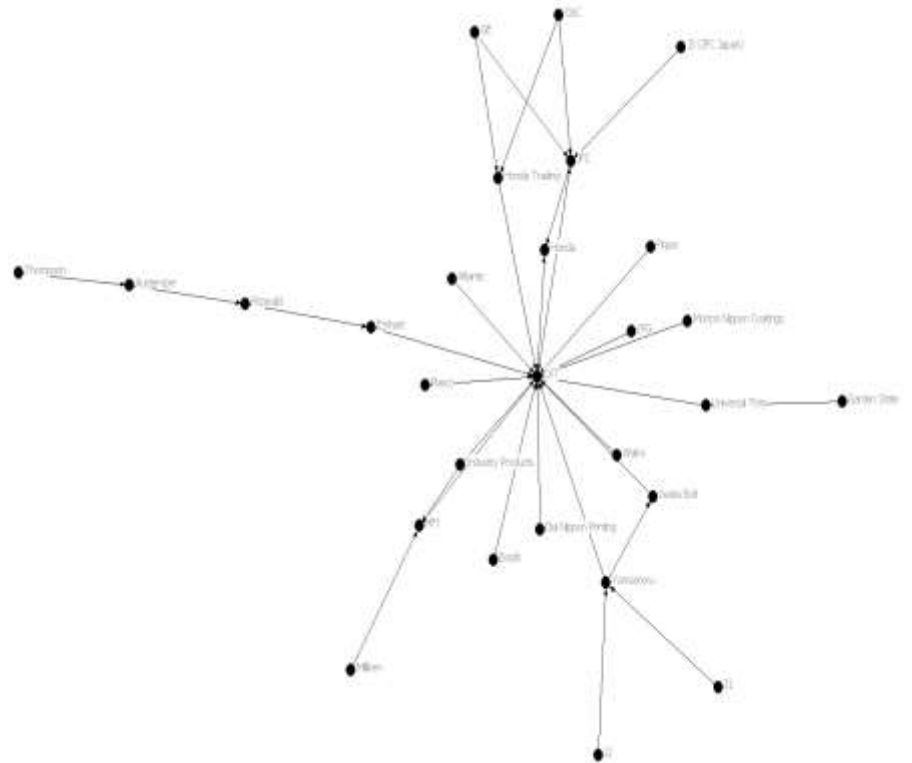
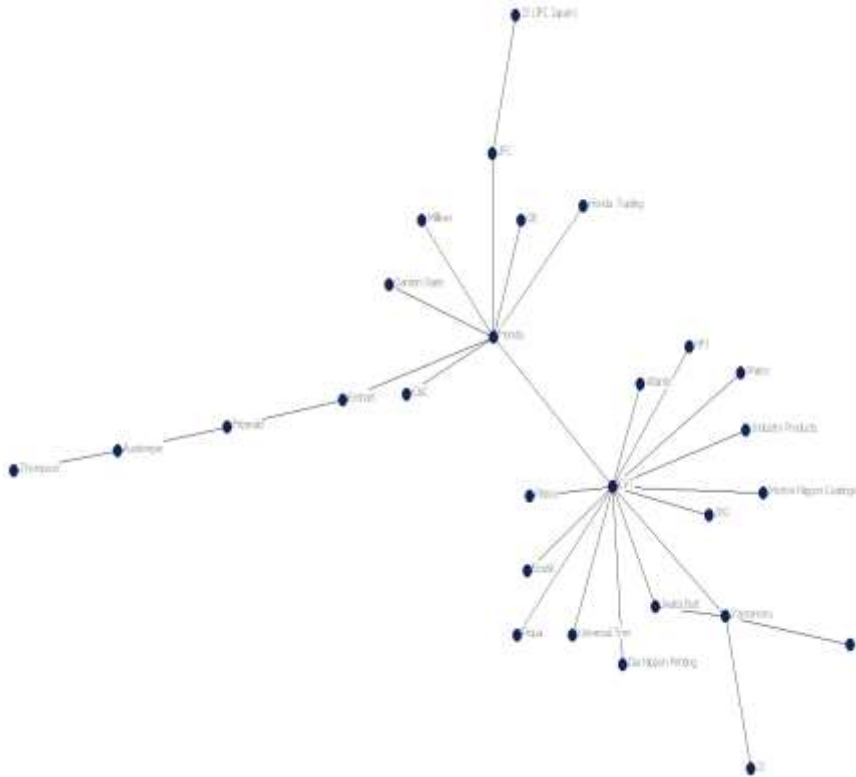
Honda Supply Network Study



Multi-Tier SC Management



Quantitative Analysis of Honda SN



Various Forms of Centrality Measures

List of key firms based on contractual relationships SN

Influential Scope ¹	Informational Independence ²	Relational Mediation ³
CVT (52), Honda (30), Yamamoru (15)	CVT (57), Honda (53), Yamamoru (40)	CVT (79), Honda (64), Emhart (21) Yamamoru (15), Fitzgerald (14)

¹ Firms with degree > 15

² Firms with closeness > 40

³ Firms with betweenness > 10

List of key firms based on materials flow SN

Supply Load ¹	Demand Load ²	Operational Criticality ³
CVT (59 ⁴), JFC (15), HFI (11)	CVT (15), C&C (7.4), JFC (7.4), GE (7.4), CVT (13), Emhart (2), Yamamoru (1.7), Yamamoru (7.4), Industry Products (7.4) Fitzgerald (1.7), JFC (1.3)	

¹ Firms with in-degree > 10

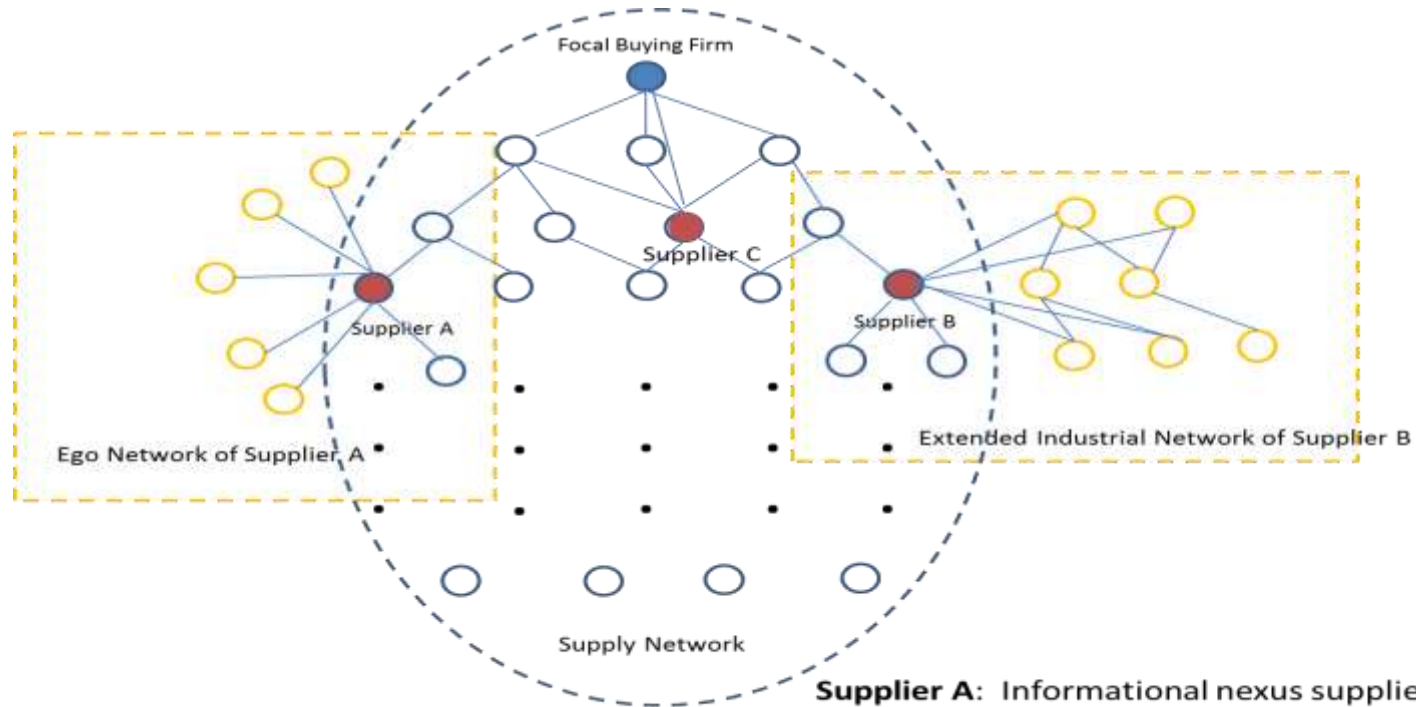
² Firms with out-degree > 6

³ Firms with betweenness > 1.0

⁴ Centrality score

- Critical suppliers due to their structural position in the network
 - Exist anywhere in the network
 - Show specific mathematical properties.
- The buying firm:
 - May not have a visual on them
 - May not yet be aware of their criticality

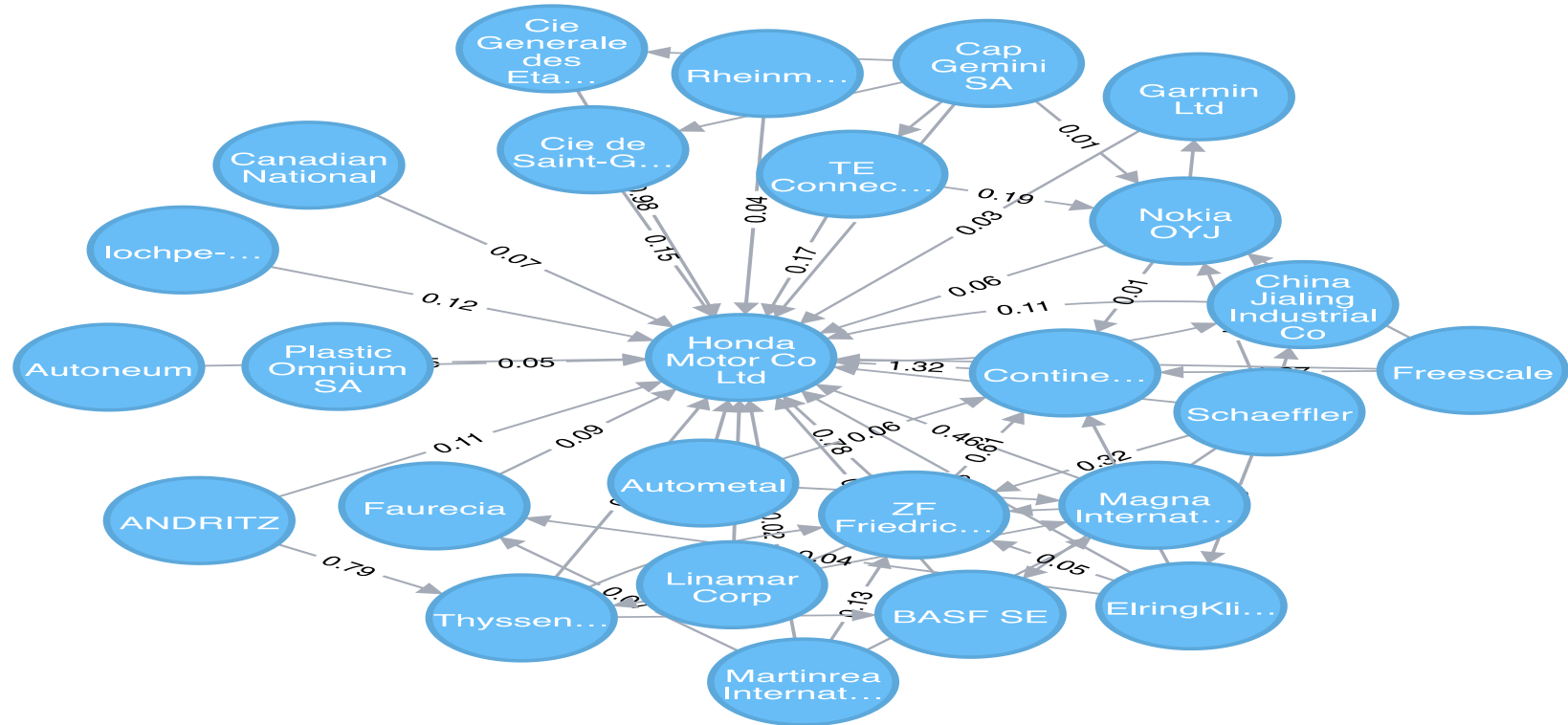
Nexus Suppliers Proposed



Supplier A: Informational nexus supplier
Supplier B: Monopolistic nexus supplier
Supplier C: Operational nexus supplier

- About 28,000 public firms worldwide
- Each firm's suppliers and customers (using information from company filings, industry reports, news articles, etc.)
- Value of relationship as a percentage of cost (or revenue)
- Firm-level data

A Tiny Part of the Network



Honda Supply Network



Nexus Supplier Index

$$\text{Maximize NSIp} = \frac{\alpha D_p + \beta B_p + \gamma V_p}{\sigma F_p} \quad (1)$$

$$\text{subject to } \frac{\alpha D_i + \beta B_i + \gamma V_i}{\sigma F_i} \leq 1 \quad (i = 1, \dots, N) \quad (2)$$

$$\alpha, \beta, \gamma, \sigma \geq 0 \quad (3)$$

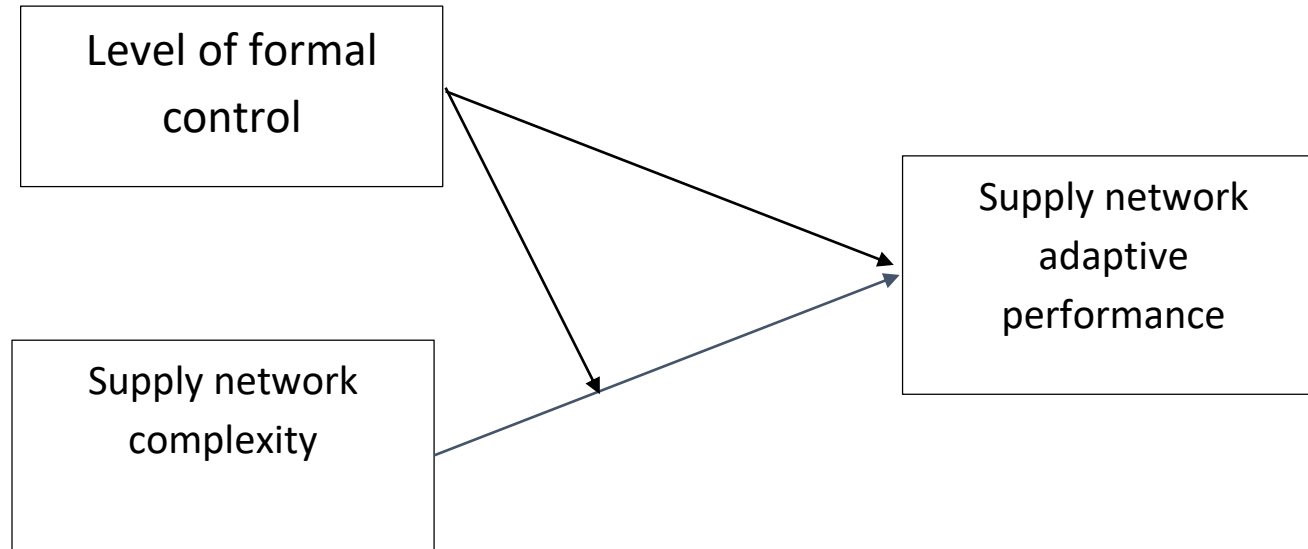
where D is degree centrality, B is betweenness centrality, V is eigenvector centrality, and F is distance farness measure.

Top 50 NSI's from 2nd and 3rd Tiers

Rank	Name	Tier	NSI
1	Siemens AG	2	1.0000
2	SAP SE	2	0.9711
3	Hewlett-Packard Co	2	0.9701
4	General Electric Co	2	0.9657
5	Samsung Electronics Co Ltd	2	0.9598
6	Microsoft Corp	2	0.9327
7	LG Electronics Inc	2	0.9319
8	Apple Inc	3	0.9267
9	Ford Motor Co	2	0.9263
10	General Motors Co	2	0.9229
11	Intel Corp	2	0.9209
12	Toyota Motor Corp	2	0.9199
13	Accenture PLC	2	0.9168
14	Akzo Nobel NV	2	0.9135
15	Sony Corp	3	0.9132
16	Flextronics International Ltd	2	0.9132
17	Infineon Technologies AG	2	0.9130
18	Zebra Technologies Corp	2	0.9119
19	Volkswagen AG	2	0.9119
20	Fujitsu Ltd	2	0.9111
21	VeriSign Inc	2	0.9100
22	ANSYS Inc	2	0.9097
23	ABB Ltd	2	0.9052
24	Linde AG	2	0.9012
25	Honeywell International Inc	2	0.9002

26	Amazon.com Inc	3	0.8998
27	Silicon Laboratories Inc	2	0.8977
28	Texas Instruments Inc	2	0.8976
29	Bayerische Motoren Werke AG	3	0.8969
30	Dow Chemical Co/The	2	0.8955
31	ON Semiconductor Corp	2	0.8954
32	BT Group PLC	2	0.8953
33	Daimler AG	2	0.8946
34	Ingram Micro Inc	2	0.8938
35	Cisco Systems Inc	2	0.8934
36	Nissan Motor Co Ltd	2	0.8922
37	Telefonaktiebolaget LM Ericsson	2	0.8915
38	Airbus Group NV	3	0.8910
39	Caterpillar Inc	2	0.8908
40	Arrow Electronics Inc	2	0.8907
41	Avago Technologies Ltd	2	0.8903
42	Vodafone Group PLC	2	0.8902
43	Atmel Corp	2	0.8901
44	Open Text Corp	2	0.8899
45	Adobe Systems Inc	2	0.8894
46	Avnet Inc	2	0.8856
47	Boeing Co/The	3	0.8844
48	Polycom Inc	2	0.8840
49	Fiat Chrysler Automobiles NV	3	0.8824
50	Danaher Corp	2	0.8820

Control, Complexity, NK Simulation



- Tetrads in Supply Networks
- SC Make versus SC Buy
- Supplier Ecosystem
- Redefining B-S with Emerging Technologies
- SC Financing across Multi-Tiers
- NSI with industry data
- Agency Theory in Triads
- Extended Supply Chains