

Social Learning in Information Technology Investment: The Role of Board Interlocks

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Online Appendix Part A: Additional Tables

Table A1: Variables

Variable		Description (data source)	Obs.	Mean	S.D.
Board interlock influence on IT investment					
<i>IT</i>	<i>CRM&SCM</i>	<i>CRM&SCM applications, total number of users using CRM and SCM applications, scaled by number of employees (CI & Compustat)</i>	1,950	0.012	0.022
	<i>IT Labor</i>	<i>IT labor expense, in \$ thousand, scaled by number of employees (CI & Compustat)</i>	1,950	0.953	1.723
<i>AvgIT_InterlockFirm</i>	<i>CRM&SCM</i>	<i>Average CRM&SCM applications (or IT labor expense) of the focal firm's interlocked firms</i>	1,950	0.012	0.016
	<i>IT Labor</i>		1,950	0.911	1.242
<i>MatchedInterlockIT</i>	<i>CRM&SCM</i>	<i>Average CRM&SCM applications (or IT labor expense) of size-matched firms, matched—by closest total assets in the same 2-digit SIC industry—for each interlocked firm (CI & Compustat)</i>	1,950	0.012	0.016
	<i>IT Labor</i>		1,950	0.930	1.214
<i>NeighborhoodIT</i>	<i>CRM&SCM</i>	<i>Average CRM&SCM applications (or IT labor expense) of firms within 100km of the focal firm, excluding its interlocked firms (CI & Compustat)</i>	1,806	0.013	0.012
	<i>IT Labor</i>		1,806	0.989	0.969
<i>IndustryIT</i>	<i>CRM&SCM</i>	<i>Lagged median industry CRM&SCM applications (or IT labor expense)</i>	1,950	0.004	0.005
	<i>IT Labor</i>		1,950	0.319	0.412

Variable	Description (data source)	Obs.	Mean	S.D.
#Meetings High	1 if number of board meetings is greater than or equal to industry median, and 0 otherwise (SEC Edgar)	1,950	0.651	0.477
#Meetings Low	1 if number of board meetings is lower than industry median, and 0 otherwise (SEC Edgar)	1,950	0.349	0.477
#InterlockFirm	Number of interlocked firms for each focal firm (RiskMetrics)	1,950	6.751	4.161
Ln(#InterlockFirm)	Natural logarithm of (1+#InterlockFirm) (RiskMetrics)	1,950	1.903	0.553
AvgIWRank_InterlockFirm	Average IW rank of interlocked firms; an interlocked firm is coded 2 if ranked in top 250, 1 if ranked 251–500, and 0 if not ranked (InformationWeek website)	974	0.543	0.399
CR4	4-firm industry concentration ratio at the 4-digit SIC level (Compustat-Segment)	1,950	0.785	0.218
Uncertainty	Standard deviation of earnings for the past five years; earnings are deflated by total assets (Compustat)	1,950	0.033	0.042
Diversification	Firm diversification of asset allocation across reported segments using Herfindahl index (Compustat-Segment)	1,950	0.582	0.294
AdjustedROA	Adjusted Return on Assets; moving average firm ROA of t-2 to t minus the median industry(SIC 2) moving average ROA of t-2 to t (Compustat)	1,950	0.048	0.082
Leverage	Leverage ratio measured as long-term debt / total assets; moving average of t-2 to t (Compustat)	1,950	0.203	0.130
Growth	Year-to-year percentage change in sales; moving average of t-2 to t (Compustat)	1,950	0.082	0.135
Auto	1 for firms in “automate industries”; 0 otherwise; classification based on Chatterjee et al. (2001) and Anderson et al. (2006)’s studies	1,950	0.376	0.485
Trans	1 for firms in “transform industries”; 0 otherwise	1,950	0.120	0.325
HighTech	1 if the primary industry is: Drugs (SIC 2833-2836), R&D Services (8731-8734), Programming (7371-7379), Computers (3570-3577), or Electronics (3600-3674)	1,950	0.088	0.283
MonitorIntensive	1 if a majority of independent directors serve on at least two of the three principal monitoring committees (i.e., audit, compensation, and nominating/governance committees) (RiskMetrics)	1,950	0.490	0.500
IndependentDirector	1 if percentage of independent directors on the focal firm’s board is greater than or equal to 50%; 0 otherwise (RiskMetrics)	1,950	0.965	0.184
CEO_Duality	1 if CEO is also chairman of the board; 0 otherwise (RiskMetrics)	1,950	0.637	0.481
Performance implication				
TobinsQ	Tobin’s Q, the ratio of the market value of the firm to the book value of assets at the end of year t (Compustat)	1,800	1.281	0.977
IndustryQ	Average Tobin’s Q in the 2-digit SIC industry	1,950	1.086	0.495
MarketShare	Market share in a 2-digit SIC industry (Compustat)	1,950	0.273	0.281
PPE	Property, plant, and equipment (PP&E) intensity, measured as the amount of PP&E scaled by total assets (Compustat)	1,950	0.284	0.212
R&D	R&D intensity, measured as research and development expense scaled by total assets (Compustat)	1,950	0.017	0.033
Adv	Advertising intensity, measure as advertising expense	1,950	0.012	0.031

Variable		Description (data source)	Obs.	Mean	S.D.
		<i>scaled by total assets (Compustat)</i>			
Size		<i>Natural logarithm of market value of equity (Compustat)</i>	1,950	8.074	1.436
InterlockDrivenIT	CRM&SCM	<i>Interlock-driven IT investment, defined by Equation (2); it is the proportion of the focal firm's CRM&SCM applications (or IT labor expense) predicted by the average</i>	974	1.047	0.240
	IT Labor	<i>CRM&SCM applications (or IT labor expense) of the focal firm's interlocked firms</i>	974	1.047	0.240
ResidualIT	CRM&SCM	<i>Residual IT investment, which equals a firm's CRM&SCM applications (or IT labor expense) less InterlockDriven</i>	974	0.001	1.754
	IT Labor	<i>CRM&SCM applications (or IT labor expense), defined by Equation (3)</i>	974	0.001	1.754
Robustness tests					
AvgIT_Newly_InterlockFirm	CRM&SCM	<i>Average CRM&SCM applications (or IT labor expense) of newly interlocked firms, defined as interlocked firms that</i>	1,950	0.003	0.011
	IT Labor	<i>have never been interlocked with the focal firm before</i>	1,950	0.216	0.816
AvgIT_Existing_InterlockFirm	CRM&SCM	<i>Average CRM&SCM applications (or IT labor expense) of interlocked firms that are not newly interlocked (i.e.,</i>	1,950	0.010	0.015
	IT Labor	<i>existing interlocked firms)</i>	1,950	0.800	1.194
AvgIT_Firm_Left_Interlock_1stYear	CRM&SCM	<i>Average CRM&SCM applications (or IT labor expense) of firms that were interlocked with the focal firm but have</i>	1,950	0.004	0.013
	IT Labor	<i>not been for 1 year</i>	1,950	0.291	0.973
AvgIT_Firm_Left_Interlock_2ndYear	CRM&SCM	<i>Average CRM&SCM applications (or IT labor expense) of firms that were interlocked with the focal firm but have</i>	1,950	0.004	0.011
	IT Labor	<i>not been for 2 years</i>	1,950	0.290	0.885
AvgIT_Firm_Left_Interlock_3rdYear	CRM&SCM	<i>Average CRM&SCM applications (or IT labor expense) of firms that were interlocked with the focal firm but have</i>	1,950	0.004	0.011
	IT Labor	<i>not been for 3 or more years</i>	1,950	0.281	0.864
#ExistingInterlockFirm		<i>Number of interlocked firms that are not newly interlocked (i.e., existing interlocked firms) (RiskMetrics)</i>	1,950	6.751	4.161
Ln(#ExistingInterlockFirm)		<i>Natural logarithm of (1+#ExistingInterlockFirm) (RiskMetrics)</i>	1,950	1.903	0.553
IT	IT hardware capital	<i>IT hardware capital, scaled by total assets (Harte-Hanks Computer Intelligence (CI) database)</i>	1,950	0.003	0.003
AvgIT_InterlockFirm	IT hardware capital	<i>Average IT hardware capital of the focal firm's interlocked firms.</i>	1,950	0.003	0.002
InterlockDrivenIT	IT hardware capital	<i>Interlock-driven IT investment, defined by Equation (2); it is the proportion of the focal firm's IT hardware capital predicted by the average IT hardware capital of the focal firm's interlocked firms</i>	974	0.003	0.000
ResidualIT	IT hardware capital	<i>Residual IT investment, which equals a firm's IT hardware capital less InterlockDriven IT hardware capital, defined by Equation (3)</i>	974	0.000	0.003
Interlock_IT_Industry_Experience		<i>1 if any interlocked directors have working experience in IT industries; 0 otherwise (SEC proxy filings and RiskMetrics)</i>	1,882	0.089	0.285
InterlockCEO		<i>1 if any interlocked directors are CEOs of interlocked firms; 0 otherwise (SEC proxy filings and RiskMetrics)</i>	1,882	0.398	0.490

Table A2: Correlation Matrix

Panel A: Correlation of Major Variables (IT=CRM&SCM)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
<i>IT</i>																									
<i>AvgIT_InterlockFirm</i>	0.100																								
<i>MatchedInterlockIT</i>	-0.070	-0.018																							
<i>NeighborhoodIT</i>	0.110	-0.028	-0.003																						
<i>log(#InterlockFirms)</i>	-0.070	-0.066	0.009	-0.062																					
<i>AvgIWRank_InterlockFirm</i>	0.038	-0.073	0.003	0.146	0.259																				
<i>CR4</i>	-0.218	0.036	0.068	-0.077	0.101	0.082																			
<i>Uncertainty</i>	0.041	-0.062	0.000	0.008	-0.084	0.034	0.011																		
<i>Diversification</i>	0.083	-0.023	-0.009	-0.034	-0.285	-0.080	-0.076	0.025																	
<i>AdjustedROA</i>	-0.057	-0.062	0.029	0.046	0.037	-0.017	0.166	-0.094	-0.061																
<i>Leverage</i>	0.080	-0.078	0.057	0.035	0.065	0.011	-0.253	-0.066	-0.078	-0.212															
<i>Growth</i>	-0.137	-0.024	0.027	0.034	-0.066	-0.003	0.081	0.052	0.025	0.167	-0.107														
<i>Auto</i>	0.066	-0.072	-0.053	0.054	0.023	-0.059	-0.251	-0.011	-0.026	-0.284	0.216	0.034													
<i>Trans</i>	0.140	0.093	0.009	0.034	-0.071	0.004	-0.027	0.122	0.046	0.016	-0.087	-0.061	-0.258												
<i>HighTech</i>	0.019	-0.021	-0.041	0.023	0.010	-0.040	-0.016	0.085	0.082	0.108	-0.028	0.012	-0.189	0.076											
<i>IndustryIT</i>	0.196	0.051	0.052	0.025	0.070	0.103	-0.113	0.045	-0.063	-0.038	0.081	0.025	0.022	0.024	-0.087										
<i>Tobin's Q</i>	0.016	-0.007	0.046	0.029	0.012	0.103	0.107	0.023	0.117	0.455	-0.201	0.137	-0.136	0.067	0.064	-0.042									
<i>InterlockDrivenIT</i>	0.134	0.862	-0.001	0.033	-0.022	0.220	0.053	-0.051	-0.020	-0.060	-0.080	-0.007	-0.082	0.104	-0.035	0.098	0.029								
<i>ResidualIT</i>	0.993	-0.006	-0.071	0.107	-0.068	0.011	-0.227	0.047	0.086	-0.050	0.091	-0.138	0.076	0.128	0.024	0.185	0.012	0.012							
<i>IndustryQ</i>	-0.103	0.064	0.075	0.041	0.013	0.066	0.327	0.073	-0.041	0.447	-0.167	0.095	-0.287	0.118	0.188	-0.059	0.327	0.073	-0.113						
<i>MarketShare</i>	-0.179	-0.026	0.114	-0.041	0.149	0.108	0.612	-0.114	-0.056	0.061	-0.062	-0.032	-0.027	-0.071	-0.091	-0.105	0.056	0.000	-0.180	0.092					
<i>PPE</i>	0.030	-0.049	-0.032	0.103	-0.008	-0.031	-0.393	-0.110	0.082	-0.131	0.332	0.032	0.397	-0.255	-0.188	0.029	-0.120	-0.058	0.037	-0.209	-0.120				
<i>RD</i>	-0.007	-0.060	-0.054	-0.013	0.005	0.010	-0.017	0.242	0.120	0.150	-0.198	-0.022	-0.119	-0.111	0.432	-0.042	0.201	-0.071	0.002	0.196	-0.096	-0.270			
<i>ADV</i>	-0.108	0.096	0.025	-0.051	0.114	0.059	0.158	-0.024	-0.035	0.059	-0.025	-0.163	-0.121	0.027	-0.046	0.032	0.096	0.098	-0.121	0.132	0.149	-0.155	0.008		
<i>Size</i>	-0.122	-0.069	0.014	0.004	0.450	0.248	-0.034	-0.075	-0.188	0.263	-0.065	0.079	0.012	-0.093	0.027	0.007	0.362	-0.048	-0.117	0.069	0.163	0.116	0.042	0.057	

Panel B: Correlation of Major Variables (IT=IT Labor)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
<i>IT</i>																									
<i>AvgIT_InterlockFirm</i>	0.101																								
<i>MatchedInterlockIT</i>	-0.073	-0.026																							
<i>NeighborhoodIT</i>	0.105	-0.035	-0.008																						
<i>log(#InterlockFirms)</i>	-0.069	-0.068	0.006	-0.065																					
<i>AvgIWRank_InterlockFirm</i>	0.029	-0.088	-0.009	0.129	0.259																				
<i>CR4</i>	-0.218	0.035	0.069	-0.076	0.101	0.082																			
<i>Uncertainty</i>	0.040	-0.064	0.000	0.008	-0.084	0.034	0.011																		
<i>Diversification</i>	0.083	-0.024	-0.007	-0.036	-0.285	-0.080	-0.076	0.025																	
<i>AdjustedROA</i>	-0.055	-0.061	0.033	0.049	0.037	-0.017	0.166	-0.094	-0.061																
<i>Leverage</i>	0.079	-0.077	0.056	0.033	0.065	0.011	-0.253	-0.066	-0.078	-0.212															
<i>Growth</i>	-0.140	-0.023	0.026	0.035	-0.066	-0.003	0.081	0.052	0.025	0.167	-0.107														
<i>Auto</i>	0.067	-0.070	-0.053	0.057	0.023	-0.059	-0.251	-0.011	-0.026	-0.284	0.216	0.034													
<i>Trans</i>	0.139	0.093	0.009	0.035	-0.071	0.004	-0.027	0.122	0.046	0.016	-0.087	-0.061	-0.258												
<i>HighTech</i>	0.021	-0.019	-0.041	0.024	0.010	-0.040	-0.016	0.085	0.082	0.108	-0.028	0.012	-0.189	0.076											
<i>IndustryIT</i>	0.196	0.043	0.041	0.012	0.065	0.072	-0.120	0.046	-0.063	-0.039	0.085	0.018	0.031	0.024	-0.086										
<i>Tobin's Q</i>	0.014	-0.011	0.044	0.026	0.012	0.103	0.107	0.023	0.117	0.455	-0.201	0.137	-0.136	0.067	0.064	-0.049									
<i>InterlockDrivenIT</i>	0.134	0.873	-0.010	0.016	-0.040	0.155	0.046	-0.055	-0.014	-0.059	-0.081	-0.005	-0.076	0.101	-0.030	0.077	0.021								
<i>ResidualIT</i>	0.993	-0.003	-0.072	0.104	-0.065	0.011	-0.226	0.047	0.085	-0.048	0.089	-0.141	0.077	0.129	0.024	0.188	0.012	0.016							
<i>IndustryQ</i>	-0.104	0.059	0.072	0.037	0.013	0.066	0.327	0.073	-0.041	0.447	-0.167	0.095	-0.287	0.118	0.188	-0.071	0.327	0.064	-0.113						
<i>MarketShare</i>	-0.179	-0.026	0.115	-0.042	0.149	0.108	0.612	-0.114	-0.056	0.061	-0.062	-0.032	-0.027	-0.071	-0.091	-0.109	0.056	-0.009	-0.180	0.092					
<i>PPE</i>	0.030	-0.048	-0.035	0.104	-0.008	-0.031	-0.393	-0.110	0.082	-0.131	0.332	0.032	0.397	-0.255	-0.188	0.037	-0.120	-0.055	0.036	-0.209	-0.120				
<i>RD</i>	-0.004	-0.060	-0.054	-0.013	0.005	0.010	-0.017	0.242	0.120	0.150	-0.198	-0.022	-0.119	-0.111	0.432	-0.042	0.201	-0.072	0.005	0.196	-0.096	-0.270			
<i>ADV</i>	-0.109	0.092	0.024	-0.052	0.114	0.059	0.158	-0.024	-0.035	0.059	-0.025	-0.163	-0.121	0.027	-0.046	0.029	0.096	0.090	-0.121	0.132	0.149	-0.155	0.008		
<i>Size</i>	-0.124	-0.070	0.012	0.003	0.450	0.248	-0.034	-0.075	-0.188	0.263	-0.065	0.079	0.012	-0.093	0.027	0.006	0.362	-0.062	-0.118	0.069	0.163	0.116	0.042	0.057	

Table A3: Ten Largest Companies (Total Assets) in Our Sample and Their Interlocked Firms, 2008

Company name	#InterlockFirms	List of interlocked firms
American International Group	14	Campbell Soup Co, EQT Corp, PepsiCo Inc., Pfizer In., Symantec Corp, Intuit Inc., Digital River Inc., Visa Inc., HSN Inc., Kate Spade & Co, Harley-Davidson Inc., Hillshire Brands Co, Intl Flavors & Fragrances, 3M Co
Hartford Financial Services	9	Alcoa Inc., CSX Corp, Rayonier Inc., Tenet Healthcare Corp, Cedar Realty Trust Inc., United Technologies Corp, DTE Energy Co, Hershey Co, American Electric Power Co
Ford Motor Co	11	Conagra Foods Inc., Intel Corp, Lilly (Eli) & Co, New York Times Co -Cl A, Twenty-First Century Fox Inc., United States Steel Corp, AGCO Corp, Lauder (Estee) Cos Inc., Masco Corp, DTE Energy Co, Centene Corp
Chevron Corp	15	Amgen Inc., Cummins Inc., General Electric Co, McDonald's Corp, New York Times Co, Nordstrom Inc., Northrop Grumman Corp, Wells Fargo & Co, Dell Inc., Exponent Inc., Callaway Golf Co, Coca-Cola Co, Vulcan Materials Co, Honeywell International Inc., Franklin Resources Inc.
Time Warner Inc.	6	Omnicom Group, FedEx Corp, Macy's Inc., Sun Microsystems Inc., Kb Home, Mondelez International Inc.
Genworth Financial Inc.	11	Interpublic Group Of Cos, Tenet Healthcare Corp, Sigma-Aldrich Corp, Scientific Games Corp, Express Scripts Holding Co, Corporate Executive Brd Co, Nasdaq OMX Group Inc., MasterCard Inc., Kate Spade & Co, Hess Corp, Textron Inc.
Johnson & Johnson	11	JPMorgan Chase & Co, Weyerhaeuser Co, Xerox Corp, Agilent Technologies Inc., MetLife Inc., Prudential Financial Inc., AMN Healthcare Services Inc., Neustar Inc., Meredith Corp, Hershey Co, Genuine Parts Co
Aflac Inc.	3	Total System Services Inc., Synovus Financial Corp, Tupperware Brands Corp
Cisco Systems Inc.	7	Autodesk Inc., Dionex Corp, National Semiconductor Corp, Wells Fargo & Co, Wal-Mart Stores Inc., Yahoo Inc., Google Inc.
United Technologies Corp	16	Intl Paper Co, Marathon Oil Corp, Tenet Healthcare Corp, Northrop Grumman Corp, Wells Fargo & Co, ConocoPhillips, Procter & Gamble Co, Schlumberger Ltd, Texas Instruments Inc., DirecTV, United States Steel Corp, Intuit Inc., Eclipsys Corp, Aon Plc, Hartford Financial Services, Deere & Co

Table A4: Three Most Frequent SIC Codes of Interlocked Firms across Industries

2-digit SIC	Industry name	Three most frequent 2-digit SIC codes of interlocked firms		
		Most freq.	2nd-most freq.	3rd-most freq.
		(firm-year frequency in parentheses)		
01	Agricultural Production – Crops	37 (7)	38 (7)	64 (7)
10	Metal, Mining	13 (12)	35 (9)	49 (9)
12	Coal Mining	49 (22)	13 (18)	28 (9)
13	Oil & Gas Extraction	13 (270)	28 (105)	49 (102)
14	Nonmetallic Minerals, Except Fuels	60 (17)	28 (14)	35 (9)
15	General Building Contractors	73 (27)	63 (20)	13 (18)
16	Heavy Construction, Except Building	13 (27)	36 (18)	49 (17)
17	Special Trade Contractors	35 (11)	49 (11)	36 (8)
20	Food & Kindred Products	73 (158)	28 (147)	60 (112)
21	Tobacco Products	73 (9)	28 (8)	27 (7)
22	Textile Mill Products	36 (11)	73 (8)	28 (7)
23	Apparel & Other Textile Products	73 (23)	60 (22)	28 (21)
24	Lumber & Wood Products	38 (21)	60 (16)	27 (14)
25	Furniture & Fixtures	36 (37)	49 (29)	73 (28)
26	Paper & Allied Products	49 (103)	28 (101)	60 (82)
27	Printing & Publishing	28 (71)	35 (55)	60 (54)
28	Chemical & Allied Products	28 (446)	38 (249)	35 (238)
29	Petroleum & Coal Products	28 (82)	49 (45)	73 (40)
30	Rubber & Misc. Plastics Products	28 (54)	48 (35)	20 (30)
31	Leather & Leather Products	56 (22)	60 (10)	25 (9)
32	Stone, Clay, & Glass Products	13 (11)	42 (10)	60 (10)
33	Primary Metal Industries	28 (69)	35 (56)	49 (47)
34	Fabricated Metal Products	49 (50)	35 (49)	28 (44)
35	Industrial Machinery & Equipment	36 (363)	35 (342)	73 (248)
36	Electronic & Other Electric Equip.	36 (410)	35 (363)	38 (218)
37	Transportation Equipment	35 (126)	28 (116)	49 (101)
38	Instruments & Related Products	28 (249)	38 (232)	36 (218)
39	Misc. Manufacturing Industries	73 (41)	28 (28)	59 (22)
40	Railroad Transportation	60 (30)	28 (29)	20 (27)
42	Trucking & Warehousing	73 (34)	49 (23)	34 (16)
44	Water Transportation	13 (26)	49 (22)	60 (17)
45	Transportation by Air	35 (31)	48 (23)	37 (21)
47	Transportation Services	36 (14)	49 (12)	63 (12)
48	Communications	28 (99)	73 (84)	49 (74)
49	Electric, Gas, & Sanitary Services	60 (276)	28 (202)	49 (162)
50	Wholesale Trade - Durable Goods	28 (91)	60 (69)	73 (68)
51	Wholesale Trade - Nondur. Goods	28 (45)	63 (35)	35 (33)
52	Building Materials & Gardening Supplies	49 (19)	36 (18)	20 (16)
53	General Merchandise Stores	73 (61)	20 (53)	28 (39)
54	Food Stores	73 (25)	49 (23)	63 (22)
55	Automotive Dealers & Service Stations	60 (16)	49 (15)	53 (12)
56	Apparel & Accessory Stores	59 (57)	56 (46)	57 (35)
57	Furniture & Homefurnishings Stores	56 (35)	73 (27)	59 (20)
58	Eating & Drinking Places	60 (63)	20 (52)	73 (40)
59	Miscellaneous Retail	56 (57)	28 (55)	73 (44)
60	Depository Institutions	49 (276)	28 (191)	35 (162)
61	Nondepository Institutions	73 (49)	28 (36)	49 (35)
62	Security & Commodity Brokers	73 (68)	28 (66)	36 (46)
63	Insurance Carriers	73 (171)	28 (162)	60 (130)
64	Insurance Agents, Brokers, & Serv.	35 (41)	49 (29)	48 (19)
65	Real Estate	67 (7)	73 (7)	49 (6)
67	Holding & Other Investment Offices	67 (124)	49 (38)	60 (35)

70	Hotels & Other Lodging Places	49 (18)	61 (11)	73 (9)
72	Personal Services	28 (10)	49 (9)	26 (8)
73	Business Services	73 (514)	35 (248)	36 (218)
75	Auto Repair, Services, & Parking	20 (19)	36 (14)	59 (14)
78	Motion Pictures	73 (9)	53 (6)	28 (3)
79	Amusement & Recreation Services	49 (25)	60 (20)	48 (12)
80	Health Services	28 (75)	80 (64)	63 (53)
83	Social Services	40 (4)	38 (2)	48 (2)
87	Engineering & Management Services	73 (60)	35 (54)	28 (38)
99	Non-Classifiable Establishments	28 (15)	20 (14)	73 (14)

Table A5: Distribution of Number of Board Meetings by Industry

2-digit SIC	Industry name	# of board meetings		
		Median	Min.	Max.
01	Agricultural Production - Crops	7	6	12
10	Metal, Mining	8	5	20
12	Coal Mining	10.5	4	21
13	Oil & Gas Extraction	6.5	4	21
14	Nonmetallic Minerals, Except Fuels	5	4	11
15	General Building Contractors	7	4	14
16	Heavy Construction, Except Building	8	5	18
17	Special Trade Contractors	8	8	8
20	Food & Kindred Products	7	4	25
21	Tobacco Products	7	7	10
22	Textile Mill Products	7	5	10
23	Apparel & Other Textile Products	6	4	25
24	Lumber & Wood Products	6	4	17
25	Furniture & Fixtures	5	4	13
26	Paper & Allied Products	6	4	16
27	Printing & Publishing	6	4	24
28	Chemical & Allied Products	7	4	32
29	Petroleum & Coal Products	8	6	12
30	Rubber & Miscellaneous Plastics Products	6	5	13
31	Leather & Leather Products	5	4	9
32	Stone, Clay, & Glass Products	6	5	13
33	Primary Metal Industries	8	4	37
34	Fabricated Metal Products	6.5	4	34
35	Industrial Machinery & Equipment	6	4	19
36	Electronic & Other Electric Equipment	7	4	25
37	Transportation Equipment	7	3	17
38	Instruments & Related Products	7	4	23
39	Miscellaneous Manufacturing Industries	6	4	10
40	Railroad Transportation	6	4	8
42	Trucking & Warehousing	6	4	10
44	Water Transportation	10	7	15
45	Transportation by Air	9	5	14
47	Transportation Services	6	4	8
48	Communications	8	1	14
49	Electric, Gas, & Sanitary Services	8	4	49
50	Wholesale Trade - Durable Goods	6	4	19
51	Wholesale Trade - Nondurable Goods	7	5	13
52	Building Materials & Gardening Supplies	4	4	4
53	General Merchandise Stores	7	4	16
54	Food Stores	7	6	13
55	Automotive Dealers & Service Stations	6	5	11
56	Apparel & Accessory Stores	7	3	28
57	Furniture & Homefurnishings Stores	6.5	4	12
58	Eating & Drinking Places	7	3	13
59	Miscellaneous Retail	7	4	29
60	Depository Institutions	15	15	15
61	Nondepository Institutions	8	4	19
62	Security & Commodity Brokers	6	4	18
63	Insurance Carriers	7	4	34
64	Insurance Agents, Brokers, & Service	7	4	17
65	Real Estate	10	9	13
67	Holding & Other Investment Offices	9	9	9
70	Hotels & Other Lodging Places	6	1	21

72	Personal Services	6	4	13
73	Business Services	7	4	20
75	Auto Repair, Services, & Parking	7	5	8
78	Motion Pictures	7	4	13
79	Amusement & Recreation Services	6	5	11
80	Health Services	5	4	12
83	Social Services	5.5	4	7
87	Engineering & Management Services	6	4	14
99	Non-Classifiable Establishments	8	7	9

Table A6: Performance Effects of Board-Interlock-Driven IT Investment Conditional on the Focal Firm's IT Capability

	DV=TobinsQ			
	IT=CRM&SCM		IT=IT Labor	
	(1) #Meetings High	(2) #Meetings Low	(3) #Meetings High	(4) #Meetings Low
InterlockDrivenIT_High_Rank	9.876*** (1.291)	0.222 (3.487)	0.133*** (0.016)	-0.003 (0.043)
InterlockDrivenIT_Low_Rank	7.437*** (1.466)	-1.787 (3.603)	0.099*** (0.019)	-0.030 (0.044)
ResidualIT	0.997*** (0.146)	1.175* (0.506)	0.013*** (0.002)	0.014* (0.006)
Lag(TobinsQ)	0.788*** (0.007)	0.771*** (0.015)	0.787*** (0.007)	0.772*** (0.015)
IndustryQ	0.262*** (0.011)	-0.124 (0.075)	0.260*** (0.011)	-0.129+ (0.075)
MarketShare	-0.011 (0.014)	-0.274*** (0.045)	-0.007 (0.014)	-0.279*** (0.044)
PPE	0.151*** (0.018)	0.124 (0.117)	0.145*** (0.018)	0.115 (0.116)
RD	-0.083 (0.134)	-0.078 (0.525)	-0.092 (0.140)	-0.130 (0.518)
ADV	0.089 (0.191)	2.944*** (0.587)	0.102 (0.193)	2.933*** (0.584)
Size	0.068*** (0.004)	0.085*** (0.011)	0.069*** (0.004)	0.085*** (0.011)
MonitorIntensive	-0.038*** (0.009)	0.026 (0.023)	-0.038*** (0.009)	0.025 (0.023)
IndependentDirector	0.035 (0.142)	0.014 (0.097)	0.033 (0.143)	0.016 (0.096)
CEO_Duality	-0.040*** (0.007)	-0.136*** (0.022)	-0.039*** (0.007)	-0.137*** (0.022)
Observations	616	277	616	277
R-squared	0.802	0.837	0.802	0.837
Number of firms	301	159	301	159
Year&industry FE	YES	YES	YES	YES

Standard errors are in parentheses and calculated by clustering firms and using heteroscedasticity-consistent estimation; *** p<0.001, ** p<0.01, * p<0.05, +p<0.1;

InterlockDrivenIT_High_Rank (InterlockDrivenIT_Low_Rank) is the board-interlock-driven IT investment of the focal firm with IW ranking higher (lower) than the sample mean; other variables are defined in Table A1.

Part B: Three-Way Interaction Analysis

In addition to the sample-split specification in the main analyses, we use a three-way interaction approach to test the joint effect of average IT of interlocked firms (*AvgIT_InterlockFirm*), the average IW ranking of interlocked firms (*AvgIWRank_InterlockFirm*), and the number of board meetings (*#Meetings*) on the focal firm's IT investment. We use this alternative model (based on a three-way interaction) to assess the robustness of our empirical results. The three-way interaction model is as follows:

$$\begin{aligned}
 IT_{lt} = & \alpha + \beta_1(AvgIT_InterlockFirm_{lt}) + \beta_2(AvgIWRank_InterlockFirm_{lt}) \\
 & + \beta_3(\#Meetings_{lt}) \\
 & + \beta_4(AvgIT_InterlockFirm_{lt} \times AvgIWRank_InterlockFirm_{lt}) \\
 & + \beta_5(AvgIT_InterlockFirm_{lt} \times \#Meetings_{lt}) \\
 & + \beta_6(AvgIWRank_InterlockFirm_{lt} \times \#Meetings_{lt}) \\
 & + \beta_7(AvgIT_InterlockFirm_{lt} \times AvgIWRank_InterlockFirm_{lt} \\
 & \times \#Meetings_{lt}) \\
 & + \sum_k \theta_k(Control\ Variable\ k_{lt}) + \varepsilon_{lt}
 \end{aligned} \tag{B1}$$

for which *IT* is either *CRM&SCM* or *IT Labor*; *#Meetings* is the within-industry percentile rank of the number of board meetings; other variables are defined in Table A1.

We expect the coefficient β_7 (on the three-way interaction term) to be positive. We report the regression results in Table B1. We find that the coefficient on the three-way interaction term is positive and significant, suggesting that the focal firm is more influenced by its interlocked partners that have higher IT capability when the board is active with frequent board meetings. The three-way interaction model thus lends further support to H1c.

We also follow Aral et al. (2012) and present a graphical cube view of the three-way interaction. Figure B1 shows a $1 \times 1 \times 1$ cube with the *x*-axis representing average IT of interlocked firms (*AvgIT_InterlockFirm*), the *y*-axis representing the average IW ranking of interlocked firms (*AvgIWRank_InterlockFirm*), and the *z*-axis representing the number of board meetings (*#Meetings*). The cube-view analysis (Aral et al. 2012) uses a binary version of the variables to label the coordinates in the cube, with 0 denoting a low level and 1 denoting a high level. For example, the coordinate (1, 1, 1) indicates a firm with high levels of average IT, IW ranking of interlocked firms, and number of board meetings. We define a high (low) level of a variable as its sample mean plus (minus) one standard deviation.

We have applied the cube-analysis for both IT measures, *CRM&SCM* or *IT Labor*. Take *CRM&SCM* as an example. When the number of board meetings is high, the effect of interlocked firms' IT (i.e., an increase of focal firms' IT when an interlocked firm's IT increases from a low level to a high level) on the focal firm's IT is 0.537 ($p=0.002$) when the average IW ranking of interlocked firms is high. The effect of interlocked firms' IT on the focal firm's IT is 0.055 ($p=0.573$) when the average IW ranking of interlocked firms is low. The difference between these two numbers—labeled as *Diff(#Meetings_High)*—is 0.483 ($p=0.003$), indicating that interlocked firms' IW ranking positively moderates the relationship between a focal firm's IT investment and that of its interlocked firms.

When the number of board meetings is low, the effect of interlocked firms' IT on the focal firm's IT is 0.351 ($p=0.088$) when the average IW ranking of interlocked firms is high. The effect of interlocked firms' IT on the focal firm's IT is 0.162 ($p=0.459$) when the average IW ranking of interlocked firms is low. The difference between these two numbers—labeled as *Diff(#Meetings_Low)*—is 0.189 ($p=0.298$), indicating that the moderation effect of interlocked firms' IW ranking is not statistically significant when the number of board meetings is low.

The cube analysis further compares the difference between the moderation effects of interlocked firms' IW ranking in the two *#Meetings_High* and *#Meetings_Low* cases by comparing *Diff(#Meetings_High)* and *Diff(#Meetings_Low)*. The difference is 0.294, which is statistically significant ($p=0.044$). This indicates that the moderation effect is significantly stronger when the focal firm holds more board meetings with its interlocked firms, thus lending support to H1c.

In conclusion, the regressions using the three-way interaction approach (Table B1) and the cube view (Figure B1) are consistent with what we have found in our main analyses.

Reference:

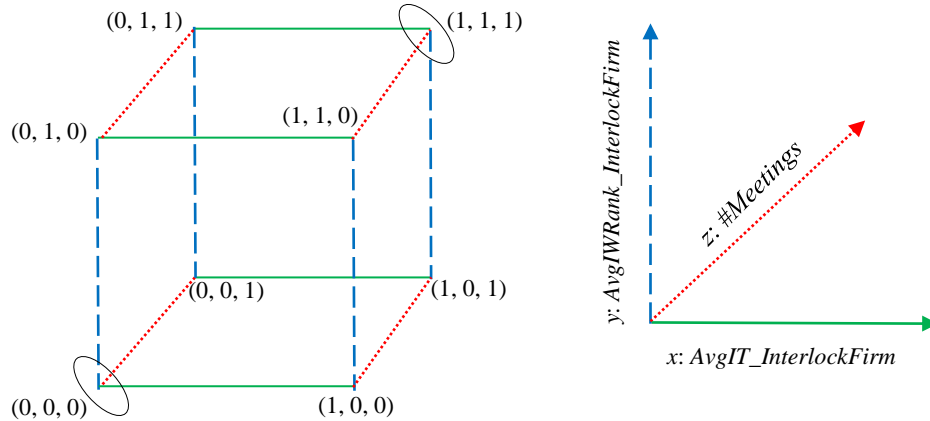
Aral, S. Brynjolfsson, E., Wu. L. 2012. Three-way complementarities: Performance pay, human resource analytics, and information technology. *Management Science* 58(5):913–931.

Table B1: Regressions Using the Three-way Interaction Approach

	IT=CRM&SCM (1)	IT=IT Labor (2)
AvgIT_InterlockFirm	0.234*** (0.034)	0.242*** (0.034)
AvgIT_InterlockFirm X AvgIWRank_InterlockFirm	0.253** (0.083)	0.235** (0.080)
AvgIT_InterlockFirm X AvgIWRank_InterlockFirm X #Meetings	0.272* (0.115)	0.311** (0.111)
AvgIT_InterlockFirm X #Meetings	0.003 (0.052)	-0.016 (0.052)
AvgIWRank_InterlockFirm X #Meetings	0.000 (0.002)	0.018 (0.141)
#Meetings	0.001+ (0.001)	0.101+ (0.055)
AvgIWRank_InterlockFirm	0.005*** (0.001)	0.387*** (0.095)
Ln(#InterlockFirm)	-0.005*** (0.001)	-0.400*** (0.044)
AvgIT_InterlockFirm X Ln(#InterlockFirm)	-0.332*** (0.053)	-0.323*** (0.055)
MatchedInterlockIT	-0.048** (0.015)	-0.045** (0.015)
NeighborhoodIT	0.145*** (0.017)	0.142*** (0.018)
CR4	0.003 (0.002)	0.166 (0.166)
Uncertainty	0.011 (0.008)	0.839 (0.660)
Diversification	0.001 (0.001)	0.118 (0.078)
AdjustedROA	0.007+ (0.004)	0.446 (0.328)
Leverage	0.001 (0.002)	0.023 (0.190)
Growth	-0.023*** (0.002)	-1.787*** (0.169)
Auto	0.008+ (0.004)	0.681* (0.341)
Trans	0.016*** (0.004)	1.253*** (0.333)
HighTech	0.001 (0.002)	0.101 (0.179)
IndustryIT	0.247*** (0.073)	0.239** (0.076)
MonitorIntensive	0.001** (0.000)	0.097** (0.031)
IndependentDirector	-0.004+ (0.002)	-0.266+ (0.152)
CEO_Duality	-0.002*** (0.000)	-0.126*** (0.038)
Observations	739	739
R-squared	0.278	0.278
Number of firms	326	326
Year&industry FE	YES	YES

Standard errors are in parentheses and calculated by clustering firms and using heteroscedasticity-consistent estimation; *** p<0.001, ** p<0.01, * p<0.05, +p<0.1

Figure B1: Cube View of Three-Way Interactions



IT=CRM&SCM			
	Effect of interlocked firms' IT on the focal firm's IT	p-value	
#Meetings High			
<i>AvgWRank_InterlockFirm</i> (High)	0.537**	0.002	F(1,1,1)-F(0,1,1)
<i>AvgWRank_InterlockFirm</i> (Low)	0.055	0.573	F(1,0,1)-F(0,0,1)
<u>Diff (#Meetings High)</u>	0.483**	0.003	[F(1,0,1)-F(0,0,1)]-[F(1,1,1)-F(0,1,1)]
#Meetings Low			
<i>AvgWRank_InterlockFirm</i> (High)	0.351†	0.088	F(1,1,0)-F(0,1,0)
<i>AvgWRank_InterlockFirm</i> (Low)	0.162	0.459	F(1,0,0)-F(0,0,0)
<u>Diff (#Meetings Low)</u>	0.189	0.298	[F(1,0,1)-F(0,0,1)]-[F(1,1,1)-F(0,1,1)]
<u>Diff (#Meetings High) - Diff (#Meetings Low)</u>	0.294*	0.044	{[F(1,0,1)-F(0,0,1)]-[F(1,1,1)-F(0,1,1)]} - {[F(1,0,1)-F(0,0,1)]-[F(1,1,1)-F(0,1,1)]}

IT=IT Labor			
	Effect of interlocked firms' IT on the focal firm's IT	p-value	
#Meetings High			
<i>AvgWRank_InterlockFirm</i> (High)	0.553**	0.001	F(1,1,1)-F(0,1,1)
<i>AvgWRank_InterlockFirm</i> (Low)	0.051	0.599	F(1,0,1)-F(0,0,1)
<u>Diff (#Meetings High)</u>	0.503**	0.004	[F(1,0,1)-F(0,0,1)]-[F(1,1,1)-F(0,1,1)]
#Meetings Low			
<i>AvgWRank_InterlockFirm</i> (High)	0.350†	0.086	F(1,1,0)-F(0,1,0)
<i>AvgWRank_InterlockFirm</i> (Low)	0.172	0.446	F(1,0,0)-F(0,0,0)
<u>Diff (#Meetings Low)</u>	0.178	0.341	[F(1,0,1)-F(0,0,1)]-[F(1,1,1)-F(0,1,1)]
<u>Diff (#Meetings High) - Diff (#Meetings Low)</u>	0.325*	0.0387	{[F(1,0,1)-F(0,0,1)]-[F(1,1,1)-F(0,1,1)]} - {[F(1,0,1)-F(0,0,1)]-[F(1,1,1)-F(0,1,1)]}

The tests are based on regression results from Table B1, where *AvgWRank_InterlockFirm* High (Low) means one standard deviation above (below) the mean; *** p<0.001, ** p<0.01, * p<0.05, + p<0.1