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Social network and radical innovation: evidence from the U.S. pharmaceutical and biotechnology industry

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Citation

Zhang, J. (2024, April 24). *Social network and radical innovation: evidence from the U.S. pharmaceutical and biotechnology industry*. Retrieved from <https://hdl.handle.net/1887/3748535>

Version: Publisher's Version

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Appendix A

Table A1. Alternative radicalness measure using longer time window

	Radicalness			
	(1)	(2)	(3)	(4)
Tie strength (ln)		-0.010*** (0.002)	-0.008*** (0.003)	-0.012*** (0.003)
Structural hole			-0.005 (0.004)	-0.007* (0.004)
Tie strength (ln) * Structural hole				0.005* (0.003)
Innovation productivity (ln)	0.003*** (0.001)	0.010*** (0.002)	0.008*** (0.002)	0.008*** (0.002)
Network size (ln)	-0.003** (0.001)	-0.006*** (0.002)	-0.006*** (0.002)	-0.006*** (0.002)
Collaboration inclination	-0.015*** (0.005)	-0.003 (0.005)	-0.006 (0.006)	-0.006 (0.006)
Year FE	Yes	Yes	Yes	Yes
Firm-location FE	Yes	Yes	Yes	Yes
N	19343	19343	19343	19343
R-square	0.726	0.727	0.727	0.727

Note: Robust standard error in parentheses. ***p < 0.01; **p < 0.05; *p < 0.1.

Table A2. Fewer controls

	Radicalness			
	(1)	(2)	(3)	(4)
Tie strength (ln)	-0.004* (0.002)	-0.011*** (0.003)	-0.016*** (0.003)	-0.009*** (0.002)
Structural hole	-0.019*** (0.004)	-0.009** (0.004)	-0.006* (0.004)	-0.012*** (0.003)
Tie strength (ln) * Structural hole	0.006** (0.003)	0.009*** (0.003)	0.007** (0.003)	0.009*** (0.003)
Innovation productivity (ln)		0.002 (0.002)	0.011*** (0.002)	
Network size (ln)	-0.006*** (0.001)		-0.010*** (0.002)	
Collaboration inclination	-0.018*** (0.004)	-0.017*** (0.005)		
Year FE	Yes	Yes	Yes	Yes
Firm-location FE	Yes	Yes	Yes	Yes
N	19343	19343	19343	19343
R-square	0.697	0.696	0.698	0.695

Note: Robust standard error in parentheses. ***p < 0.01; **p < 0.05; *p < 0.1.

Appendix B

Table B1. Robustness test: Dropping control variables

[illegible]

	Innovation success											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
R-square	0.753	0.752	0.753	0.757	0.757	0.758	0.758	0.757	0.758	0.752	0.751	0.752
F Statistic	61.96***	56.95***	60.24***	71.38***	66.52***	69.04***	71.73***	67.11***	69.42***	65.95***	60.41***	63.86***

Note: Robust standard error in parentheses. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

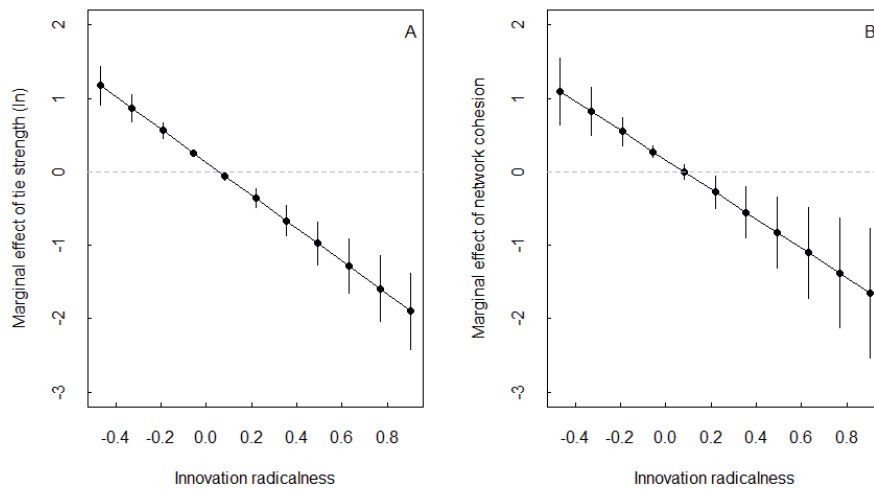


Figure B1. Robustness test: Dropping control variables. Points represent the regression coefficients, and vertical bars represent 90% confidence interval.

Appendix C

Table C1. Do not control the number of citations

	ln(Private value) OLS			
	(1)	(2)	(3)	(4)
Destructiveness	-0.080*** (0.004)		-0.077*** (0.004)	-0.078*** (0.004)
Dissimilarity		0.199*** (0.006)	0.198*** (0.006)	0.198*** (0.006)
Dissimilarity * Destructiveness				0.019*** (0.003)
ln(References)	0.159*** (0.006)	0.198*** (0.006)	0.167*** (0.006)	0.167*** (0.006)
Patent class * Year fixed effects	Y	Y	Y	Y
N	1066637	1066637	1066637	1066637
R-square	0.193	0.197	0.198	0.198

Note. Destructiveness and dissimilarity are standardized. Robust standard error clustered at patent class * year level in paratheses. *** p<.001, ** p<.01, * p<.05.

Table C2. Alternative destructiveness measure: Shorter and fixed time window

	ln(Private value)			
	OLS			
	(1)	(2)	(3)	(4)
Destructiveness (5Y)	-0.139*** (0.004)		-0.135*** (0.004)	-0.135*** (0.004)
Dissimilarity		0.203*** (0.006)	0.200*** (0.006)	0.200*** (0.006)
Dissimilarity * Destructiveness (5Y)				0.024*** (0.003)
ln(References)	0.109*** (0.006)	0.171*** (0.006)	0.118*** (0.006)	0.118*** (0.006)
ln(Citations 5Y)	0.202*** (0.005)	0.180*** (0.005)	0.199*** (0.005)	0.199*** (0.005)
Patent class * Year fixed effects	Y	Y	Y	Y
N	950308	950308	950308	950308
R-square	0.203	0.205	0.208	0.208

Note. Destructiveness (5Y) and dissimilarity are standardized. Robust standard error clustered at patent class * year level in paratheses. *** p<.001, ** p<.01, * p<.05.

Table C3. Alternative destructiveness measure: Originality

	ln(Private value)			
	OLS			
	(1)	(2)	(3)	(4)
Originality	-0.054*** (0.003)		-0.051*** (0.003)	-0.054*** (0.003)
Dissimilarity		0.196*** (0.006)	0.195*** (0.006)	0.194*** (0.006)
Dissimilarity * Originality				0.014*** (0.003)
ln(References)	0.148*** (0.006)	0.153*** (0.006)	0.156*** (0.006)	0.156*** (0.006)
ln(Citations)	0.210*** (0.004)	0.209*** (0.004)	0.208*** (0.004)	0.208*** (0.004)
Patent class * Year fixed effects	Y	Y	Y	Y
N	1066637	1066637	1066637	1066637
R-square	0.202	0.206	0.207	0.207

Note. Originality and dissimilarity and are standardized. Robust standard error clustered at patent class * year level in paratheses. *** p<.001, ** p<.01, * p<.05.

Table C4. Alternative dissimilarity measures: Ratio of new keywords

	ln(Private value)			
	OLS			
	(1)	(2)	(3)	(4)
Destructiveness	-0.143*** (0.004)		-0.143*** (0.004)	-0.146*** (0.004)
Ratio of new keywords		0.008** (0.002)	0.009*** (0.002)	0.007** (0.002)
Ratio of new keywords * Destructiveness				0.012*** (0.002)
ln(References)	0.082*** (0.006)	0.145*** (0.006)	0.083*** (0.006)	0.082*** (0.006)
ln(Citations)	0.237*** (0.005)	0.211*** (0.004)	0.237*** (0.005)	0.237*** (0.005)
Patent class * Year fixed effects	Y	Y	Y	Y
N	1066637	1066637	1066637	1066637
R-square	0.204	0.201	0.204	0.204

Note. Destructiveness and ratio of new keywords are standardized. Robust standard error clustered at patent class * year level in paratheses. *** p<.001, ** p<.01, * p<.05.

Table C5. Alternative dissimilarity measures: Ratio of new keyword pairs

	ln(Private value)			
	OLS			
	(1)	(2)	(3)	(4)
Destructiveness	-0.143*** (0.004)		-0.144*** (0.004)	-0.151*** (0.004)
Ratio of new keyword pairs		0.031*** (0.003)	0.034*** (0.003)	0.030*** (0.003)
Ratio of new keyword pairs * Destructiveness				0.020*** (0.002)
ln(References)	0.082*** (0.006)	0.146*** (0.006)	0.083*** (0.006)	0.081*** (0.006)
ln(Citations)	0.237*** (0.005)	0.209*** (0.004)	0.236*** (0.005)	0.236*** (0.005)
Patent class * Year fixed effects	Y	Y	Y	Y
N	1066637	1066637	1066637	1066637
R-square	0.204	0.201	0.204	0.204

Note. Destructiveness and ratio of new keyword pairs are standardized. Robust standard error clustered at patent class * year level in paratheses. *** p<.001, ** p<.01, * p<.05.

References

- Ahuja, G. (2000a). Collaboration networks, structural holes, and innovation: A longitudinal study. *Administrative Science Quarterly*, 45(3), 425-455.
- Ahuja, G. (2000b). The duality of collaboration: Inducements and opportunities in the formation of interfirm linkages. *Strategic Management Journal*, 21(3), 317-343.
- Ahuja, G., Lampert, C. M., & Tandon, V. (2014). Paradigm-changing vs. paradigm-deepening innovation: How firm scope influences firm technological response to shocks. *Organization Science*, 25(3), 653-669.
- Ahuja, G., & Morris Lampert, C. (2001). Entrepreneurship in the large corporation: a longitudinal study of how established firms create breakthrough inventions. *Strategic Management Journal*, 22(6-7), 521-543. <https://doi.org/10.1002/smj.176>
- Al-Laham, A., Tzabbar, D., & Amburgey, T. L. (2011). The dynamics of knowledge stocks and knowledge flows: innovation consequences of recruitment and collaboration in biotech. *Industrial and Corporate Change*, 20(2), 555-583.
- Alcácer, J., & Zhao, M. (2012). Local R&D Strategies and Multilocation Firms: The Role of Internal Linkages. *Management Science*, 58(4), 734-753. <https://doi.org/10.1287/mnsc.1110.1451>
- Almeida, P., & Phene, A. (2004). Subsidiaries and knowledge creation: The influence of the MNC and host country on innovation. *Strategic Management Journal*, 25(8-9), 847-864. <https://doi.org/Doi 10.1002/Smj.388>
- Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of Personality and Social Psychology*, 45(2), 357-376. <https://doi.org/10.1037//0022-3514.45.2.357>
- Anderson, N., Potočník, K., & Zhou, J. (2014). Innovation and creativity in organizations: A state-of-the-science review, prospective commentary, and guiding framework. *Journal of Management*, 40(5), 1297-1333.
- Anderson, P., & Tushman, M. L. (1990). Technological discontinuities and dominant designs: A cyclical model of technological change [Article]. *Administrative Science Quarterly*, 35(4), 604-633. <https://doi.org/10.2307/2393511>
- Arts, S., Cassiman, B., & Gomez, J. C. (2018). Text matching to measure patent similarity [Article]. *Strategic Management Journal*, 39(1), 62-84. <https://doi.org/10.1002/smj.2699>
- Arts, S., Hou, J. A., & Gomez, J. C. (2021). Natural language processing to identify

the creation and impact of new technologies in patent text: Code, data, and new measures [Article]. *Research Policy*, 50(2), 13, Article 104144. <https://doi.org/10.1016/j.respol.2020.104144>

- Audia, P. G., & Goncalo, J. A. (2007). Past success and creativity over time: A study of inventors in the hard disk drive industry. *Management Science*, 53(1), 1-15.
- Baer, M. (2010). The strength-of-weak-ties perspective on creativity: A comprehensive examination and extension. *Journal of applied psychology*, 95(3), 592.
- Baer, M. (2012). Putting creativity to work: The implementation of creative ideas in organizations. *Academy of Management Journal*, 55(5), 1102-1119.
- Balachandran, S., & Hernandez, E. (2018). Networks and innovation: Accounting for structural and institutional sources of recombination in brokerage triads. *Organization Science*, 29(1), 80-99.
- Barbulescu, R. (2015). The strength of many kinds of ties: Unpacking the role of social contacts across stages of the job search process. *Organization Science*, 26(4), 1040-1058.
- Bartoloni, E., & Baussola, M. (2018). Driving business performance: innovation complementarities and persistence patterns. *Industry and Innovation*, 25(5), 505-525.
- Belderbos, R., Grabowska, M., Kelchtermans, S., Leten, B., Jacob, J., & Riccaboni, M. (2021). Whither geographic proximity? Bypassing local R&D units in foreign university collaboration. *Journal of International Business Studies*, 52, 1302-1330.
- Belderbos, R., Leten, B., & Suzuki, S. (2017). Scientific research, firm heterogeneity, and foreign R&D locations of multinational firms. *Journal of Economics & Management Strategy*, 26(3), 691-711.
- Bernal, P., Maicas, J. P., & Vargas, P. (2019). Exploration, exploitation and innovation performance: disentangling the evolution of industry. *Industry and Innovation*, 26(3), 295-320.
- Bharadwaj, S., & Menon, A. (2000). Making Innovation Happen in Organizations: Individual Creativity Mechanisms, Organizational Creativity Mechanisms or Both? *Journal of Product Innovation Management*, 17(6), 424-434. <https://doi.org/https://doi.org/10.1111/1540-5885.1760424>
- Bian, Y. J. (1997). Bringing strong ties back in: Indirect ties, network bridges, and job searches in China [Article; Proceedings Paper]. *American Sociological*

- Review*, 62(3), 366-385. <https://doi.org/10.2307/2657311>
- Borgatti, S. P. (1997). Structural holes: Unpacking Burt's redundancy measures. *Connections*, 20(1), 35-38.
- Bourreau, M., Gensollen, M., & Moreau, F. (2012). The impact of a radical innovation on business models: incremental adjustments or big bang? *Industry and Innovation*, 19(5), 415-435.
- Bower, J. L., & Christensen, C. M. (1995). Disruptive technologies: catching the wave.
- Bu, Y., Waltman, L., & Huang, Y. (2021). A multidimensional framework for characterizing the citation impact of scientific publications. *Quantitative Science Studies*, 2(1), 155-183.
- Burt, R. S. (1990). Kinds of relations in American discussion networks. *Structures of power and constraint*, 411-451.
- Burt, R. S. (1992). *Structural holes: The social structure of competition*. Harvard university press.
- Burt, R. S. (2000). The network structure of social capital. *Research in Organizational Behavior*, 22, 345-423.
- Burt, R. S. (2004). Structural holes and good ideas. *American Journal of Sociology*, 110(2), 349-399.
- Capaldo, A. (2007). Network structure and innovation: The leveraging of a dual network as a distinctive relational capability. *Strategic Management Journal*, 28(6), 585-608.
- Capponi, G., Martinelli, A., & Nuvolari, A. (2022). Breakthrough innovations and where to find them. *Research Policy*, 51(1), 104376.
- Carlile, P. R. (2004). Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. *Organization Science*, 15(5), 555-568.
- Carlile, P. R., & Rebentisch, E. S. (2003). Into the black box: The knowledge transformation cycle. *Management Science*, 49(9), 1180-1195.
- Cattani, G., & Ferriani, S. (2008). A core/periphery perspective on individual creative performance: Social networks and cinematic achievements in the Hollywood film industry. *Organization Science*, 19(6), 824-844.
- Chang, Y.-C., Chang, H.-T., Chi, H.-R., Chen, M.-H., & Deng, L.-L. (2012). How do established firms improve radical innovation performance? The organizational capabilities view. *Technovation*, 32(7-8), 441-451.
- Chen, J., Shao, D., & Fan, S. (2021). Destabilization and consolidation:

Conceptualizing, measuring, and validating the dual characteristics of technology. *Research Policy*, 50(1).
<https://doi.org/10.1016/j.respol.2020.104115>

- Christensen, C. M. (2013). *The innovator's dilemma: when new technologies cause great firms to fail*. Harvard Business Review Press.
- Clark, K. B. (1987). *Managing technology in international competition: The case of product development in response to foreign entry*. Division of Research, Harvard Business School.
- Cohen, L., Diether, K., & Malloy, C. (2013). Misvaluing innovation [Article]. *Review of Financial Studies*, 26(3), 635-666.
<https://doi.org/10.1093/rfs/hhs183>
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 128-152.
- Coleman, J. S. (1988). Social Capital in the Creation of Human Capital. *American Journal of Sociology*, 94, S95-S120. <https://doi.org/10.2307/2780243>
- Cozzolino, A., Verona, G., & Rothaermel, F. T. (2018). Unpacking the disruption process: New technology, business models, and incumbent adaptation. *Journal of Management Studies*, 55(7), 1166-1202.
- Csikszentmihalyi, M. (1997). *Creativity: Flow and the psychology of discovery and invention*. Harper Collins.
- D'Ippolito, B., Petruzzelli, A. M., & Panniello, U. (2019). Archetypes of incumbents' strategic responses to digital innovation. *Journal of Intellectual Capital*.
- Dahlin, K. B., & Behrens, D. M. (2005). When is an invention really radical? Defining and measuring technological radicalness. *Research Policy*, 34(5), 717-737.
- De Rassenfosse, G., Kozak, J., & Seliger, F. (2019). Geocoding of worldwide patent data. *Scientific data*, 6(1), 1-15.
- Delgado-Verde, M., Martín-de Castro, G., & Amores-Salvadó, J. (2016). Intellectual capital and radical innovation: Exploring the quadratic effects in technology-based manufacturing firms. *Technovation*, 54, 35-47.
- Deyle, H.-G., & Grupp, H. (2005). Commuters and the regional assignment of innovative activities: A methodological patent study of German districts. *Research Policy*, 34(2), 221-234.
- Dong, J. Q., & Yang, C.-H. (2016). Being central is a double-edged sword: Knowledge network centrality and new product development in US pharmaceutical industry. *Technological Forecasting and Social Change*, 113,

379-385.

- Dosi, G. (1982). Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change [Article]. *Research Policy*, 11(3), 147-162. [https://doi.org/10.1016/0048-7333\(82\)90016-6](https://doi.org/10.1016/0048-7333(82)90016-6)
- Doz, Y. L. (1996). The evolution of cooperation in strategic alliances: initial conditions or learning processes? *Strategic Management Journal*, 17(S1), 55-83.
- Drazin, R., Glynn, M. A., & Kazanjian, R. K. (1999). Multilevel theorizing about creativity in organizations: A sensemaking perspective. *Academy of Management Review*, 24(2), 286-307. <https://doi.org/10.2307/259083>
- Du, H. S., Belderbos, R., & Somers, D. (2022). Research versus development: global cities and the location of MNCs' cross-border R&D investments. *Regional Studies*, 56(12), 2001-2018.
- Fazlıoğlu, B., Dalgıç, B., & Yereli, A. B. (2019). The effect of innovation on productivity: evidence from Turkish manufacturing firms. *Industry and Innovation*, 26(4), 439-460.
- Ferguson, J. P., & Carnabuci, G. (2017). Risky recombinations: Institutional gatekeeping in the innovation process [Article]. *Organization Science*, 28(1), 133-151. <https://doi.org/10.1287/orsc.2016.1106>
- Festinger, L., Schachter, S., & Back, K. (1950). Social pressures in informal groups; a study of human factors in housing.
- Fischer, C. S. (1982). *To dwell among friends: Personal networks in town and city*. University of Chicago Press.
- Fitzgerald, T., Balsmeier, B., Fleming, L., & Manso, G. (2021). Innovation search strategy and predictable returns [Article]. *Management Science*, 67(2), 30. <https://doi.org/10.1287/mnsc.2019.3480>
- Fleming, L. (2001). Recombinant uncertainty in technological search [Article]. *Management Science*, 47(1), 117-132. <https://doi.org/10.1287/mnsc.47.1.117.10671>
- Fleming, L., Mingo, S., & Chen, D. (2007). Collaborative brokerage, generative creativity, and creative success. *Administrative Science Quarterly*, 52(3), 443-475.
- Ford, C. M. (1996). Theory of individual creative action in multiple social domains. *Academy of Management Review*, 21(4), 1112-1142. <https://doi.org/10.2307/259166>

- Fox, C. R., & Tversky, A. (1995). Ambiguity aversion and comparative ignorance [Article]. *Quarterly Journal of Economics*, 110(3), 585-603. <https://doi.org/10.2307/2946693>
- Fredberg, T., & Piller, F. T. (2011). The paradox of tie strength in customer relationships for innovation: a longitudinal case study in the sports industry. *R&D Management*, 41(5), 470-484.
- Freeman, C. (1982). The economics of industrial innovation. In: Cambridge: The MIT Press.
- Funk, R. J., & Owen-Smith, J. (2017). A Dynamic Network Measure of Technological Change. *Management Science*, 63(3), 791-817. <https://doi.org/10.1287/mnsc.2015.2366>
- Garg, R., & Telang, R. (2018). To be or not to be linked: Online social networks and job search by unemployed workforce. *Management Science*, 64(8), 3926-3941.
- Gargiulo, M., & Benassi, M. (2000). Trapped in your own net? Network cohesion, structural holes, and the adaptation of social capital. *Organization Science*, 11(2), 183-196.
- Gargiulo, M., Ertug, G., & Galunic, C. (2009). The Two Faces of Control: Network Closure and Individual Performance among Knowledge Workers. *Administrative Science Quarterly*, 54(2), 299-333. <https://doi.org/10.2189/asqu.2009.54.2.299>
- Gee, L. K., Jones, J., & Burke, M. (2017). Social networks and labor markets: How strong ties relate to job finding on Facebook's social network. *Journal of Labor Economics*, 35(2), 485-518.
- Geroski, P., & Mazzucato, M. (2002). Learning and the sources of corporate growth. *Industrial and Corporate Change*, 11(4), 623-644.
- Granovetter, M. (1982). The strength of weak ties: A network theory revisited. Social structure and network analysis. PV Marsden and N. Lin. Beverly Hills. In: CA, Sage.
- Granovetter, M. (1995). *Getting a job: A study of contacts and careers*. 2nd ed. Cambridge, MA: Harvard University Press.
- Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology*, 78(6), 1360-1380.
- Gulati, R., Nohria, N., & Zaheer, A. (2000). Strategic networks. *Strategic Management Journal*, 21(3), 203-215.
- Hain, D., Jurowetzki, R., Buchmann, T., & Wolf, P. (2020). Text-based Technological

Signatures and Similarities: How to create them and what to do with them.
arXiv preprint arXiv:2003.12303.

- Hall, B. H., Jaffe, A., & Trajtenberg, M. (2005). Market value and patent citations [Article]. *Rand Journal of Economics*, 36(1), 16-38. <Go to ISI>://WOS:000229848900002
- Hall, B. H., Jaffe, A. B., & Trajtenberg, M. (2001). The NBER patent citation data file: Lessons, insights and methodological tools. In: National Bureau of Economic Research Cambridge, Mass., USA.
- Hansen, M. T. (1999). The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits [Article]. *Administrative Science Quarterly*, 44(1), 82-111. <https://doi.org/10.2307/2667032>
- Hargadon, A., & Sutton, R. I. (1997). Technology brokering and innovation in a product development firm. *Administrative Science Quarterly*, 716-749.
- Harhoff, D., Scherer, F. M., & Vopel, K. (2003). Citations, family size, opposition and the value of patent rights. *Research Policy*, 32(8), 1343-1363.
- Henderson, R. (1993). Underinvestment and incompetence as responses to radical innovation: Evidence from the photolithographic alignment equipment industry [Article]. *Rand Journal of Economics*, 24(2), 248-270. <https://doi.org/10.2307/2555761>
- Henderson, R. M., & Clark, K. B. (1990). Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms [Article]. *Administrative Science Quarterly*, 35(1), 9-30. <https://doi.org/10.2307/2393549>
- Hirshleifer, D., Hsu, P. H., & Li, D. M. (2013). Innovative efficiency and stock returns [Article]. *Journal of Financial Economics*, 107(3), 632-654. <https://doi.org/10.1016/j.jfineco.2012.09.011>
- Hirshleifer, D., Hsu, P. H., & Li, D. M. (2018). Innovative originality, profitability, and stock returns [Article]. *Review of Financial Studies*, 31(7), 2553-2605. <https://doi.org/10.1093/rfs/hhx101>
- Hoang, H., & Rothaermel, F. T. (2005). The effect of general and partner-specific alliance experience on joint R&D project performance. *Academy of Management Journal*, 48(2), 332-345.
- Hsieh, W. L., Ganotakis, P., Kafouros, M., & Wang, C. (2018). Foreign and domestic collaboration, product innovation novelty, and firm growth. *Journal of Product Innovation Management*, 35(4), 652-672.
- Hsu, G. (2006). Evaluative schemas and the attention of critics in the US film

- industry. *Industrial and Corporate Change*, 15(3), 467-496.
- Hsu, G., Hannan, M. T., & Koçak, Ö. (2009). Multiple category memberships in markets: An integrative theory and two empirical tests. *American Sociological Review*, 74(1), 150-169.
- Jarillo, J. C. (1988). On strategic networks. *Strategic Management Journal*, 9(1), 31-41.
- Kachra, A., & White, R. E. (2008). Know-how transfer: the role of social, economic/competitive, and firm boundary factors. *Strategic Management Journal*, 29(4), 425-445.
- Kaplan, S., & Tripsas, M. (2008). Thinking about technology: Applying a cognitive lens to technical change [Review]. *Research Policy*, 37(5), 790-805. <https://doi.org/10.1016/j.respol.2008.02.002>
- Kaplan, S., & Vakili, K. (2015). The double-edged sword of recombination in breakthrough innovation [Review]. *Strategic Management Journal*, 36(10), 1435-1457. <https://doi.org/10.1002/smj.2294>
- Katz, E., & Lazarsfeld, P. F. (2017). *Personal influence: The part played by people in the flow of mass communications*. Routledge.
- Kelly, B., Papanikolaou, D., Seru, A., & Taddy, M. (2021). Measuring technological innovation over the long run. *American Economic Review: Insights*, 3(3), 303-320.
- Kleinbaum, A. M., & Tushman, M. L. (2007). Building bridges: The social structure of interdependent innovation. *Strategic Entrepreneurship Journal*, 1(1-2), 103-122.
- Kobarg, S., Stumpf-Wollersheim, J., & Welpe, I. M. (2019). More is not always better: Effects of collaboration breadth and depth on radical and incremental innovation performance at the project level. *Research Policy*, 48(1), 1-10.
- Kock, A., Gemünden, H. G., Salomo, S., & Schultz, C. (2011). The Mixed Blessings of Technological Innovativeness for the Commercial Success of New Products. *Journal of Product Innovation Management*, 28(s1), 28-43. <https://doi.org/10.1111/j.1540-5885.2011.00859.x>
- Kogan, L., Papanikolaou, D., Seru, A., & Stoffman, N. (2017). Technological Innovation, Resource Allocation, and Growth*. *The Quarterly Journal of Economics*, 132(2), 665-712. <https://doi.org/10.1093/qje/qjw040>
- Kovacs, B., Carnabuci, G., & Wezel, F. C. (2021). Categories, attention, and the impact of inventions [Article]. *Strategic Management Journal*, 42(5), 992-1023. <https://doi.org/10.1002/smj.3271>

- Krackhardt, D., Nohria, N., & Eccles, B. (2003). The strength of strong ties. *Networks in the knowledge economy*, 82.
- Kraft, P. S., & Bausch, A. (2018). Managerial Social Networks and Innovation: A Meta-Analysis of Bonding and Bridging Effects across Institutional Environments. *Journal of Product Innovation Management*, 35(6), 865-889. <https://doi.org/10.1111/jpim.12450>
- Kuemmerle, W. (1997). Building effective R&D capabilities abroad. *Harvard Business Review*, 75(2), 61-70. <Go to ISI>://A1997WM74700012
- Larson, A. (1992). Network dyads in entrepreneurial settings: A study of the governance of exchange relationships. *Administrative Science Quarterly*, 76-104.
- Lavie, D., & Drori, I. (2012). Collaborating for knowledge creation and application: The case of nanotechnology research programs. *Organization Science*, 23(3), 704-724. <https://doi.org/10.1287/orsc.1110.0656>
- Leahey, E., Beckman, C. M., & Stanko, T. L. (2017). Prominent but less productive: The impact of interdisciplinarity on scientists' research. *Administrative Science Quarterly*, 62(1), 105-139.
- Lee, Y.-N., Walsh, J. P., & Wang, J. (2015). Creativity in scientific teams: Unpacking novelty and impact. *Research Policy*, 44(3), 684-697. <https://doi.org/10.1016/j.respol.2014.10.007>
- Levin, D. Z., & Cross, R. (2004). The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer. *Management Science*, 50(11), 1477-1490.
- Levin, D. Z., Walter, J., & Murnighan, J. K. (2011). Dormant ties: The value of reconnecting [Article]. *Organization Science*, 22(4), 923-939. <https://doi.org/10.1287/orsc.1100.0576>
- Lewin, A. Y., Massini, S., & Peeters, C. (2009). Why are companies offshoring innovation? The emerging global race for talent. *Journal of International Business Studies*, 40(6), 901-925. <https://doi.org/10.1057/jibs.2008.92>
- Lin, N., & Ensel, W. M. (1989). Life Stress and Health: Stressors and Resources. *American Sociological Review*, 54(3), 382-382. <http://www.library.gatech.edu:2048/login?url=http://search.proquest.com/docview/218792659?accountid=11107>
- Lopez-Vega, H., & Moodysson, J. (2023). Digital Transformation of the Automotive Industry: An Integrating Framework to Analyse Technological Novelty and Breadth. *Industry and Innovation*, 30(1), 67-102.

- Mansfield, E. (1968). Industrial research and technological innovation: An econometric analysis. New York: Norton.
- Marsden, P. V. (1987). Core discussion networks of Americans. *American Sociological Review*, 122-131.
- Martínez, C. (2011). Patent families: When do different definitions really matter? *Scientometrics*, 86(1), 39-63.
- Martínez-Ros, E., & Orfila-Sintes, F. (2009). Innovation activity in the hotel industry. *Technovation*, 29(9), 632-641.
- Matthews, L., Heyden, M. L., & Zhou, D. (2022). Paradoxical transparency? Capital market responses to exploration and exploitation disclosure. *Research Policy*, 51(1), 104396.
- McEvily, B., Perrone, V., & Zaheer, A. (2003). Trust as an organizing principle. *Organization Science*, 14(1), 91-103.
- McFadyen, M. A., & Cannella Jr, A. A. (2004). Social capital and knowledge creation: Diminishing returns of the number and strength of exchange relationships. *Academy of Management Journal*, 47(5), 735-746.
- McFadyen, M. A., Semadeni, M., & Cannella, A. A. (2009). Value of strong ties to disconnected others: Examining knowledge creation in biomedicine [Article]. *Organization Science*, 20(3), 552-564. <https://doi.org/10.1287/orsc.1080.0388>
- McPherson, J. M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, 27, 415-444. <http://www.jstor.org/stable/2678628>
- Mednick, S. A. (1962). The associative basis of the creative process. *Psychological Review*, 69(3), 220-232. <https://doi.org/10.1037/h0048850>
- Menon, T., & Pfeffer, J. (2003). Valuing internal vs. external knowledge: Explaining the preference for outsiders. *Management Science*, 49(4), 497-513.
- Messeni Petruzzelli, A., Albino, V., Carbonara, N., & Rotolo, D. (2010). Leveraging learning behavior and network structure to improve knowledge gatekeepers' performance. *Journal of Knowledge Management*, 14(5), 635-658.
- Michelfelder, I., & Kratzer, J. (2013). Why and how combining strong and weak ties within a single interorganizational R&D collaboration outperforms other collaboration structures. *Journal of Product Innovation Management*, 30(6), 1159-1177.
- Montgomery, J. D. (1992). Job search and network composition: Implications of the strength-of-weak-ties hypothesis [Article]. *American Sociological Review*,

57(5), 586-596. <https://doi.org/10.2307/2095914>

Morrison, E. W. (2002). Newcomers' relationships: The role of social network ties during socialization. *Academy of Management Journal*, 45(6), 1149-1160.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review*, 23(2), 242-266.

Nelson, R. R., & Winter, S. G. (1982). *An Evolutionary Theory of Economic Change*. Belknap Press of Harvard University Press.

Obstfeld, D. (2005). Social networks, the tertius iungens orientation, and involvement in innovation. *Administrative Science Quarterly*, 50(1), 100-130.

Ozer, M., & Zhang, G. (2019). The roles of knowledge providers, knowledge recipients, and knowledge usage in bridging structural holes. *Journal of Product Innovation Management*, 36(2), 224-240.

Ozer, M., & Zhang, G. (2022). Interpersonal relationships and creativity at work: A network building perspective. *Journal of Product Innovation Management*, 39(3), 312-333. <https://doi.org/https://doi.org/10.1111/jpim.12575>

Padgett, J. F., & Ansell, C. K. (1993). Robust Action and the Rise of the Medici, 1400-1434. *American Journal of Sociology*, 98(6), 1259-1319.

Page, S. E. (2007). *The difference : how the power of diversity creates better groups, firms, schools, and societies*. Princeton University Press. Publisher description <http://www.loc.gov/catdir/enhancements/fy0704/2006044678-d.html>

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<http://www.loc.gov/catdir/enhancements/fy0704/2006044678-t.html>

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<http://www.loc.gov/catdir/enhancements/fy0734/2006044678-b.html>

Park, M., Leahey, E., & Funk, R. J. (2023). Papers and patents are becoming less disruptive over time. *Nature*, 613(7942), 138-144.

Perry-Smith, J. E. (2006). Social yet creative: The role of social relationships in facilitating individual creativity [Article]. *Academy of Management Journal*, 49(1), 85-101. <Go to ISI>://WOS:000236642400008

Perry-Smith, J. E., & Mannucci, P. V. (2017). From Creativity to Innovation: The Social Network Drivers of the Four Phases of the Idea Journey. *Academy of Management Review*, 42(1), 53-79. <https://doi.org/10.5465/amr.2014.0462>

Perry-Smith, J. E., & Shalley, C. E. (2003). The social side of creativity: A static and dynamic social network perspective [Article]. *Academy of Management*

Review, 28(1), 89-106. <Go to ISI>://WOS:000180314700007

- Perry-Smith, J. E., & Shalley, C. E. (2014). A social composition view of team creativity: The role of member nationality-heterogeneous ties outside of the team. *Organization Science*, 25(5), 1434-1452. <https://doi.org/10.1287/orsc.2014.0912>
- Pezzoni, M., Veugelers, R., & Visentin, F. (2022). How fast is this novel technology going to be a hit? Antecedents predicting follow-on inventions. *Research Policy*, 51(3), 104454.
- Podolny, J. M., & Baron, J. N. (1997). Resources and relationships: Social networks and mobility in the workplace. *American Sociological Review*, 673-693.
- Poege, F., Harhoff, D., Gaessler, F., & Baruffaldi, S. (2019). Science quality and the value of inventions. *Science Advances*, 5(12), eaay7323.
- Polidoro, F. (2020). Knowledge, routines, and cognitive effects in nonmarket selection environments: An examination of the regulatory review of innovations [Review]. *Strategic Management Journal*, 41(13), 2400-2435. <https://doi.org/10.1002/smj.3196>
- Pontikes, E. G. (2012). Two sides of the same coin: How ambiguous classification affects multiple audiences' evaluations [Article]. *Administrative Science Quarterly*, 57(1), 81-118. <https://doi.org/10.1177/0001839212446689>
- Rajkumar, K., Saint-Jacques, G., Bojinov, I., Brynjolfsson, E., & Aral, S. (2022). A causal test of the strength of weak ties. *Science*, 377(6612), 1304-1310.
- Reagans, R., & McEvily, B. (2003). Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly*, 48(2), 240-267.
- Rodan, S. (2010). Structural holes and managerial performance: Identifying the underlying mechanisms. *Social Networks*, 32(3), 168-179.
- Rosch, E. (1978). *Principle of categorization*. Hillsdale, NJ: Erlbaum.
- Rosenkopf, L., & Nerkar, A. (2001). Beyond local search: Boundary-spanning, exploration, and impact in the optical disk industry [Article]. *Strategic Management Journal*, 22(4), 287-306. <https://doi.org/10.1002/smj.160>
- Rost, K. (2011). The strength of strong ties in the creation of innovation [Article]. *Research Policy*, 40(4), 588-604. <https://doi.org/10.1016/j.respol.2010.12.001>
- Schoenmakers, W., & Duysters, G. (2010). The technological origins of radical inventions [Article]. *Research Policy*, 39(8), 1051-1059. <https://doi.org/10.1016/j.respol.2010.05.013>

- Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Harvard University Press, Cambridge, MA.
- Schumpeter, J. A. (1939). *Business Cycles; A Theoretical, Historical, and Statistical Analysis of the Capitalist Process* (1st ed.). McGraw-Hill Book Company, inc.
- Schumpeter, J. A. (1942). *Socialism, capitalism and democracy*. Cambridge, MA: Harvard University Press.
- Seibert, S. E., Kraimer, M. L., & Liden, R. C. (2001). A social capital theory of career success. *Academy of Management Journal*, 44(2), 219-237.
- Shane, S. (2001). Technological opportunities and new firm creation [Article]. *Management Science*, 47(2), 205-220. <https://doi.org/10.1287/mnsc.47.2.205.9837>
- Shibayama, S., & Wang, J. (2020). Measuring originality in science [Article]. *Scientometrics*, 122(1), 409-427. <https://doi.org/10.1007/s11192-019-03263-0>
- Shleifer, A., & Vishny, R. W. (1997). The limits of arbitrage. *The Journal of finance*, 52(1), 35-55.
- Si, S., & Chen, H. (2020). A literature review of disruptive innovation: What it is, how it works and where it goes. *Journal of Engineering and Technology Management*, 56, 101568. <https://doi.org/https://doi.org/10.1016/j.jengtecman.2020.101568>
- Simms, C., Frishammar, J., & Ford, N. (2021). The front end in radical process innovation projects: sources of knowledge problems and coping mechanisms. *Technovation*, 105, 102214.
- Simonton, D. K. (1999). *Origins of genius: Darwinian perspectives on creativity*. Oxford University Press.
- Simonton, D. K. (2003). Scientific creativity as constrained stochastic behavior: the integration of product, person, and process perspectives. *Psychological Bulletin*, 129(4), 475-494. <https://doi.org/10.1037/0033-2909.129.4.475>
- Singh, J., & Fleming, L. (2010). Lone inventors as sources of breakthroughs: Myth or reality? [Article]. *Management Science*, 56(1), 41-56. <https://doi.org/10.1287/mnsc.1090.1072>
- Smith, K. G., Collins, C. J., & Clark, K. D. (2005). Existing knowledge, knowledge creation capability, and the rate of new product introduction in high-technology firms. *Academy of Management Journal*, 48(2), 346-357.

- Soda, G., Usai, A., & Zaheer, A. (2004). Network memory: The influence of past and current networks on performance. *Academy of Management Journal*, 47(6), 893-906.
- Sorenson, O., & Fleming, L. (2004). Science and the diffusion of knowledge. *Research Policy*, 33(10), 1615-1634.
- Sosa, M. E. (2011). Where do creative interactions come from? The role of tie content and social networks [Article]. *Organization Science*, 22(1), 1-21. <https://doi.org/10.1287/orsc.1090.0519>
- Su, C., Kong, L., Ciabuschi, F., & Holm, U. (2020). Demand and willingness for knowledge transfer in springboard subsidiaries of Chinese multinationals. *Journal of Business Research*, 109, 297-309.
- Tortoriello, M., & Krackhardt, D. (2010). Activating cross-boundary knowledge: The role of Simmelian ties in the generation of innovations. *Academy of Management Journal*, 53(1), 167-181.
- Tortoriello, M., Reagans, R., & McEvily, B. (2012). Bridging the knowledge gap: The influence of strong ties, network cohesion, and network range on the transfer of knowledge between organizational units. *Organization Science*, 23(4), 1024-1039.
- Trajtenberg, M., Henderson, R., & Jaffe, A. (1997). University versus corporate patents: A window on the basicness of invention. *Economics of Innovation and New Technology*, 5(1), 19-50.
- Tushman, M. L., & Anderson, P. (1986). Technological discontinuities and organizational environments [Article]. *Administrative Science Quarterly*, 31(3), 439-465. <https://doi.org/10.2307/2392832>
- Tzabbar, D., & Vestal, A. (2015). Bridging the social chasm in geographically distributed R&D teams: The moderating effects of relational strength and status asymmetry on the novelty of team innovation. *Organization Science*, 26(3), 811-829.
- Ukobitz, D. V., & Faillant, R. (2022). The relative impact of isomorphic pressures on the adoption of radical technology: Evidence from 3D printing. *Technovation*, 113, 102418.
- Utterback, J. M. (1996). *Mastering the dynamics of innovation: How companies can seize opportunities in the face of technological change*. Harvard Business Press, Cambridge, MA.
- Uzzi, B. (1996). The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *American Sociological*

Review, 674-698.

- Uzzi, B. (1997). Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness. *Administrative Science Quarterly*, 35-67.
- Uzzi, B., & Spiro, J. (2005). Collaboration and creativity: The small world problem. *American Journal of Sociology*, 111(2), 447-504.
- Vanhaverbeke, W., Gilsing, V., & Duysters, G. (2012). Competence and governance in strategic collaboration: The differential effect of network structure on the creation of core and noncore technology. *Journal of Product Innovation Management*, 29(5), 784-802.
- Verhoeven, D., Bakker, J., & Veugelers, R. (2016). Measuring technological novelty with patent-based indicators. *Research Policy*, 45(3), 707-723. <https://doi.org/10.1016/j.respol.2015.11.010>
- Wang, J. (2016). Knowledge creation in collaboration networks: Effects of tie configuration. *Research Policy*, 45(1), 68-80. <https://doi.org/10.1016/j.respol.2015.09.003>
- Wang, J., Veugelers, R., & Stephan, P. (2017). Bias against novelty in science: A cautionary tale for users of bibliometric indicators [Article]. *Research Policy*, 46(8), 1416-1436. <https://doi.org/10.1016/j.respol.2017.06.006>
- Wen, J., Qualls, W. J., & Zeng, D. (2021). To explore or exploit: The influence of inter-firm R&D network diversity and structural holes on innovation outcomes. *Technovation*, 100, 102178.
- West, M. A. (2002). Sparkling fountains or stagnant ponds: An integrative model of creativity and innovation implementation in work groups. *Applied Psychology-an International Review-Psychologie Appliquee-Revue Internationale*, 51(3), 355-387. <https://doi.org/10.1111/1464-0597.00951>
- Woodman, R. W., Sawyer, J. E., & Griffin, R. W. (1993). Toward a theory of organizational creativity. *Academy of Management Review*, 18(2), 293-321. <https://doi.org/10.2307/258761>
- Wu, L., Wang, D., & Evans, J. A. (2019). Large teams develop and small teams disrupt science and technology. *Nature*, 566(7744), 378-382.
- Yakubovich, V. (2005). Weak ties, information, and influence: How workers find jobs in a local Russian labor market [Article]. *American Sociological Review*, 70(3), 408-421. <https://doi.org/10.1177/000312240507000303>
- Zaheer, A., & Soda, G. (2009). Network evolution: The origins of structural holes [Article]. *Administrative Science Quarterly*, 54(1), 1-31. <https://doi.org/10.2189/asqu.2009.54.1.1>

- Zhou, J., Shin, S. J., Brass, D. J., Choi, J., & Zhang, Z.-X. (2009). Social networks, personal values, and creativity: Evidence for curvilinear and interaction effects. *Journal of applied psychology*, 94(6), 1544.
- Zuckerman, E. W. (1999). The categorical imperative: Securities analysts and the illegitimacy discount [Review]. *American Journal of Sociology*, 104(5), 1398-1438. <https://doi.org/10.1086/210178>
- Zuckerman, E. W., Kim, T. Y., Ukanwa, K., & von Rittmann, J. (2003). Robust identities or nonentities? Typecasting in the feature-film labor market [Review]. *American Journal of Sociology*, 108(5), 1018-1074. <https://doi.org/10.1086/377518>