



Chapter 15: An Open Elite Arbiters, Catalysts or Gatekeepers in Industry Evolution?

Walter W. Powell

Jason Owen-Smith



Dynamics of an Open Elite

- Amphibious entrepreneurs created science-based companies, largely out of naïveté, forging and repurposing practices of science and finance.
- These firms in business to do science, the VCs who funded them, and the nonprofit (but commercially engaged) research institutes they worked with became anchor tenants of three robust regional clusters.
- How do highly central organizations retain their position in an expanding global field in which scientific discovery and commercial competition are intense?
- Put differently, when knowledge is advancing rapidly and is geographically dispersed, networks become the locus of innovation. But what factors enable densely connected networks to avoid lock-in and ossification? The aim of this chapter is to explain industrial dynamics of simultaneous expansion and contraction.



Structural Features of the Biopharmaceutical Industry

- Continuous innovation, rapidly developing scientific base, high rates of R&D failure, over-reliance on blockbuster drugs by big pharma, strong regulatory and IP environment, fluid labor markets, unusual mix of very large and small firms, nonprofit and government institutes and universities, new forms of venture financing tied to fads in equity market, customer attachment to treatments, not producers.
- Expert opinion and canonical theory is divided as to how to explain this industry's evolution:
 - Cockburn and Stern (2010), Kleinman and Vallas (2006): Remaking of insular world of big Pharma, and entrepreneurial university science lead to hybrid model of partially open, IP-protected science (gales of creative destruction - - a recombination story)
 - Pisano (2006), Nightingale and Martin (2004), Coriat et al (2003): The dominant process is the outsourcing of upstream R&D to biotech firms and universities, with Pharma companies reaping the lion's share of advantage. (Chandlerian story *or* neoliberal project of lean and mean).



Our alternative approach

- Industries can be conceived of as relational fields - - configurations of relationships *and* communities of diverse organizations, engaged in common activities subject to similar pressures. Networks are the skeletons of fields. The most central organizations in a field are its backbone.
- New tie formation by core organizations is the motor of field evolution (Powell et al, 2005). The affiliation networks of organizations not only mark past experiences but are a road map of future prospects.
- The organizing principles of complex systems are encoded in their network topologies. The logics of preferential attachment vary depending on which activities are being conducted with whom.



How should we think about an elite in network terms?

- A small number of organizations who dominate the majority of affiliations. This highly influential group can be either closed or permeable.
- To analyze this idea, we use K-cores – concentric circles reflecting increasing relational density.
- The most connected k-core is a highly cohesive cluster
- Does such a structural elite have self-awareness?
 - in a class solidarity sense **NO**
 - in terms of oligarchic interests **PERHAPS**
 - with regard to status endogamy **YES**



Elite ties serve multiple purposes. New connections can...

- **Protect existing status** - - Elites form multiple, non-redundant ties with other well connected participants. We term these *conserving ties* as they are new partnerships with organizations of similar high connectivity. Such affiliations stabilize the power of the best connected, at the risk of lock-in.
- **Prospect for novelty** - - Elites form new ties with outsiders (overwhelmingly new entrants and young organizations) who have no prior ties to other members of the elite. This search for novelty represents an *expansion tie*. These linkages afford access to new ideas, at the risk of upsetting the status order.
- **Validate up and comers** - - An additional tie is forged between another member of the elite and a new entrant. We term these *closure ties* because they mark the outsider as an promising prospect. Over time, ties to additional members of the elite can pull the prospect into the inner circle. These closure ties reflect sponsored mobility.



Data and Methods:

- Same relational data set as previous chapter, extended to cover 1984-2004 and global affiliations, not just U.S. A two-mode network: 691 biotech firms, 3,000 plus collaborators, 15,197 relationships.
- To identify the most connected members of the network, we use the method of **k-core decomposition** (White and Harary, 2001; Moody and White, 2003). Conceives of the architecture of a network as a set of successively enclosed substructures. Used to study protein interactions, friendship cliques, kinship lineages, disease transmission.
- Put simply, a k-core decomposition is like peeling an onion layer by layer, revealing the structure from the outmost skin to the inner bulb. By peeling away the least connected members of the field, we can determine who the most connected, cohesive members are.



The Database: Ties

- Formal contractual agreements among DBFs and between DBFs and Partners, 1984 – 2004.

<u>Type of Tie</u>	<u>Typical Partners</u>
<i>R&D:</i> Biotech firm develops research program with another organization for a specific target.	Other biotechs, pharmaceutical corps., universities, research institutes, government labs.
<i>Finance:</i> Partner invests funds in a DBF, or DBF invests funds (and scientific expertise) in a partner.	Venture capital firms, larger biotech companies, pharmaceutical corp.
<i>Licensing:</i> DBF either licenses its intellectual property (IP) to another party, or acquires others' IP.	Universities, Research Institutes, DBFs, pharmaceuticals, govt. labs.
<i>Commercialization:</i> DBF contracts with partner to manufacture and market its product, or DBF agrees to supply product to a distributor for sales.	Large pharmaceutical or chemical corps., larger DBFs

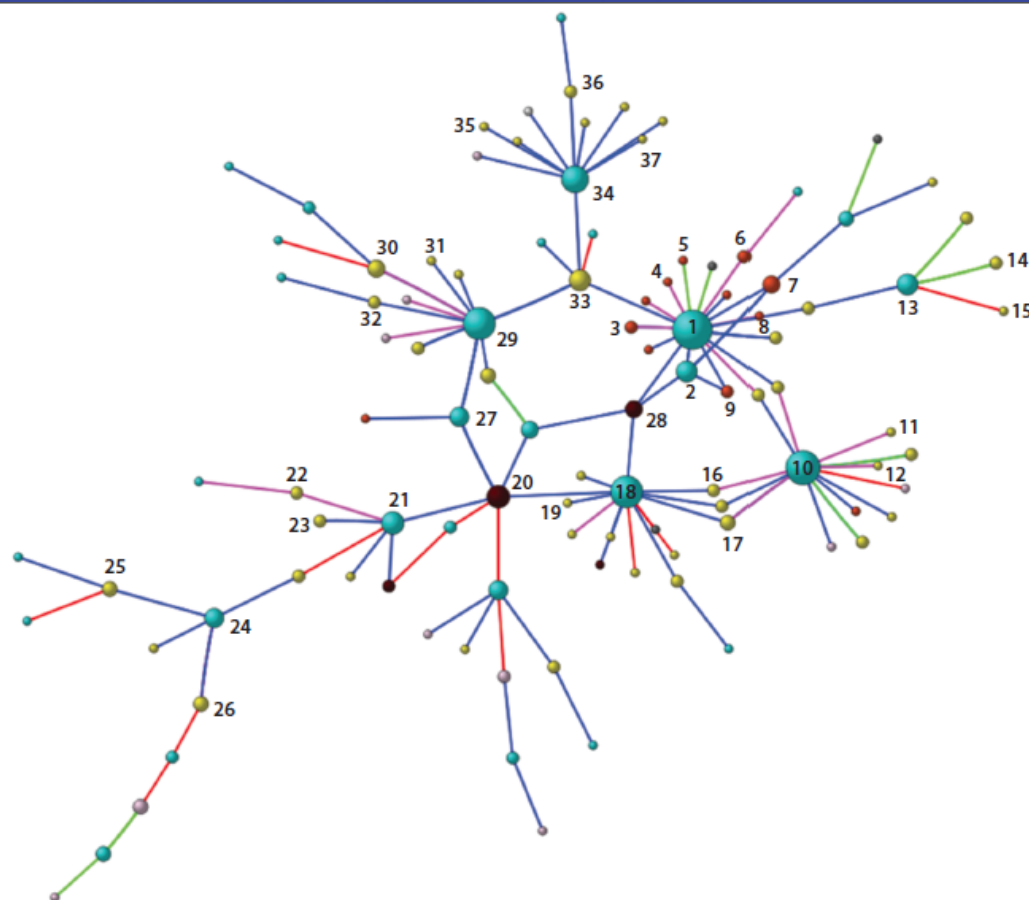


What to look for in a k-core visualization

- Present a fast network movie - - 4 snapshots of the most connected component of organizations.
- What to watch for:
 - How does character of relations change from time? Both *form* and *content*, i.e., organizations and activities
 - How do *position* and *structure* co-evolve? Who is at the center and does overall composition shrink, expand, or re-shuffle?
- Not shown, but trust us!:
 - Analysis of tie formation in terms of characteristics of new tie participants.



Main component,
2 core, 1984



Dominant
activity is the
selling by early
biotechs of
their lead
molecules to
pharma
companies.

Activity	Tie Color	# Ties	%
Commerce	Blue	87	64.9
Finance	Green	13	9.7
Licensing	Purple	18	13.4
Science	Red	16	11.9
Total		134	

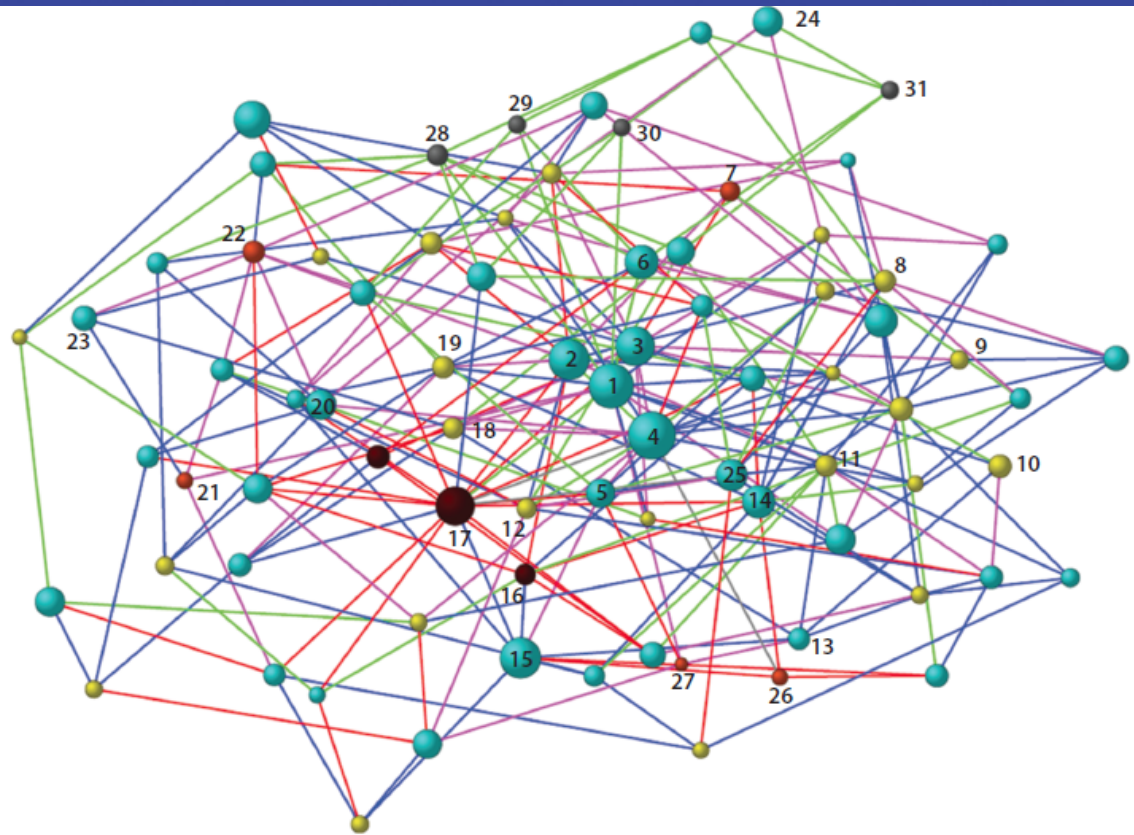
Organization	Node Color	# Nodes	%
DBF	Blue	30	28.3
Finance	Grey	3	2.8
Government	Black	4	3.8
Pharmaceutical	Yellow	47	44.3
PRO	Red	12	11.3
Biomedical	Purple	10	9.4
Total		106	

Influential Members

1. Centocor	20. NIH
2. Repligen	21. Oscient
3. Massachusetts General Hospital	22. Ciba-Geigy
4. Memorial Sloan Kettering	23. Sandoz
5. Wistar Institute	24. Chiron
6. Dana Farber Cancer Center	25. Merck
7. MIT	26. Novo Nordisk
8. New York University	27. Genzyme
9. Duke University	28. NCI
10. Biogen	29. Immunex
11. BASF	30. Syntex
12. Knoll AG	31. Hoechst
13. Amgen	32. Marion Merrill Dow
14. Kirin Brewery	33. Hoffman La Roche
15. Texaco	34. Genentech
16. Green Cross	35. Eastman Kodak
17. Kabi AB	36. Eli Lilly
18. Genex	37. Boehringer Ingelheim
19. Bristol Myers Squibb	



Main component, 4 core, 1990 (4 or more nonredundant ties with one another)

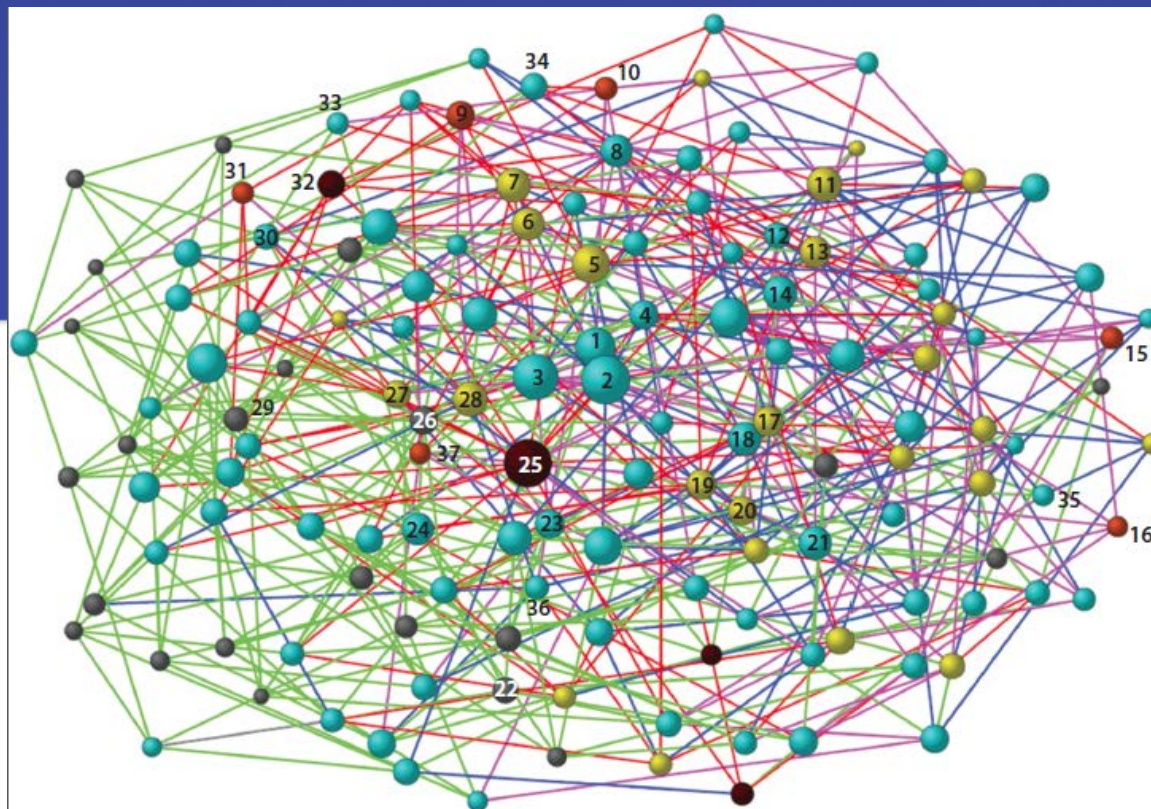


Growing salience of finance (entry of VCs) and science (entry of universities, centrality of NIH) affiliations. Composition shifts to centrality of first generation DBFs.

Activity	Tie Color	# Ties	%
Commerce	Blue	93	37.7
Finance	Green	50	20.2
Licensing	Purple	57	23.1
Science	Red	44	17.8
Other	Grey	3	1.2
Total		247	

Organization	Node Color	# Nodes	%
DBF	Light Blue	43	54.4
Finance	Grey	4	5.1
Government	Dark Red	3	3.8
Pharmaceutical	Yellow	24	30.4
PRO	Orange	5	6.3
Total		79	

Influential Members	
1. Centocor	17. NIH
2. Scios	18. SmithKline Beecham
3. Biogen	19. DuPont
4. Genentech	20. Genzyme
5. Genetics Institute	21. Stanford University
6. Repligen	22. MIT
7. Harvard University	23. Immunex
8. Merck	24. IDEC
9. Ciba-Geigy	25. Celltech
10. Hoffmann-La Roche	26. University of California
11. Johnson & Johnson	27. Memorial Sloan Kettering
12. Pfizer	28. Biotech Investments
13. Amgen	29. Hambrecht & Quist
14. Chiron	30. Venrock
15. Cetus	31. Abingworth
16. NCI	



Financial relations supplant commercial ties. VCs and pharma offer different modes of financial support. (Recall contrast of in science to do business vs. in business to do science.)

Main component, 5 core, 1996
Number of members and affiliations grows markedly.

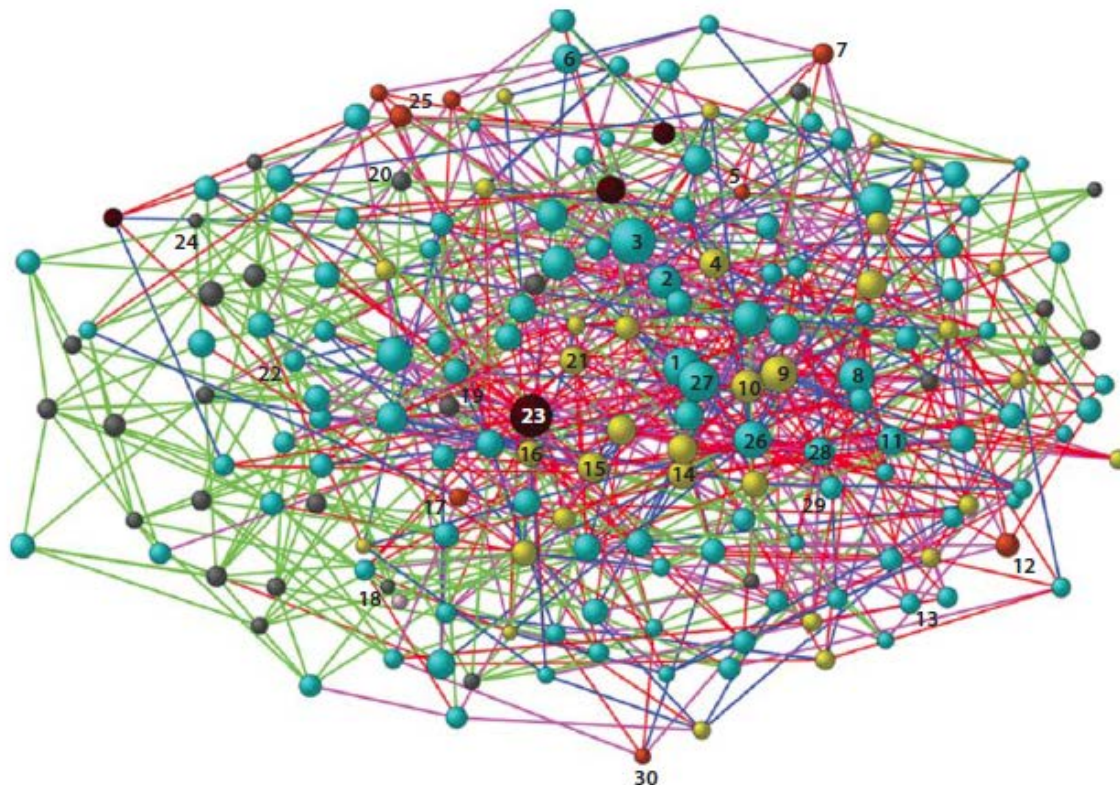
Activity	Tie Color	# Ties	%
Commerce	Blue	111	20.5
Finance	Green	211	38.9
Licensing	Purple	105	19.4
Science	Red	114	21.0
Other	Grey	1	0.1
Total		542	

Organization	Node Color	# Nodes	%
DBF	Light Blue	83	59.3
Finance	Dark Grey	23	16.4
Government	Dark Red	4	2.9
Pharmaceutical	Yellow	24	17.1
PRO	Orange	6	4.3
Total		140	

Influential Members	
1. Centocor	20. Ciba-Geigy
2. Chiron	21. Incyte
3. Genentech	22. Hambrecht & Quist
4. Ligand	23. Repligen
5. Boehringer Ingelheim	24. Athena Neurosciences
6. SmithKline Beecham	25. NIH
7. Hoffman La Roche	26. Kleiner, Perkins, Caufield & Byers
8. Genzyme	27. Glaxo
9. University of California	28. Pharmacia & Upjohn
10. Stanford University	29. New Enterprise Associates
11. Merck	30. Gilead Sciences
12. Biogen	31. Memorial Sloan Kettering
13. Johnson & Johnson	32. NCI
14. IDEC	33. Neurocrine
15. Harvard University	34. Vical
16. MIT	35. Corvas
17. Eli Lilly	36. Genzia
18. Genetics Institute	37. Johns Hopkins University
19. Schering-Plough	



Main component,
5 core,
2002



Science and finance ties at the center; re-entry of select pharma corps. under new logic of attachment.

Activity	Tie Color	# Ties	%
Commerce	Blue	131	16.6
Finance	Green	237	29.9
Licensing	Purple	188	23.8
Science	Red	231	29.2
Other	Grey	4	0.5
Total		791	

Organization	Node Color	# Nodes	%
DBF	Light Blue	112	60.9
Finance	Dark Grey	26	14.1
Government	Dark Red	4	2.2
Pharmaceutical	Yellow	33	17.9
PRO	Orange	8	4.3
Biomedical	Light Grey	1	0.5
Total		184	

Influential Members

1. Genentech	16. Johnson & Johnson
2. Genzyme	17. Massachusetts General Hospital
3. Chiron	18. Kleiner, Perkins, Caufield & Byers
4. Hoffmann-LaRoche	19. Biotechnology Venture Fund
5. Stanford Univ	20. Hambrecht & Quist
6. Amgen	21. Bristol Myers Squibb
7. MIT	22. Gilead Sciences
8. IDEC	23. NIH
9. Schering-Plough	24. Alta Partners
10. Eli Lilly	25. Harvard Univ
11. Biogen	26. Affymetrix
12. UnivOf California	27. Incyte
13. Immunex	28. Arqule
14. SmithKline Beecham	29. Human Genome Sciences
15. Novartis	30. Salk Institute



Results:

- Elite expansion is notable (no pulling up ladders), reflects entry of venture capital, maturation of biotech firms, increased involvement of top-tier universities and institutes.
- Sponsorship involves drawing recognizable new entrants into the club, not assisting friends of inner circle. In technical terms, triadic closure is uncommon; prospecting more likely.
- Shifting logics of attachment preclude formation of an oligarchy. Most frequent relationships move from commercial to financial to scientific. Elite members use prospecting as a means to retain centrality as they learn new capabilities.
- Staying on top is hard work. Elite position affords both influence and opportunity. **Running faster to stay in place** - - searching, fending off and acquiring rivals, and adapting to new skills. The 'game' involves ceding control over one form of power and garnering support to develop new tools of influence.
- Structurally, organizations of a similar form and comparable connectivity compete with one another; those of different form and level of connectivity collaborate.



Implications:

- The mantra of our book is: in the short run, ***actors make relations*** but in the long run, ***relations make actors***.
- The narrative we have told is one where the tools of everyday practice were used in unfamiliar circumstances at a time when there was a green field. As norms of science spread into commercial biomedicine, new forms of collaboration and modes of financing medical discovery developed, giving rise to robust, but highly select, industrial districts. Key participants outside those clusters had to engage with them, but on their terms. A densely connected, global elite formed that was open to promising newcomers, not out of generosity but in order to retain central position.