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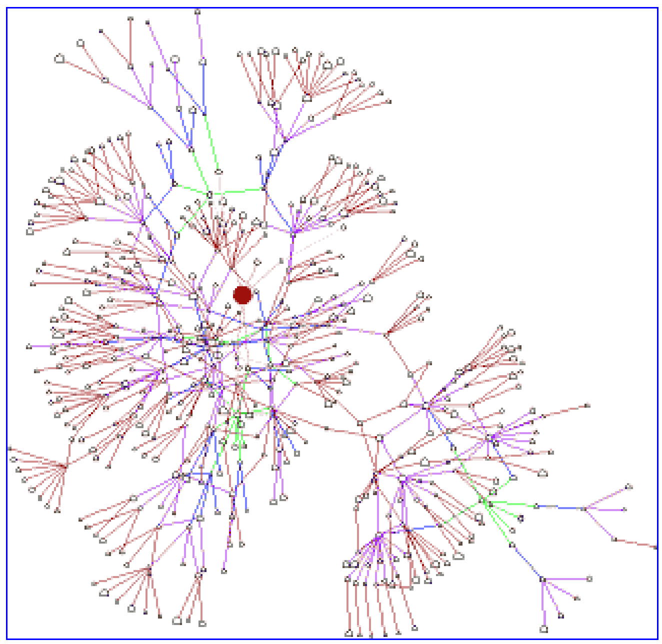
Exploring Network Economics

There is a central difference between the old and new economies: the old industrial economy was driven by *economies of scale*; the new information economy is driven by *economics of networks*.

Carl Shapiro and Hal R. Varian
Information Rules [1]

Network advantages appear to increase future sales more than future expenses. This evidence contributes to the stream of recent accounting literature that seeks to understand the link between non-financial leading indicators and future earnings.

Shivaram Rajgopal, Mohan Venkatachalam, and Suresh Kotha
The Value-Relevance of Network Advantages:The Case of E-Commerce Firms [2]



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- **There are different types of networks with varying degrees of network effects. As investors, we seek businesses where network effects are strong and where the company can capture the economic benefits.**
- **The combination of demand-side scale economies and high upfront, low incremental cost of information goods creates businesses unlike those in the traditional industrial economy.**
- **Network businesses offer substantial opportunity for wealth creation. Successful networks see sales grow faster than costs.**

Introduction

A central task for investors is to understand what a business will look like in the future, and judge whether or not today's stock price properly handicaps that outcome. For many companies the past is prologue; companies always strive to get bigger and better, but their fundamental activities don't change much. These goods and services businesses generally have production-based roots and classic industrial economics effectively address their growth and business model characteristics.

In recent years, information technology and networks have merged to create companies with characteristics quite different from their production-based counterparts. These include unprecedented market shares, very high returns on invested capital, and rapid growth. As important, the market doesn't always anticipate how the fundamentals of these companies unfold, leading to investable opportunities. [3]

Networks—canals, railroads, and highways—have been around for a long time and played an important role in global economic development. However, our primary interest is not in physical networks but rather in networks that rely on information technology.

Economists have successfully described the economics of both information and networks. These economic principles appear durable. It is the *combination* of information and network properties that creates opportunities for businesses and investors. Most investors have not internalized these ideas.

We believe the importance of information-based networks is increasing in today's global economy for four reasons:

1. *Physical capital needs are lower than they were in the past*. Information-based networks require less capital as they grow than physical networks do.
2. *Networks demonstrate increasing returns.* Most industries benefit from supply-side increasing returns to scale: higher volume leads to lower unit costs, up to a point. In contrast, successful networks generate increasing returns from the demand-side as users beget users.
3. *Networks can form faster and more frequently than in the past.* Because of plummeting communication and computing costs, the barriers to creating a network are declining. But even though the barriers to entry are low, the barriers to success remain high.
4. *Networks can spread globally*. Because many networks have high upfront costs and low incremental costs, they can expand rapidly within countries and across borders.

This report focuses on how to categorize networks, how they affect economic value, and how they form.

Network Effects

Imagine you are the first person to own a fax machine. It is effectively worthless because of its inability to communicate with other machines. As more people purchase faxes, the value of your machine rises sharply: the larger the network of users, the greater the value of the network.

More formally, we know this concept as network effects. A network effect exists when the value of a good or service increases as more people use that good or service. In a typical network, the addition of a new customer increases the willingness of all participants to pay for network services. [4]

Ethernet inventor Bob Metcalfe formalized this idea mathematically in the 1970s. Metcalfe's Law states that the value (V) of a network increases by the square of its nodes (n). Metcalfe's formula states that $V = n^2 – n$. So a network of ten people has a value of ninety (100 – 10 = 90) but a network twice the size has a value three times higher (400 – 20 = 380). While Metcalfe's fundamental insight is correct, the precise formula has no basis in economic theory and substantially overstates the value of large networks. [5]

Metcalfe also noted that the costs are unlikely to rise as fast as the value of the network. After reaching some point of critical mass (we'll return to this idea later), value soars. In Metcalfe's words: [6]

When you connect computers together, the cost of doing so is n, but the value is n^2, because each of the machines that you hook up gets to talk to all of the other machines on the network. When you graph that, you see that over time your costs go down while the value of the network goes up.

Network effects are central to evaluating networks, but we have to bear in mind that the *intensity* of network effects varies from network-to-network and that network values *dissipate* at different user-base levels.

Network Taxonomy

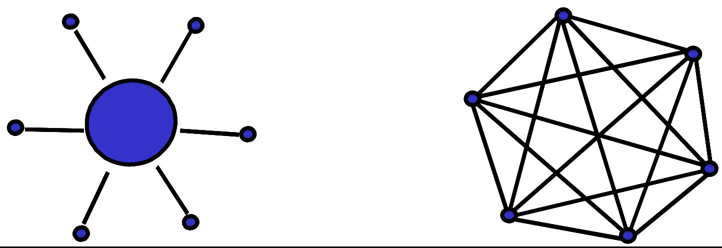
One important distinction is between *real networks* based on physical connections (railroads, telephones) and *virtual networks* built around complementary products or services (DVD players and DVDs, printers and toner cartridges, xBox and games).

Real networks take two forms, each with very different degrees of network effect intensity. (See Exhibit 1.) In a radial network, a hub reaches out to spokes. Major airlines and retailers are examples.

Network effects tend to be weak for radial networks. Think of a traditional hub-and-spoke airline. As long as the carrier takes you where you want to go, you probably don't care if other passengers use the same service (in fact, ideally you'd like to have the middle seat empty). But network effects do exist, because more passengers allow the airline to expand routes and provide users with additional services.

In a combinatorial network, the nodes connect directly to one another. These networks can often expand substantially without degrading the service. Illustrations include telecommunication systems and on-line auction companies. Combinatorial networks generally possess strong network effects. These networks are relatively rare.

Exhibit 1: Radial versus Combinatorial Networks



Source: LMCM.

As investors, we're interested in situations where network effects are powerful *and* where a company can capture the economic benefits. These benefits show up in rapid sales growth, rising margins, and high and sustainable returns on invested capital.

All networks need some dimension of compatibility, or a reason for users to come to the network. Compatibility takes three fundamental forms:

- *Transactions*. A network based on transaction compatibility derives its value from creating a forum for economic exchange. As more buyers and sellers join the network, the network value grows sharply. Companies capturing a sliver from each transaction in return for hosting the network see their value rise along with network growth.

  The canonical example for a transaction network is eBay, the first to attain scale in online auction. eBay has realized tremendous growth in registered users, gross merchandise sales, sales, and profits since its inception less than ten years ago. Other illustrations include Innocentive (an online community to solve R&D problems) and Tradesports (an online trading and betting exchange).

- *Community*. These networks allow for, and derive value from, direct interaction between members. These networks are not about economic exchange but rather finding and connecting with the right person. Further, a gathered community has value for content providers, advertisers, and vendors.

  Nextel Communications benefits from community-based network effects. Nextel's push-to-talk technology allows users to communicate rapidly and effortlessly. This technology is especially valuable for small businesses with workers in the field. Other examples of community networks include AOL's instant messaging, Skype (Internet-based communications), Partypoker.com, Friendster, and InterActive Corporation's Match.com.

- *Complementary*. The values of these networks depend on the availability of ancillary and complementary goods or services. Often they reflect the co-evolution of hardware and software.

  The interplay between game console makers (Nintendo, Sony, and Microsoft) and game software producers (Electronic Arts, Activision) is a good example of a complementary network. New generations of hardware spawn better software, and vice versa.[7]

After establishing the basics of networks effects and outlining some different network types, we're now ready to look at the economics of networks: how and why they create value.

Networks and Economic Value

A company's ability to create shareholder value derives fundamentally from its ability to generate returns on invested capital in excess of the cost of capital for as long as possible. We can express excess returns as the difference between sales and costs (including the opportunity cost of capital) and the duration of excess returns as the result of competitive advantage.

In this section, we explore ways networks generate revenues, their cost dynamics, and how they sustain returns. Analysis of these drivers provides a foundation for assessing and judging appropriate valuations for network businesses.

Sales

We need to consider two dimensions of sales: the sources and the growth rate. Both are important, but the rate of growth holds particular interest because it can be nonlinear when strong network effects exist. Since the stock market tends to be poor at discounting nonlinear growth, this may provide opportunities. [8]

First, we outline sales sources. Many established networks gather sales from more than one of these categories, and in some instances there are revenue opportunities that developed networks have yet to exploit. More than classifying sales, these categories provide a way to think about potential value creation. [9]

- *Commerce/transactions*. Companies that are a de facto standard or stewards of a network can either sell goods directly or can steer customers to a transaction and collect a fee (indirect). Direct sales are conceptually straightforward and generally easy to track. The success of a company's indirect sales relates to its ability to reduce customer *search costs*. Large networks that can effectively direct users are very valuable.
- *Advertising*. A large user network attracts advertisers by allowing them to reach users cost effectively. Companies that amassed such groups can monetize them by selling advertising. Since an advertising-based business model is typically only viable for companies with a sizable user base, companies trying to build such a model often discount or give away their product in order to corral users. The give-away is a costly means to a profitable end: becoming an attractive vehicle for advertisers. This currently forms the core of Google's business model.
- *Subscription*. Some successful networks can charge users a subscription fee, or dues, for access to a network and its content. Subscription models usually apply for one of two extremes: very specialized networks or very large networks.
- *Data*. One of the benefits—and concerns—of the digital age is an unprecedented ability to collect information. Companies with large user bases, especially those Internet-based, have a treasure chest of data about their customers that is valuable because it can be sold to third parties. These data can be either aggregated, hence skirting privacy issues, or used to offer specific consumer profiles.
- *Incubation*. Once established, a network can "link-and-leverage" its position into new business opportunities. [10] This means transferring a user base to an adjacent technology or product. For example, Microsoft used its strong operating system position to capture adjacent markets in applications and Internet browsers.

Now that we have outlined revenue sources, we can return to the issue of growth rates. To do that, we must introduce and explore the notion of *positive feedback*—the idea that the strong get stronger and (as necessary corollary) the weak get weaker. We will explore two related facets of positive feedback: winner-take-most outcomes and supply- versus demand-side scale economies.

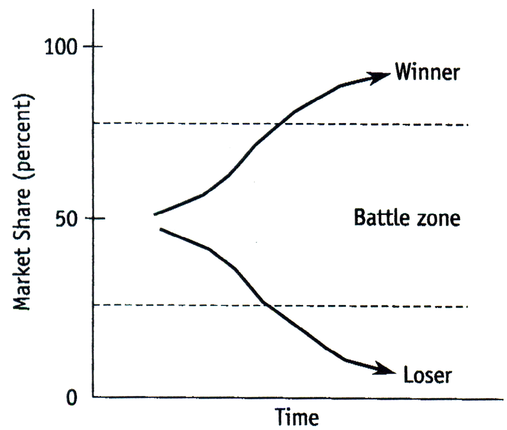
Winner takes most. In the presence of network effects, the value of a good or service increases as more people adopt that good or service. But what happens when multiple products compete in a business subject to network effects? Often one company gathers the vast majority of market share—the winner takes most.

Consider the case of the VHS versus Beta video recorder standard-setting battle in the late 1970s and early 1980s.[11] The two technologies competed across a range of features, including product design, picture quality, playing time, and price. While the point is in dispute, the two products were generally viewed as similar in capability.

Notably, the first application for video recorders was to tape shows on TV—there were no prepackaged cassettes. In 1976, Beta had over 60% market share (in units). By 1978, Beta's share slipped to 40%, but unit sales growth remained strong and the product had a loyal following.

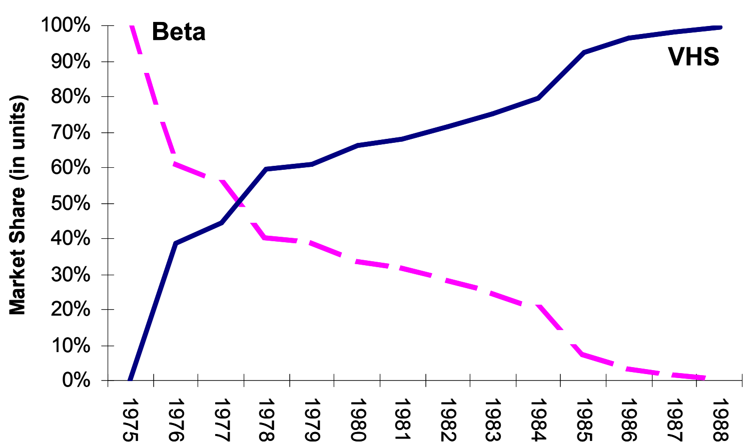
Once the studios began to license content, the prerecorded videocassette market was born and network effects strengthened. VHS had already reached a point of critical mass. Consumers had an incentive to buy a VHS because it had the most complementary content, which spurred more content, and so forth. In 1980 VHS's share climbed to 66%, by 1985 it was 92%, and it was in excess of 99% by 1988. Exhibit 2 shows the pattern of winner-take-most battles, and Exhibit 3 documents the VHS versus beta battle.

Exhibit 2: Positive Feedback



Source: Carl Shapiro and Hal R. Varian, *Information Rules* (Boston: Harvard Business School Press, 1999), 177. Copyrighted material, used by permission.

Exhibit 3: VHS versus Beta



Economist W. Brian Arthur says it more bluntly in what we can call Arthur's Law: *Of networks, there will be few.*[12] In a particular space one network tends to dominate, while the rest fight over the scraps. Network builders understand that anything other than first place is an also-ran. Microsoft and eBay's 90%-plus market shares offer testament to this point. Natural monopolies are the progeny of strong network effects.

One important idea here is *path dependence*, which in general means that history matters. Economists interested in innovation often point to path dependence to show why small events—random choices, luck, a chance meeting—can lead to outcomes unexplained solely by product attributes and features. While some economists doubt the role of path dependence, studies of networks outside of economics suggest that path dependence is an important consideration. [13]

Supply- versus demand-side scale economies. The difference between a firm's sales and costs (including opportunity cost) determine whether or not it creates value. [14] Fundamentally, a company can create more value by either reducing its costs or increasing the price it receives. Evidence suggests that differences in customer willingness-to-pay account for more of the profit variability among competitors than disparities in cost levels. [15]

Positive feedback as a result of scale economies has been around for a long time. The well-known cost curve shows that as a manufacturing company increases its output, its marginal and average unit costs decline (to a point). For these companies, the positive feedback is *supply-side* driven. It's all about lowering costs. This is classic increasing returns-to-scale.

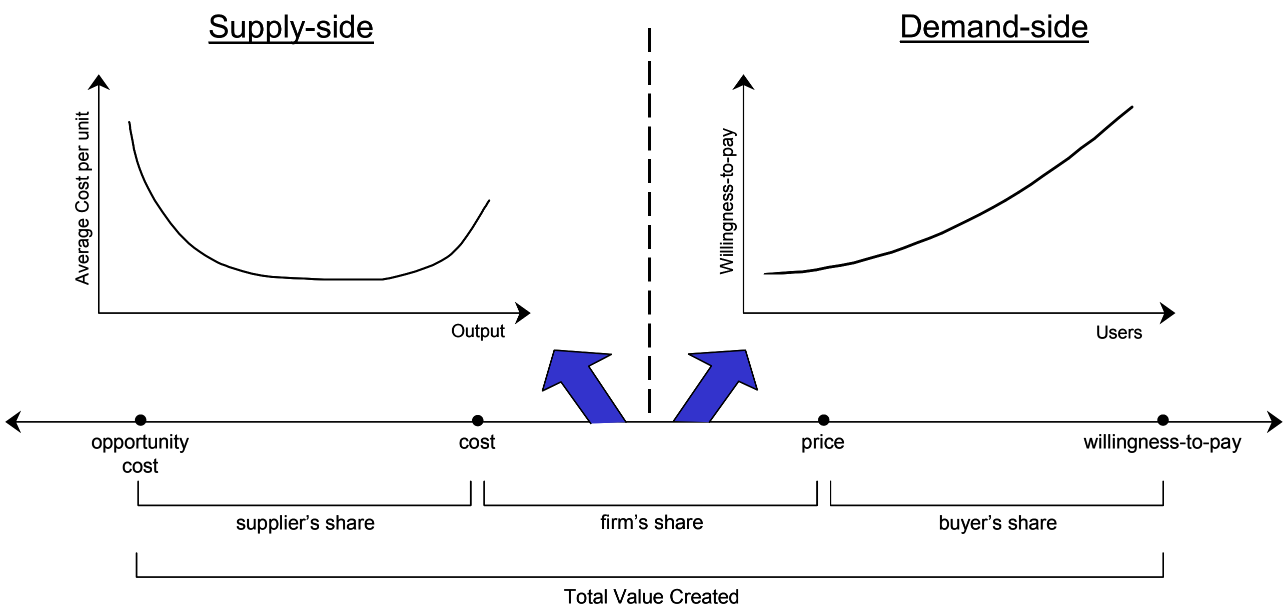
However, for manufacturing companies positive feedback tends to dissipate because of bureaucracy, complexity, or input scarcity. This generally happens at a level well before dominance: Market shares in the industrial world rarely top 50%.

For networks, the primary source of positive feedback is network effects. Rather than being supply-side driven, network effects are *demand-side* driven. This has two implications. First, the *value to the users* increases sharply once a network passes critical mass. Irrespective of costs, the willingness-to-pay rises.

Second, size does not govern market share for networks based on information. One network can, and often does, become totally dominant. Recognition of networks effects as the primary driver of increasing returns is key.

Exhibit 4 illustrates the distinction between supply- and demand-side scale economies.

Exhibit 4: Supply- versus Demand-Side Driven Scale Economies



Source: LMCM.

Costs

Many of the networks formed in recent years are based more on information than physical assets. One of the distinctions between the industrial economy and the information economy is the nature of costs. The hallmark of an information good is high upfront and low incremental cost. Think of a piece of software. Writing code the first time is costly. Once finished, the cost of replicating and distributing that code is often very low.

When network effects and the cost characteristics of information goods merge, the results are potentially significant. A surge in demand-side driven sales, coupled with negligible incremental cost, can lead to significant value creation. As a result some network businesses garnered multi-billion dollar valuations very quickly.

That is not to say that information-based networks don't enjoy some supply-side economies; they do. But it is the combination of network effects and low variable costs that provide substantial opportunity to increase operating profit margins. Exhibit 5 is a simple illustration. As units rise the high-fixed cost, low-variable cost Company B shows significantly greater operating profit margin leverage than the higher variable cost Company A.

Exhibit 5: Cost Structure and Margin Scalability

Company A				
Cost structure 30% fixed/70% variable	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Units	750,000	1,000,000	1,500,000	2,000,000
Sales ($15.00 per unit)	11,250,000	15,000,000	22,500,000	30,000,000
Fixed costs	4,050,000	4,050,000	4,050,000	4,050,000
Variable costs	7,087,500	9,450,000	14,175,000	18,900,000
Total costs	11,137,500	13,500,000	18,225,000	22,950,000
Operating profit	112,500	1,500,000	4,275,000	7,050,000
Operating profit margin	1.0%	10.0%	19.0%	23.5%

Company B				
Cost structure 70% fixed/30% variable				
Units	750,000	1,000,000	1,500,000	2,000,000
Sales ($15.00 per unit)	11,250,000	15,000,000	22,500,000	30,000,000
Fixed costs	9,450,000	9,450,000	9,450,000	9,450,000
Variable costs	3,037,500	4,050,000	6,075,000	8,100,000
Total costs	12,487,500	13,500,000	15,525,000	17,550,000
Operating profit	(1,237,500)	1,500,000	6,975,000	12,450,000
Operating profit margin	-11.0%	10.0%	31.0%	41.5%

Cost structure based on 1 million units

Source: LMCM.

The combination of demand-side driven network effects and the economics of information goods brings good news to the winners. As long as an information-based product or service stays current, sales and costs can become uncoupled for a time.

But there is bad news. Typically, developing an information-oriented network requires significant upfront costs. Moreover, only one company will likely get a disproportionate percentage of the economic profit. Many try, and few succeed.

Next, the high-fixed-cost, low-variable-cost structure of information companies may lead to greater profit variability as broader economic circumstances affect sales growth. Strong evidence suggests that cost structure played an important role in the sharp profit drop and upswing in recent years. [16]

Finally, while information-based networks may have low variable costs, they must keep spending for their products or services to stay up-to-date at the risk of losing users to a more technologically advanced offering.

Sustainability

We believe networks provide one of the few sources of sustainable competitive advantage. Once entrenched, dominant networks prove difficult to dislodge. Network users become locked-in, and their switching costs rise sharply. Lock-in and switching costs are central to a network's sustainable competitive advantage.

Users must bear switching costs when they switch from one system to another. These costs fall into a number of categories. Here are the three we consider most important: [17]

- *Replacement cost*. Once you purchase a product in a complementary network—say you had a great vinyl record collection and turntable—you have to bear the cost to change networks (and buy a CD player). This cost declines as the durable good ages.
- *Learning cost.* Once you learn to use a product (application software is a good example) changing vendors will require you to spend time learning a new system. This is also relevant for airlines as they select aircraft: it's easier to fly and maintain similar planes than to use multiple aircraft.

- *Search cost.* Buyers and sellers incur these costs to find each other. High search costs contribute to the lock-in for eBay. Innocentive is trying to build similar lock-in on its site dedicated to the scientific R&D community.

Exhibit 6 summarizes these costs and the lock-in behind them.

Exhibit 6: Lock-in and Switching Costs

Type of Lock-In	Switching Costs
Durable purchases	Replacement of equipment; tends to decline as the durable ages
Brand-specific training	Learning a new system, both direct costs and lost productivity; tends to rise over time
Search costs	Combined buyer and seller search costs; includes learning about quality of alternatives

Source: Carl Shapiro and Hal R. Varian, *Information Rules* (Boston: Harvard Business School Press, 1999), 117. Copyrighted material, used by permission.

To win, a new network must be vastly superior to an old one. Consider the daunting decision the first customer faces as they ponder a switch to a new network. Even if the new network *is* inherently better, there are no network effects with a single user. So that individual faces huge switching costs.

Even if a sufficient number of people *are* willing to switch to a superior network, coordination presents many difficulties. In fact, collective switching costs are far higher than all individual switching costs because of this coordination hurdle.

When evaluating a network of users, you have to consider switching costs on a per user basis and aggregate those costs. Small switching costs for a huge user base can be equivalent to large switching costs for a single user, even though the latter is much easier to appreciate. Most companies benefiting from network effects understand this point and work hard to increase lock-in (often called stickiness).

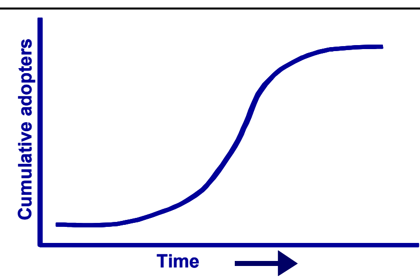
Network Formation

We now turn to the question of how networks form. If you want to understand network formation, you can start by thinking about how the flu spreads. There are two key dimensions, both intuitive. First, the degree of interaction describes how often people run into one another. Second, the degree of contagiousness describes how easily the flu spreads.

With a lot of interaction but a mildly contagious flu strand, the flu will not take off. A highly contagious flu strand with isolated carriers will not take off either. But combine contagiousness with interaction, and you've got an epidemic.

As it turns out, the graphs of how innovations and diseases spread both follow an S-curve. Adoption starts slowly and increases at an increasing rate once the innovation (disease) takes hold. Exhibit 7 shows the familiar pattern.

Exhibit 7: S-Curve

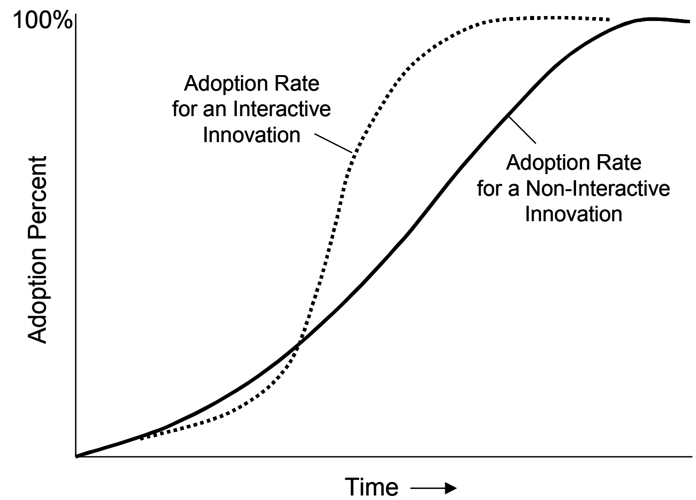


Source: LMCM.

Not surprisingly, our biological metaphor parallels the business-world. We can model the degree of interaction using insights from network research. And we can model susceptibility, or contagiousness, as adoption thresholds. This metaphor does have limitations, but captures many of the important features of network growth.[18]

Before proceeding we need to distinguish between how non-interactive and interactive innovations diffuse. The benefit of a non-interactive innovation increases for future adopters as more and more individuals adopt. So it follows an S-curve. With interactive innovations—including networks with strong network effects—earlier adopters influence later adopters, but *later adopters also influence earlier adopters*. The benefits from each additional adoption flow to *all* existing and future users. As a result, an interactive innovation follows a much steeper S-curve (see Exhibit 8).

Exhibit 8: Interactive Innovations Follow a Steeper S-Curve



Source: LMCM.

We all know only a handful of innovations succeed. So what's the key to rapid adoption? The good or service has to achieve critical mass, a metaphor borrowed from physics. Critical mass is the key to detonating an atom bomb. When the unstable nucleus of uranium breaks up, it releases energy. Neutrons emanating from the breakup of one may hit another and cause it to break up, but most neutrons miss other nuclei and project harmlessly into space. If, however, you appropriately condense the quantity of uranium—critical mass—the typical neutron that leaves one nucleus will hit another, and so on, causing a self-sustaining chain reaction.

Similarly, an innovation is said to reach critical mass when adoption begins to increase at an increasing rate. Even if a company stops actively promoting the innovation, the process continues. The innovation is self-sustaining, and it becomes nearly impossible for competitors (and the company's management miscues) to change the course.

Most people don't adopt an innovation based solely on its intrinsic benefits. The actions of other people influence them, and not all adopters are equivalent in their potential to be influenced. (This is one of the key limitations in applying a biological metaphor.)

Individuals have an *adoption threshold*, defined by the number of other people who must engage in an activity before a given individual joins in. Think of a recent fad or fashion. Were you an early adopter (low adoption threshold) or did you wait until nearly everyone else adopted (high adoption threshold) before you jumped in?

Interestingly, adoption in an individual's personal communication network influences them more than aggregate adoption. This means that the *structure* of communication networks helps assess how the diffusion process works for interactive innovations. An innovation spreads much more quickly over a network with an average of six degrees of separation than one with sixty. Studies of the small world effect have formally explored the structure of social networks.

One central idea in the small world literature is clustering, or the degree to which the connections to one node also connect to one another. For example, clustering reflects the extent to which your friends know one another. Not surprisingly, many real-world networks are highly clustered.

When modeling networks, researchers discovered something fascinating: Just a few, random long-range connections between local, clustered networks dramatically reduce the degrees of separation. A social analogy would be a tightly knit group of friends living in Boston, with a member still in contact with friends in San Francisco. With just a few random links, and the overall degrees of separation plummet.

How does this affect network formation? The tremendous potential of a network is *not* a function of how many people have adopted it. Rather, *a network's potential comes from how many non-adopters are in the social cluster of the adopters.* The true power of the network effect lies in the adoption cascade through the various social clusters. Given the degree of interconnectedness the Internet affords, the small world effect suggests network formation should occur more rapidly than ever.

In fact, it does. Less than six months after its launch, Hotmail, a free email service, registered its 1 millionth user. And less than 18 months later, the subscriber number shot up to over 12 million people. Skype, a peer-to-peer Internet communications company, gathered 9.5 million users in its first year. [19]

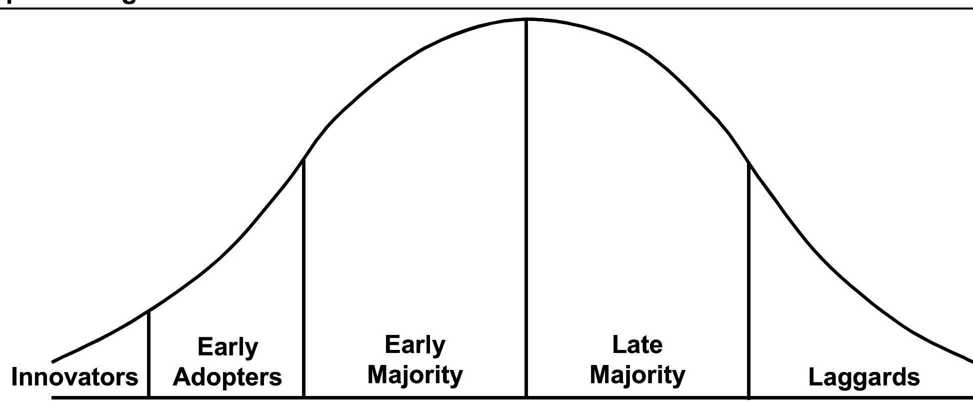
We can now summarize three key points:

- Interactive innovations, including networks, grow at a faster rate than non-interactive ones.
- An individual's adoption threshold is defined by how many other people in their social cluster engage in an activity before they join in as well.
- The small world effect shows us how communications technology makes us more connected to one another than ever before.

So far, we have focused largely on the architecture of network formation. We will now review the *process* of formation. For that, we turn to the dean of diffusion, Everett Rogers. Rogers first published his classic book, *Diffusion of Innovations*, in 1962.

The familiar S-curve represents *cumulative* adopters of an innovation. Rogers found that the plot of new adopters tends to follow a normal distribution (see Exhibit 9). This insight allowed him to partition adopters based on how early they are willing to adopt an innovation relative to others. Rogers broke adopters into five groups, based on statistical measures. Fans of technology strategist Geoff Moore—especially his books *Crossing the Chasm* and *Inside the Tornado*—will find the graphic and nomenclature familiar. Crossing the chasm means getting to critical mass.

Exhibit 9: Adopter Categorization



Source: Geoffrey A. Moore, *Crossing the Chasm* (New York: HarperBusiness, 1991), 12. Copyrighted material, used by permission.

The process starts with *innovators* and *early adopters*. Innovators are a group obsessed with "venturesomeness." They are known for their technological savvy and willingness to cope with the distinct possibility that the mainstream will never adopt the innovation. The innovators are the gatekeepers of new ideas.

Early adopters are more integrated with society than innovators and are often opinion leaders. Since early adopters often provide advice, they understand that they must make judicious innovation decisions.

In an attempt to get to critical mass, the *early majority* is the crucial group. The transition from early adopters to the early majority is the chasm. The early majority remains cautious about embracing a new idea. Still, this large group provides a key ingredient any innovation needs—legitimacy.

Interactive networks encourage adoption by providing the early majority incentives that a regular network can't. Once an interactive network takes root, strong network effects provide benefits that fit neatly with the needs of later adopters, thus accelerating overall adoption rates. In contrast to the innovators and early adopters, the early majority can clearly see the benefit of network effects and factor them into the decision making process.

Transaction networks have more liquidity, device markets supply more complementary products, and community networks contain more members with which to interact. This factor becomes a substantial input in the value calculus, rather than just the intrinsic product merit.

Exhaustive studies of innovation diffusion show that the point of critical mass is typically between 5% and 20% penetration of the total market. Beyond this point, increased adoption becomes self-sustaining. Moore calls this period of growth "the tornado."

You can also view critical mass as the "tipping point." When two or more firms compete for a market where there is strong feedback, one typically emerges as the winner. The point of no return, where one company's success begets further success, occurs at the tipping point.

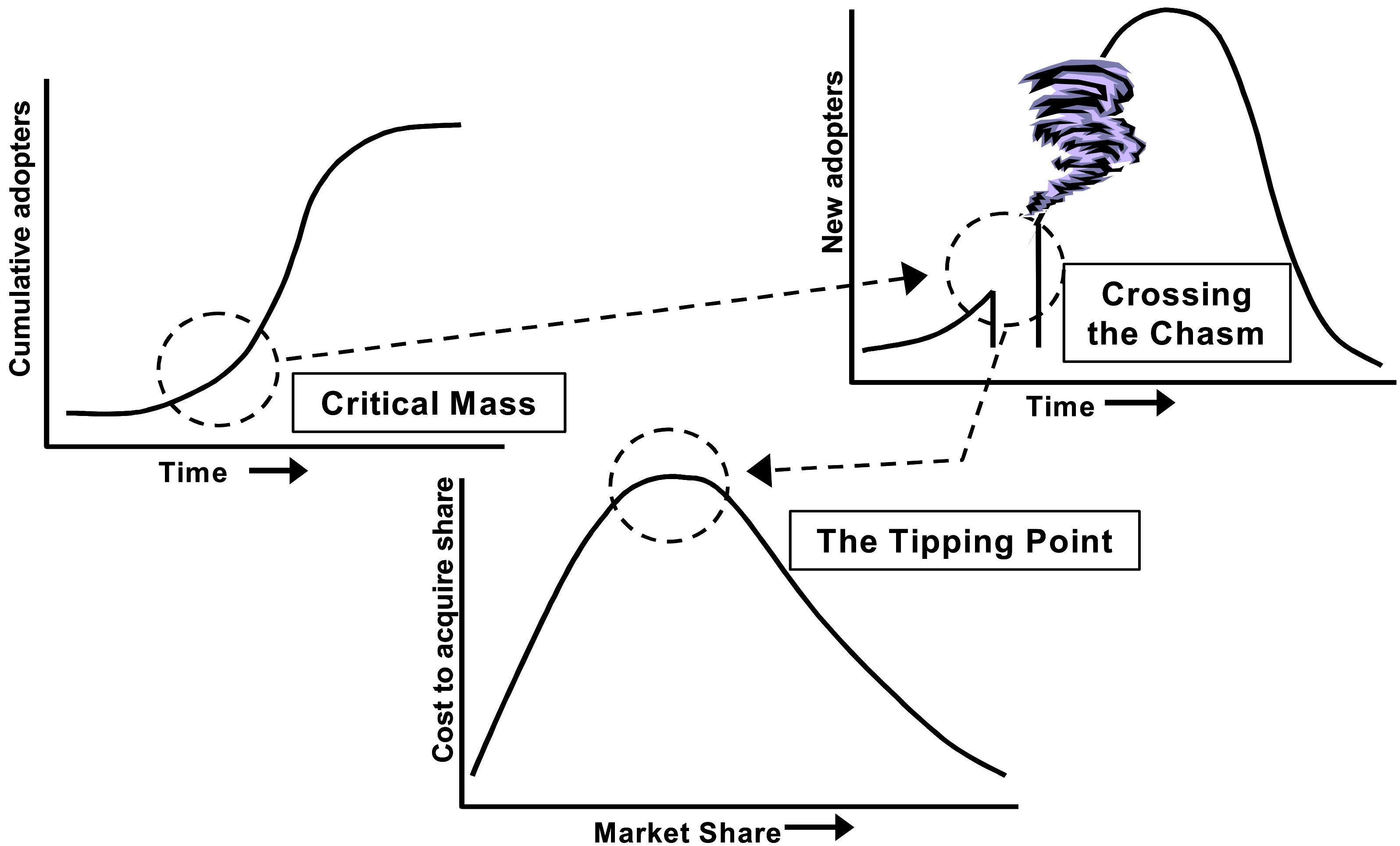
The real message in the tipping point is an economic one. Typically one or more companies will vie to become the network of choice. Early market share gains come with great challenge and expense. If by skill, foresight, or luck one company gets a lead in a "tippy" market, positive feedback will likely to carry it to the tipping point, or point of critical mass. [20] From there, it is shareholder value nirvana: market share rises precisely as the cost of gaining that market share declines.

Exhibit 10 provides a complete map of critical mass. We can describe critical mass in three ways:

- The inflection point—or elbow—in an S-curve.
- The transition from the early adopters to the early majority— or "crossing the chasm."
- The tipping point, where incremental market share comes at incrementally lower cost.

While our discussion dwelled largely on the mechanics of network formation, we cannot lose sight of the fact that most networks never get to critical mass. Equally important, however, is that an intrinsically valuable network or innovation won't necessarily win in the market place. *A great offering is a necessary, but not sufficient, condition for getting to critical mass.*

Exhibit 10: The Tipping Point



Source: Geoffrey A. Moore, *Crossing the Chasm* (New York: HarperBusiness, 1991) and Jeffrey R. Williams, *Renewable Advantage* (New York: Free Press, 1999). Copyrighted material, used by permission.

Summary

- There are different types of networks with varying degrees of network effects. As investors, we seek businesses where network effects are strong and where the company can capture the economic benefits.
- The combination of demand-side scale economies and high upfront, low incremental cost of information goods creates businesses unlike those in the traditional industrial economy.
- Network business offer substantial opportunity for wealth creation. Successful networks see sales grow faster than costs.
- Lock-in and associated switching costs are key to a network business's sustainable competitive advantage.
- Interactive innovations diffuse faster than non-interactive ones.
- Network companies need to get to critical mass.

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Endnotes

[1] Carl Shapiro and Hal R. Varian, *Information Rules: A Strategic Guide to the Network Economy* (Boston: Harvard Business School Press, 1999), 173.
[2] Shivaram Rajgopal, Mohan Venkatachalam, and Suresh Kotha, "The Value-Relevance of Network Advantages: The Case of E-Commerce Firms," *Journal of Accounting and Research*, Vol. 41, 1, March 2003, 135-162. http://faculty.fuqua.duke.edu/~vmohan/bio/files/published papers/rvk_jar2003.pdf.
[3] See http://www.leggmason.com/billmiller/vt4q03.asp
[4] Nicholas Economides, "Network Economics with Application to Finance," *Financial Markets, Institutions & Instruments*, Vol. 2, 5, December 1993, 89-97. http://www.stern.nyu.edu/networks/fmii93.pdf.
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[6] Anthony B. Perkins, "Networking with Bob Metcalfe," *Red Herring Magazine*, November 1994.
[7] The future of gaming is very likely to shift to community-based, as players will be able to interact directly via newer technology. This will likely enhance the value from users.
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[10] W. Brian Arthur, "Increasing Returns and the New World of Business," *Harvard Business Review*, July-August 1996. http://www.santafe.edu/arthur/Papers/Pdf_files/HBR.pdf.
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[12] http://www.santafe.edu/arthur/Papers/Pdf_files/Credit_Suisse_Web.pdf.
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[15] R.E. Caves and P. Ghemawat, "Identifying Mobility Barriers," *Strategic Management Journal*, Vol. 13, 1, 1992, 1-12.
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[17] Shapiro and Varian, 103-134.
[18] For an excellent discussion, see Duncan J. Watts, *Six Degrees: The Science of a Connected Age* (New York: W.W. Norton & Company, 2003), 220-252.
[19] http://www.skype.com/company/news/2004/company_niklas_letter.html.
[20] Markets that are most likely to tip have low demand variability and high scale economies. Some high-demand variability, high scalability markets also tip. See Shapiro and Varian, 186-190.

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