

Chapter 16

Implications of Results

“Software companies caught in a downward spiral find it exceptionally difficult to escape. Yet a few determined succeed.”

(Blumling et al. 2002)

While the pursued customer network-centric valuation approach contains a variety of implications, this chapter summarizes the most relevant issues with respect to the outlined target group. First, findings relevant to managers of companies operating in software markets are presented, before implications for financial sponsors are depicted. Then, the consequences for various streams of research conclude this chapter.

16.1 Implications for Management

In this first section the most relevant implications for managers are investigated. All in all, managers should note that the outlined approach supports decision making in software markets based on a better understanding of customer networks, their topologies and their dynamics. This has implications on various aspects of management, such as strategic management, marketing and turnaround management. It is important to note that the following categories are not mutually exclusive and collectively exhaustive as some of the following implications are relevant to more than one cluster.

16.1.1 Implications for Strategic Management

The findings have a variety of implications on strategic management as it generated new insights by combining theoretical models, empirical data and numerical simulations. In the following, the most relevant implications are depicted concerning the modeling of product diffusions in software markets, the software design strategies, mega institution management and innovation portfolio management.

Modeling Product Diffusions in Software Markets

The analysis reveals that the customer network is one of their most valuable assets of software companies. With the outlined method it can be approximately valued. For this reason managers should note that the outlined approach supports decision making in software markets and that any management strategy should aim at supporting this very important asset. Moreover, it is important to note that the modeling task should be performed by experienced professionals familiar with such complex networks and the respective valuation literature on the other hand. New insights from the theory on how networks develop can be gained by applying the developed model to strategic management decisions and marketing strategies. However, management will not be likely to obtain the information required and knowledge by themselves.

Software Design Strategies

The investigations reveal that compatibility is a key lever of strategic management to position products in software markets due to network effects. This finding is confirmed by research with similar findings (Wiese 1990). If the design of two products is incompatible, competitors are confronted with the start-up problem and with inter-sectoral competition. In the case that both rivaling suppliers design compatible products, they reinforce each other to overcome the start-up problem in an innovative market, but at the same time they are also in intra-sectional competition. The research illustrates the underlying fundamental trade-off between openness and control. Open standards increase the probability that a certain standard dominates a market, but at the same time limits the opportunity to control the market development. In turn, a high degree of control is likely to delay the product diffusion (Shapiro and Varian 1998). Therefore, software companies have the choice to face more intense competition in larger markets and less intense competition in smaller markets. While compatibility relaxes the competitive pressure in the early stages of the product-life cycle, it intensifies the pressure in later stages (Katz and Shapiro 1986). At the same time, compatibility changes the nature of competition as consumers gain the flexibility to combine products from various suppliers. In turn, some companies introduce incompatible products in order to create a temporary competitive advantage that is used in order to set the market standard. As consumers try to avoid stranding costs, it can be rational for competitors to agree on a common standard in order to jointly develop the market based on a common installed base.¹

Mega Institution Management

Empirical studies investigating the distribution of company turnover in various industries observe a trend towards mega institutions (Zanini 2005). In other words, the distribution of companies according to their turnover follows a powerlaw.

¹ A recent example is the decision of Toshiba to abandon the development of the HD-DVD standard in order to boost the development of the High Definition format.

Moreover, a comparative-static analysis, comparing the distribution of companies from 1994, 2007 and 2008, reveals that this mega institution trend is reinforced over time. In this study, the distribution of companies with respect to their size is compared for various dates. The comparison identifies increasingly steeper power curves. This means that few companies are extremely large, while many others are very small. While this phenomenon can be identified in various sectors, it is primarily evident in intangible asset intensive industries, such as software markets. In addition, it is interesting to note that the domination of few dominant companies is reinforced by the economic crisis of 2008 (Zanini 2008). The studies reveal that such developments are particularly relevant for companies operating in software markets (Zanini 2008). This phenomenon can be interpreted and explained based on the conducted investigations of this research. Our research revealed the outstanding role of customer networks in software markets, which are governed by network effects. From a customer network-centric perspective, software companies generate disproportionately high revenues if they benefit from strong customer networks that provides them with a dominant market position. If the network effects are strong enough, some already large companies are transformed into mega-institutions that dominate the business landscape, e.g., Microsoft (Zanini 2005).² Hence, the developed complex networks framework can be applied in order to generate a numerical network model that can be used to simulate the dynamics of the complex customer network. Such investigations allow a better understanding of the industry dynamics which, in turn, is a prerequisite for determining the optimal strategy in the management of mega institutions.

Innovation Portfolio Management

Manager can apply the complex networks framework in order to optimize innovation management. A fundamental problem of innovation management is to rationalize investments in innovations. Although innovations are generally perceived to be positive, value tracking, controlling and valuation of innovations is challenging. In this context, the complex networks framework for valuations in software markets closes a research gap. Based on the customer network-centric perspective, innovation projects can be interpreted and valued as innovation options. From this real options perspective, a company is a portfolio of individual projects that are options on cash flows. Since the various options interact with each other, portfolio management strategies can be applied in order to optimize the performance of the innovation portfolio. A prerequisite is that it is possible to quantify the value of an innovation option. Based on the complex networks valuation approach, innovation options can be valued in order to determine the optimal innovation strategy based on transferring insights from portfolio management, e.g., risk diversification. Moreover, if innovations are interpreted as innovation options, it is possible to determine a return on

² Please confer Sect. 5.3.4.

the innovation by comparing the investment costs with the respective returns of the innovation. From this perspective, the venture capital market can be interpreted as a market exchange for innovations and financial investors can be seen as innovation brokers. They can apply the developed complex networks framework in order to optimize their innovation portfolio management.

16.1.2 Implications For Marketing Strategies

The research has also implications on marketing strategies of software companies. The systematic complex networks approach can be applied in order to develop an integrated marketing and financing strategy that can be communicated to customers and financial investors. The following approaches allow one to apply the insights on network characteristics and dynamics into normative marketing strategies in the following subsections.

Guerilla Marketing Strategy

Guerilla marketing is an unconventional marketing measure that creates social interactions with respect to a product, a brand or a company based on the surprise effect (Levinson 1984).³ Its forms are manifold, but share the principles of guerilla tactics such as rebellion, surprise, and efficiency. Such actions are not expensive, and do not use classic channels of communication. Norms are broken in order to create a surprising effect for crossing the recognition barrier of the target audience. Successful guerilla measures are innovative and unique. Depending on varying degrees of media resonance, three subforms of guerilla marketing are distinguished.

1. *PR-Guerilla*. The intention of PR-guerilla is to get attention through controversial actions (Zerr 2004). The media resonance resulting from such actions is relative to other news and bears the risk that journalists respond with a negative feedback (Koppelman 2006).
2. *Live-Guerilla*. Live-guerilla actions are based on a live performance that intends to stimulate the attention of potential customers. A product, brand or company can be the focus of the action or just a part of the performance. Examples are professional actors playing satisfied customers or hired chatroom-users.
3. *Street-Guerilla*. The purpose of Street-guerilla is to use unconventional methods to gain the direct attention of potential customers. An example is a beer brewery that delivers the beer through the front door during main customer hours in order to incite discussions.

From a complex networks perspective, all three Guerilla marketing strategies can be reasonable options in software markets. As a vital goal of Guerilla marketing is

³ Guerilla marketing is also coined Street-, Grassroots-, Ambush-, or Buzz-Marketing.

to foster, with minimal resources the social interactions in the customer network, it is necessary to define the exact communication goals and to test the effects of the planned actions in the network. Guerilla tactics can only be successful in software markets if the recognition boundaries of potential software users are crossed. Therefore, a campaign should be designed to primarily target opinion leaders of a customer network in order to maximize the impact of the campaign.

Viral Marketing Strategy

Viral marketing describes the development of entertaining or informative messages that incite receivers to pass it via primarily digital distribution channels to other potential customers or existing consumers (Rayport 1996; Groeger 2008).⁴ The goal is to benefit from the network effects of digital word-of-mouth in social networks (Watts and Preretti 2007). Successful campaigns reach several million users within a short-time horizon, and are based on low spreading loss through the filtering in the social network among the nodes of the networks.⁵ A prerequisite is a target group oriented design of the campaign that balances creativity, provocation and the product or company message. In addition to personal communication videos, audiofiles, animations, documents, online games and microsites are also possible distribution channels.⁶

From a network perspective, the following aspects are particularly relevant for a viral marketing strategy in software markets. The goal is to foster the social interaction among the customer network based on multi-stage referrals. Therefore, it is necessary to formulate a clear message that shall be transported. In software markets, the focus of such a campaign will be on the software product or the respective software company, and there frequently will be no direct interactions. It is also possible to combine this strategy with other measures, such as a combination of a guerilla strategy that is propagated based on viral marketing. In software markets, the viral marketing message can contain entertaining or informative content. The success of such measures is determined by the personal relevance, the emotional surprise and it can maximize its impact if the respective opinion leaders are targeted. An integrated approach requires that supportive additional measures are executed. But although an increasing budget is likely to provide an increasing level of flexibility, it is not possible to guarantee the success of a viral marketing strategy, particularly in software markets, as individual factors such as fads, trends and moods influence the outcome of a viral marketing campaign.

⁴ The research on viral marketing dates back to a publication of Rayport in 1996 (Rayport 1996). While there are no coherent definitions of the term, the concept is also known as Virus-Marketing.

⁵ The Quiksilver Dynamite Surfing campaign is an example that in 2007 reached a million users during the first week after its launch, and more than 10 millions users within the first 2 months.

⁶ Microsites are personalized websites with a focus on a specific topic for a target audience.

Seed Marketing Strategy

A seed marketing strategy suggests that a company provides limited or unlimited access to one or multiple products for a selected group of test users for free or at a discount in order to foster social interactions between them and their environment with respect to the product (Solomon and Rabolt 2004; Groeger 2008). While the give-away of free samples is not an innovative concept, seed-marketing strategies do not aim at a general public audience, but primarily at selected opinion leaders.⁷ The goal of such a strategy is to overcome potential financial barriers of the opinion leaders, to allow them to identify with the product and to benefit from the endowment effect, according to which people value a good or service more once a property right to it has been established (Kahneman et al. 1990).⁸ The concrete implementation of the seed marketing strategy depends on the characteristics of the product, the goal of the campaign and the company. It is frequently related to additional background information on the product. Thereby, the opinion leader have more information than their social environment and can use it in order to underline their opinion leader status. The feedback of the opinion leaders provide additional possibilities for social interactions. As it is possible to combine various network marketing strategies, it is also possible to invite the participants of a Guerilla event to participate in a seed marketing campaign by inviting them with free samples of the promoted product.

From a complex networks perspective, a seed marketing strategy intends to foster the social interactions of the nodes in the customer network based on personal referrals by opinion leader. It can comprise personal as well as digital interactions through direct personal experiences, and thereby allows a strong identification of the opinion leader with the software which is not typical of classical marketing strategies. It seems like an old concept with a new label, but the organized design of a multiple stage referral strategy based on personal experiences allows a new dimension of involvement and commitment of the participant which increases the probabilities of a reinforcing feedback loop in the customer network. If the seed marketing strategy successfully creates the experience of personalized exclusivity and an advanced level of information, the participants are more likely to propagate the software in their social environment and, thereby, emphasizes their role as opinion leader.

User Generated Marketing Strategy

The idea of user generated marketing is to actively involve the consumers in the design of the product development and marketing strategy (Groeger 2008). An extreme example is the product development process of Brewtopia, an Australian

⁷ Please confer (Solomon and Rabolt 2004) for further details on the distinction between product placement, free samples and seed marketing.

⁸ A popular example is the invitations of Hasbro for 1,600 kids between eight and thirteen, who are considered to be cool alpha pups in order to let them test unreleased videogames with the twofold purpose of gaining an upfront feedback of highly relevant customers and to use them as multipliers through the artificially created exclusivity.

brewery, which created a previously non existing product in a contested market without any investments into marketing, without its own production, without personnel and without capital. The founder invited 140 people to a 13-week workshop with the goal of designing a new beer, to find a name for the beer, to determine a fair price and to discover optimal distribution channels in exchange for one share per vote. Based on this user generated beer design the company reached 16,000 participants, sells beer in 50 countries and went public in 2006, 4 years after its foundation (Ramage 2008). The idea behind this strategy is to create a strong relationship with the consumer based on recognition and entertainment which is shared with friends and families. This creates a strong product related message that is spread in the social environment and incites others to join the network.⁹ Such an decisive influence from the customer on entrepreneurial decisions is seen from a variety of perspectives. While some researchers emphasize the loss of control in the design of the marketing strategy which can lead to a blurring or even opportunistic image of the company, other research identifies the user generated marketing as a necessary step resulting from a paradigm shift in marketing.¹⁰

A user generated marketing strategy in software markets intends to incite opinion leaders of the software to participate in the design and marketing of the software. But while it is very risky to transfer the full responsibility to the customer, it is also possible to consider an increasing degree of participation. Accordingly, existing social interactions with the customer network should be monitored closely and extended if this is reasonable. However, it is important to note that this strategy is not suitable for all software products and companies. The increasing degree of participation can be distinguished in the following steps. In the first step, it is possible to integrate customer contribution into the marketing strategy, e.g., by customer generated commercials, Internet sites or jingles. In another step, a company may integrate suggestions of customers with respect to the design of the product packaging, which, however, is not a crucial aspect in software markets. Moreover, it is possible to integrate customer contributions into the product development of existing as well as into the product design of new software. This escalating involvement approach allows a company to integrate the customers actively into the user generated marketing strategy, while the control over the software remains with the software company. A comparison with the seed marketing strategy reveals that the user generated approach should be preferred if the customer network is larger, and if the relevance of the individual hubs is lower. It provides, however, the opportunity to discover opinion leaders and to integrate them into the customer network through their higher involvement if they have the corresponding incentives.

Vaporware in Software Markets

Expectations are vital determinants of diffusion processes in network effect markets that have to be carefully managed (Choi et al. 2005). As previously outlined

⁹ This phenomenon is also known as the Hawthorne-effect. Please confer (Jones 1992) for further details.

¹⁰ Please confer (Groeger 2008) for further details on this discussion.

autoregressive market expectations of customers shape the competitive landscape and can be influenced by investments in research and development, human capital, and infrastructure, as they are interpreted as credible commitments of companies (Besen and Farrell 1994).¹¹ This relationship emphasizes the importance of information management and investor relations. Announcements of product launches, or of compatibility influence the purchasing decision of customers and, thereby, the future development of the company (Swann and Shurmer 1994). In this context it is interesting to note that it is common practice in software markets to pre-emptively announce vaporware in order to increase the entry barriers that deter potential rivals to enter the market.¹² A review of the empirical literature reveals that it is a widely adopted practice to announce innovations well in advance of actual market availability. Accordingly, firms announce innovations in order to convince market participants that their own innovation will become a market standard and, thereby, to reduce the perceived uncertainty of potential customers. Incentives for such pre-announcements are even stronger in markets with network effects, since the announcements are used to reduce the delay of purchases and to sabotage the build-up of competing installed bases. If such announcements are not fulfilled, however, the credibility of the company is damaged which is harmful for long-term development. Therefore, management of the customer's expectations is a prerequisite for a long-term success in software markets.

Opinion Leadership in Software Markets

The opinion leadership concept assumes heterogeneity of agents in a network, and states that certain participants of the network have a higher influence on the adoption decision of others than the average agent (Valente and Davis 1999). Hence, they should be the primary target group of marketing activities as they help to overcome the market introduction phase more quickly, allow for a longer and broader harvesting in the growth and saturation phase, and establish customer loyalty in the decline phase. This insight leads to the design of optimal market penetration strategies, such as the two-step flow strategy according to which opinion leaders are targeted first, in order to convince, and in the second step the market followers as selective individuals with a high centrality have a high influence on the decision of other participants. A successful example of such an opinion leader marketing is the pharmaceutical industry which spends approximately 32% of the marketing budget for attempting to influence the opinion leaders of social networks. Similarly, the analysis of customer networks in software markets revealed that they frequently have a scale-free topology. There are some nodes which have a higher degree than other actors. Consequently, an optimal allocation of resources requires one to segment the potential customers into various strata according to their connectivity potential, and to focus marketing efforts on these opinion leaders according to a hierarchy of customers (Shapiro and Varian 1998). In scale-free networks there are two classic levers for

¹¹ Please confer Sect. 5.3.1.

¹² Vaporware are products which are not yet ready for a market launch.

growth. The first one is to back a viral adoption of the network by relying on the scale-free network topology, i.e., every new user of a network is potentially a new node of the social network structure. Hence, it is necessary to develop and utilize respective tools that induce them to bring all their real-world connections into the virtual community. Second, it is important to support the animation of the network as a central hub may not be an animator for other customers. In this case, animation is essential in order to convince other customers to buy the software. But in order to pursue this strategy, it is necessary to identify opinion leaders in real-world networks. Innovative results can be achieved by combining ideas of epidemiology with those of network resilience, similar to vaccination strategies. From a complex networks perspective, vaccination can be interpreted as the removal of some particular set of vertices from a network, which in turn can be modeled as site and bond percolations on networks (Callaway et al. 2001). If the site percolation is correlated with the vertex degrees of networks, the structure and function of complex networks it is possible to develop targeted vaccination strategies, e.g., by removing vertices with the highest degree (Pastor-Satorras and Vespignani 2002). As networks tend to be particularly vulnerable to the removal of their highest degree vertices, this kind of targeted vaccination is expected to be particularly effective. However, it is not easy to identify the highest degree vertices in real-world social networks. With respect to software markets, this goal is equivalent to the problem of identifying opinion leaders in customer networks. An interesting approach to solving this problem is based on the observations that since the probability of reaching a particular vertex by following a randomly chosen edge in a graph is proportional to the degree of the vertex, it is more likely to find high-degree vertices by pursuing edges than by choosing vertices at random (Cohen et al. 2002). Consequently, research suggests that a population should be immunized by choosing a random person from that population and vaccinating a friend of that person by asking about a personal relationships with a higher degree and then repeating this process (Newman 2003b). Analytic calculations and computer simulations reveal that this strategy is substantially more effective than random vaccination (Cohen et al. 2002). Contact tracing methods used to control sexually transmitted diseases and ring vaccination method used to control smallpox are both examples of such vaccination strategies (Kretzschmar et al. 1996; Mueller et al. 2000). Such insights on vaccination strategies can be transferred, within the outlined limits, to software markets. Accordingly, a random customer is chosen from the customer network and asked to recommend a neighbor with a higher node degree. If the customers cooperate, this search strategy is far more efficient than analyzing the total customer network. A crucial issue of this strategy, however, is to provide the incentive for customers to participate in the referral process which is an open research issue for marketing research.

Pricing Strategies in Software Markets

Network effects are pervasive in software markets. While software vendors consider pricing strategies, they also must take into account the impact of network effects

on sales as they can be used to protect or to extend the market share, e.g., due to the start-up problem (Farrell and Saloner 1986).¹³ Pricing strategies are primarily applied to satisfy one of five common strategic objectives (Besen and Farrell 1994; Wied-Nebbeling 2003).

1. Profit maximization
2. Achieve a target return on investment
3. Achieve a target sales level
4. Achieve a target market share
5. Prevent or influence competition

Accordingly, factors that determine pricing policies can be summarized in the following four clusters (Varian 1993; Besen and Farrell 1994; Shy 2001):

1. *Customers.* Consideration of customer expectations about price must be addressed. Empirical research reveals that there exist psychological pricing barriers that have to be taken into consideration. Ideally, a business should attempt to quantify its demand curve to estimate what volume of sales will be achieved at given prices.
2. *Competitors.* If the business is a monopolist, then it can set any price. At the other extreme, if a firm operates under conditions of perfect competition, it has no choice and must accept the market price. In most cases the market entry and exit barriers are in the middle. Hence, the chosen price needs to be very carefully considered relative to those of close competitors.
3. *Costs.* While in the short-term it may be acceptable for a company to price a product below total cost if this price exceeds the marginal cost of production, a business model has to ensure in the long run that its products are priced above their total average cost. In addition, it is also important to consider learning curve effects and economies of scale. These vary along the product life cycle and are vital determinants of the optimal pricing strategy, due to multiplier and obsolescence effects.
4. *Business objectives.* A fourth factor is the outlined business objectives. These are comprised of maximizing profits, to meet a specific target performance level, to achieve a target sales level, to influence the market share or the competition.

In order to achieve these objectives based on the respective factors, a variety of pricing strategies are available along the product life cycle for competition in software markets (Pechtl 2005):

1. *Marginal cost pricing strategy.* According to the marginal cost pricing strategy, prices are set in relation to the variable costs of production. Its objective is to achieve a contribution towards fixed costs and profit. Hence, prices are set using variable costing by determining a target contribution per unit which reflects a

¹³ Pricing strategies are defined as constitutional decisions with respect to pricing parameters under consideration of long-term effects (Vahlen 2006).

target variable cost per unit, total fixed costs or a desired level of target profit. The marginal cost pricing strategy is suitable for short-term decision-making, avoids any arbitrary allocation of fixed costs as well as overhead. It narrows the focus of the business towards a break-even perspective that is pretty common in software markets. Nevertheless, there are some potential disadvantages of using this method, such as the risk that the price set will not recover total fixed costs in the long-term, and it may be difficult to raise prices if the contribution per unit is set too low.

2. *Cost plus pricing strategy.* The full cost plus pricing strategy aims to set a price that accounts for all relevant costs of production. In comparison to the marginal cost pricing strategy, it has a variety of advantages as price increases can be justified due to rising costs, and a price stability may arise if competitors take the same approach and have a similar cost structure. In turn, some disadvantages are that the cost plus method ignores the price elasticity of demand, i.e., it may be possible to charge a higher price to maximize profits, the business has less incentive to save costs, it requires an estimate of business overheads and it may leave a business in a vicious circle.
3. *Penetration pricing strategy.* Penetration pricing is based on setting lower, rather than higher prices in order to gain a large, if not dominant market share. Market penetration strategies differentiate between opinion leaders and market followers and are primarily applied if a new market is entered. The expectation is that a quick product diffusion allows to benefit from cost degression that allows a market leadership position. Popular examples of penetration pricing are Internet browser, such as Netscape, business networks, such as Xing, Facebook, or m-Commerce applications such as Paybox. All products have in common that the products are introduced for free, before the price, at least for specific services, are increased. Penetration pricing is frequently considered to be an optimal for software markets in order to gain a critical mass of customers, while other empirical examples contradict this claim, e.g., the failure of Borland's discount strategy (Farrell and Saloner 1986). Hence, it is only possible if the demand for the software is highly elastic, i.e., demand is sufficiently price-sensitive. If applied successfully, penetration pricing may lead to large sales volume and relatively low costs per unit. Economies of both scale and experience allow lower production costs, which justifies the use of penetration pricing strategies to gain market share. But a penetration pricing strategy is also frequently applied in order to promote complimentary products. While the main software may be priced with a low mark-up to attract sales, customers are then required to buy additional products which are sold at higher mark-ups. A crucial issue is that a supplier must be certain that it has the production and distribution capabilities to meet the anticipated increase in demand before a penetration pricing strategy is implemented. But due to the large scalability of software, such penetration strategies are frequently applied in software markets. A potential disadvantage of penetration pricing strategies is the possibility that competitors copy the strategy by reducing their prices too, thus nullifying any advantage of the reduced price. In

addition, there is an impact by the reduced price on the image of the offering, particularly where buyers associate price with quality.

4. *Price skimming strategy.* Price skimming strategies imply charging a relatively high price, at least temporarily above the long-term optimal price, for a short time if a product is launched into a market, before it is decreased subsequently. A classical example is the pricing strategy of Intel for new processors. The objective is to differentiate the willingness-to-pay of customers who are willing to pay more for having the product sooner, as later prices are lowered when demand decreases. Its success is largely dependent on the inelasticity of demand for the product, either by the market as a whole, or by certain market segments. Thereby, the supplier benefits in the short term from monopoly profits. But depending on the network effects which are barriers to entry additional competitors are likely to be attracted to the market with increasing profitability. Hence, prices will fall as soon as competition increases. Thus, the main objective of a price-skimming strategy is to benefit from high short-term profits due to market segmentation. Price skimming has a variety of advantages such as high returns on the high set-up costs, a high-quality image, effective segmentation of the market and higher mark-ups for dealers.
5. *Expansionistic pricing.* An expansionistic pricing strategy is a more drastic form of penetration pricing as it implies setting very low prices in order to establish mass markets. It is suitable if the market is characterized by a high price elasticity of demand, such that the adoption of a very low price implies a significant increase in sales volumes. The strategy is applied for reasons similar to the penetration pricing strategy. Expansionistic pricing strategies may be applied by companies attempting to enter new or highly contested markets. Additional lower-cost versions of a product may be offered at a very low price to gain recognition and acceptance of consumers. As soon as acceptance has been achieved, more expensive versions or models could be offered. Markets that might benefit from expansionistic pricing strategies include magazine and newspaper publishers.

In general, the relevance of pricing strategies are market- and company-specific, e.g., relative size, competition, cost structure, etc. Nevertheless, it is possible to derive some application guidelines for software markets from a complex networks perspective. Cost-based pricing strategies are not an option as the costs of reproduction are close to zero. Instead, software companies frequently choose a customer-value strategy which is based on the assumption that the product provides a specific value to the customer that justifies a differential pricing strategy (Shapiro and Varian 1998). Alternatively, skimming, penetration pricing and entry limit pricing are possible (Späth 1994). In addition to the outlined pricing strategies, a technology can be sponsored or unsponsored (Besen and Farrell 1994). If a sponsored strategy is pursued, the software company subsidizes the diffusion of a technology. Such a sponsoring may be profitable if it is reasonable to increase its popularity, to increase its market share or to cross the critical mass in a market. Unsponsored technologies, in turn, are sold based exclusively on the original and derivative utility generated by product. Further strategic options are to reduce

the marginal costs by process innovations, or to raise the market entry barriers for competitors by monopolizing restrictive production factors, e.g., by increasing investments in research and development. This has an impact on the dynamics of the customer network, if the respective process innovations allow a decreasing indirect costs which in turn increases the probability that the software crosses the critical mass of customers. In summary, the software firm will charge a lower price to attract more users in the first stage, before it increases the prices of the software. If multiple product generations are compared, a dynamic analysis reveals that the optimal upgrade time is when gross profit of the first software edition equals the gross profit of the second edition (Yang 1996). Hence, too early or late promotion of the new edition will cause profit losses. The findings imply that the complex networks adoption and diffusion simulator can also be applied in order to support the determination of pricing strategies and the optimal upgrade time.

16.1.3 Implications For Turnaround Strategies

The findings of the research reveal that investigations of customer networks contain a variety of information that can be used for management decisions. They have in particular implications for turnaround assessments in software markets. Corporate turnaround decisions are frequently irreversible investments, but the research indicates that it can be rational to invest into a software company despite of negative operative cash flows. It can be a value-maximizing strategy to interpret temporary losses as an option premium in exchange for potential future pay-offs from a real growth option. In this context, the suggested complex networks valuation framework enhances the transparency and the quality of valuations based on which the turnaround decisions are made. Therefore, accurate valuations in software markets are a central element of efficient turnaround assessments, an aspect which is not covered sufficiently by existing financial research. Consequently, irrational investment decisions occur due to the underinvestment problem as the intangible but valuable customer equity of customer networks is frequently ignored. But, since the customer base is identified as a central strategic variable in competition, it may be reasonable to extend the installed base despite of temporarily negative cash flows, if the overall value including the implied managerial flexibilities is positive.

Intertemporal Resource Allocation

Companies in turnaround are frequently in a dilemma. On the one hand operative short-term measures are required in order to assure the operative business, while on the other hand it is important to finance medium- to long-term projects in order to assure the sustainable success of the company. Research on turnaround reveals that successful turnaround strategies require successful management of both. It is important to provide the short-term liquidity in order to keep up the operational business, but it is also important to allocate enough resources into the research pipeline.

In this dilemma a crucial aspect is to convince internal and external financiers that investments, e.g., into the customer network are not voluntary, but are as necessary as operative funds, e.g., if they are required in order to reach a critical mass of customers within a short-term time horizon. In such negotiations the complex networks framework for valuation in software markets can bridge the gap between both parties by providing a theory-based communication tool that allows one to discuss the underlying assumptions, but provides a platform for illustrating the intangible value of such software companies as the concepts also have ontological implications. It provides both parties, the financial investor and the management, with a common framework which is the basis for the negotiations. The model is not supposed to rationalize each and every investment, but to provide a common language for the discussion of the significant underlying problems. The perception of individual parameters and their values will be different, but the parties will be enabled to exchange information within the synchronized mental model and, thereby, to focus the negotiation process on the controversial underlying assumptions.

Undervaluation Problem

The research reveals that traditional implicit approximations of customer networks in corporate turnaround assessments are frequently inadequate. They tend to underestimate the value of the analyzed company as it is necessary to consider intangible customer networks as intangible but valuable assets of software companies. This implies that a reliable turnaround assessment has to account for network effects. Consequently, it is rational to invest into the customer basis in the short-run despite of negative operative cash flows as such investments can be decisive to reach a critical mass of customers. Undervaluation, in turn, implies that some companies are not considered for turnarounds. In this case, the ignorance of network effects and complex networks leads to inefficient turnaround decisions based on biased assessments. Credible turnaround assessment models account for network effects of customer networks, as they are supposed to increase financial transparency and to avoid inefficient capital budgeting decisions. While traditional approaches have several limitations, alternative real options approaches provide a platform to frame strategic and operative flexibilities. Hence, it can be a value-maximizing strategy to accept short-term losses in software markets and to interpret them as an option premium for potential future pay-offs.

Cost Cutting Potential

A complex networks analysis can illustrate a variety of cost cutting potential. Traditionally cost reductions are achieved by saving personal expenses. But another important aspect is the role of customer retention that contains a variety of cost cutting potential. First, the efficiency of retained customers is greater as retention costs are frequently lower than the costs of acquiring new customers (Rust et al. 1995; Blattberg and Deighton 1996; Sheth and Parvatiyar 1995). This implies that even

higher marketing investments are necessary if the company performance is low and requires a turnaround. These increased investments have to be financed with financial resources. Such insights are particularly important in the design process of a turnaround strategy, as marketing costs will all else being equal decrease with an increasing success of the company. Moreover, it is necessary to consider a focus on the most profitable clients. From a complex networks perspective, such customers are the central hubs of the customer network who should be targeted in order to optimize the allocation of resources.

Integrity of Internal and External Corporate Networks

A vital result of respective network theoretical investigations is that the integrity of internal and external corporate networks is extremely fragile in turnarounds. Investigations on the resilience of networks reveal the vital importance of network integrity (Hommel and Kemper 2006). Similar to positive reinforcing effects, even a few central nodes can threaten the integrity of internal and external corporate networks with rebalancing negative effects, e.g., by eroding a loyal customer basis. Due to hyper-competition, such attacks can have significant implications on the performance of the company. Depending on the circumstances, it is possible that internal and external networks are disintegrated inciting, which in a worst case scenario can cause the liquidation of companies (Hommel and Kemper 2006). Percolation models can be applied in order to test the resilience of customer networks in software markets, as they allow to calculate implications of a random edge deletion. Such features are particularly useful for observing the effects of targeted attacks on the average path length of networks as in the cascading failure model (Holme et al. 2002). Accordingly, if networks are restricted by a maximum carrying capacity per node, the failure of a node implies a redistribution of its load on neighbor nodes. This can cause a cascade of subsequent collapses, if the network operates close to its carrying capacity. Hence, the failure of a single node can result in the total collapse of a network. Applied to software markets, the complex networks software market models developed with the simulator can be applied in order to investigate the resilience of customer networks. For this purpose, various destabilization strategies could be applied, e.g., to delete randomly customers or central customer, in order to assess the stability of the customer network. Such network theoretical information on the customer networks are highly relevant in order to develop sustainable business models.

16.2 Implications for Financial Sponsors

In this section, the focus is on implications for the business of financial investors, investment banks and venture capitalists. Although some of the concepts are increasingly recognized in the corporate finance practice, the overall popularity and impact

is rather limited, despite a broad variety of implications (Mauboussin et al. 2000). Hence, the most relevant aspects for financial sponsors are highlighted in the following sections.

16.2.1 Business Plan Analysis

The analysis of business plans is at the core of many investment and financing decisions of banks and financial sponsors. In this context, the outlined complex networks adoption and diffusion simulator can provide a valuable contribution by testing the plausibility of business plan assumptions in order to rationalize the respective investment decisions. Such investigations are particularly reasonable as part of a commercial due diligence, i.e., an in depth market analysis.¹⁴ If the commercial due diligence has a high deal relevance, e.g., as in a turnaround assessment, complex networks investigations based on the outlined adoption and diffusion simulator may contribute to a better understanding of the market. Consequently, it is possible to design more reliable market models as input factors for valuations and subsequent investment decisions.

16.2.2 Critical Mass Turnaround Financing Opportunities

Based on the outlined business plan application, another central implication for financial sponsors concerns the turnaround financing analysis of turnaround candidates. A large proportion of companies in the dynamic software markets struggled in the beginning of the century, and many vanished from the market. The reason being is that despite a desperate need for financial resources, a significant number of software companies are not capable of convincing frustrated financial investors of further investments. While it is difficult to achieve a successful turnaround in any industry, this is a particular challenge in software markets.¹⁵ On the other hand, investments into turnarounds can be very profitable if they are picked wisely. Empirical research reveals that 59% of the observed turnarounds decrease in value, whereas some of the successful cases are listed among the 25 most valuable software firms of the world.¹⁶ Among the remaining companies, some 15% were acquired by competitors or financial investors, and 13% stopped the decline in value, but were not able to significantly increase their financial performance (Beer and Nohria 2001). But the outlined effects can be captured only with highly complex models

¹⁴ Please confer (Sebastian et al. 2005; Niederdrenk and Maack 2008) for further information on a market or commercial due diligence.

¹⁵ Research on turnarounds indicates that more than 70% of turnarounds fail, whereas only 13% of software turnarounds are successful (Blumling et al. 2002).

¹⁶ Examples are BEA Systems, Oracle, and Peoplesoft.

(Meise 1998; Hommel and Müller 1999; Kühn et al. 2000). Therefore, a financial analyst is in a dilemma between the accuracy of the valuation and the information costs, as a variety of expensive data is frequently required. As the quality of the input data determines the quality of the financial analysis, prohibitive elevated prices can prevent the application of the real options approach, despite additional accuracy. In turnaround valuations for turnaround assessments such additional information can be worth the additional costs, as frequently a unique decision has to be made based on which the future of the company is decided. Therefore, the incremental gain of information can be worth the additional effort. The discussion on the contribution of real options to the outlined research question reveals that the exploration of the underlying cash flows is a central open issue in the design of turnaround valuation. These depend on the respective market developments and require a comprehensive analysis of the underlying customer network. Essentially, financial sponsors are confronted in such situations with critical mass turnaround financing opportunities. Accordingly, the key question is whether it is profitable for the financial sponsor to finance the corporate turnaround, or whether it is better to reject it. This question can be stated differently from a network theoretical perspective: Is the probability that a critical mass of customers can be reached within a predetermined time horizon, with a specific amount of financial funds, large enough to compensate for the respective opportunity costs? Or, in other words, is the probability that the software company gains the required X customers to reach the critical mass in this market segment within the next 6 months, if the company is equipped with Y financial funds, large enough to compensate for the respective risks? In order to solve this key question it is necessary to investigate the critical mass of customers which, in turn, depends on the customer network topology as depicted in the previous analysis. Hence, the complex networks adoption and diffusion simulator could be applied in order to support the turnaround financing decisions of financial sponsors. The key to answering this question is to interpret the turnaround investment as a real option, and to apply the complex networks framework for valuation in software markets. This allows us to investigate the relationship between the total company value, including the real option component, due to network effects and the respective costs. If the total value is positive, the turnaround project should be pursued, while it should be rejected if the respective value is negative. This critical mass turnaround financing analysis can be applied to other industries as well, but due to its dynamic nature it is particularly suited to software markets. Therefore, the findings of the research are a particularly relevant to turnaround financing decisions in software markets.

16.2.3 Business Identification Tools

The previous research provides the possibility to develop business identification tools for investment banks as the volatility in certain network effect markets can be observed. Hence, potential targets can be identified. Characteristics of an interesting target are a strong position in customer networks of software markets, e.g.,

opinion leader, accelerating sales growth and low reproduction costs. Targets with these attributes should be investigated thoroughly in order to identify lucrative investment opportunities (Mauboussin et al. 2000). On the other hand, rapid cluster formation in customer networks limits the organic growth potential of expanding software companies, as switching behavior of customers in software markets becomes increasingly unlikely with increasing network effects. Such network theoretical constellations in software markets may help to identify targets for mergers and acquisitions. Then, the customer network assessments can be conducted for potential clients in order to identify suitable corporations that benefit from better positions in customer networks. Moreover, they have access to data that could be collected in order to derive other industry specific network characteristics, which could be used for future network assessments, or aggregated and sold to clients interested in such customer network investigations.

16.3 Implications for Research

The previous findings provide interdisciplinary implications, but also implications specific to the involved streams of research. In the following section, first some interdisciplinary implications are summarized, before these findings are reviewed with respect to the corresponding discipline.

16.3.1 *Interdisciplinary Implications for Research*

Research on quantum mechanics revealed that it is impossible to predict the future.¹⁷ Nevertheless, it is important for managers and financiers to base their decisions on solid information and reasonable decision making tools. Probability theory and option pricing theory fill this void between the unrealistic quest for certainty and an odyssey in uncertainty. In this context it is important to note that the contributions of complex networks allow us to analyze uncertainty in network systems by providing some general insights into the mechanics of diffusions in networks. The probabilistic description of network diffusion, with the help of network theory, provides a means to condense the information about the uncertain future into a probability distribution, which is transformed with the help of option pricing theory. The complex networks approach allows us to derive additional network theoretical information at

¹⁷ This insight is an implication of the Heisenberg uncertainty principle stating that values of special pairs of variables cannot both be known with arbitrary precision. In other words, the more precisely a property is known, the less precisely the other can be known, e.g., position and momentum. Thus, it is not possible to develop a deterministic prediction of the future. It is important to note that this principle is not a statement about the limitations of research, but rather about the nature of the system itself (Heisenberg 1967).

the expense of certain modeling costs which can enhance the information base for decisions if the required information is available. This trade-off between additional costs and additional information is not profitable in all situations, e.g., a small local bakery is not likely to set up a network diffusion model for the global bakery market. Nevertheless, this additional modeling and valuation effort can be worthwhile in specific managerial situations, such as turnaround financing decisions. Therefore, the outlined research is relevant on a conceptual level to multiple managerial decisions while it should be implemented only if the possible benefits can outweigh the related costs. Research, however, in such cases revealed that the outlined models can provide valuable additional information which in turn will hopefully contribute to better decisions. After this general review of interdisciplinary implications, the most relevant implications are classified in the following, according to their respective disciplines.

16.3.2 Implications for Financial Research

As there are a variety of implications for financial research, only the most relevant are depicted in the following sections.

Convergence of Finance and Marketing Research

Research reveals a variety of aspects that point towards a convergence of financial and marketing research. Solid marketing research is required in order to configure the complex networks adoption and diffusion simulator for a better understanding of the customer network. In essence, this customer network perspective is a vital bridge between marketing and finance. The predominant DCF valuation method discounts expected cash flows at a risk-adjusted and capital weighted discount factor in order to derive the present value of the valued object. Hence, the projected cash flows are the vital input factor of this model. The estimation of the cash flows itself, however, depends on sales projection which are traditionally based on implicit marketing assumptions. In the current business practice, sales projections are frequently approximated based on historic data. For this reason, it is reasonable to consider the outlined concepts in marketing research, in financial research, and at the respective boundary between both disciplines.

16.3.3 Implications for Network Economic Research

The research on complex network economics is a logical extension of the classical network economic literature. While network effects are increasingly understood, the complex networks perspective allows an application of statistical mechanic tools

in order to extend the analysis, particularly of large-scale networks. This enables the modeling of larger networks and, thereby, increases the realism of the models. Depending on the development of the computing power, an application of the outlined concepts and programs on upcoming computers with even higher performance allows the development of even more realistic models and simulations. Moreover, the outlined research illustrates that the combination of research on network economics and on complex networks provides a variety of insights. Such research on complex networks economics has a focus on the implications of network effects on large-size complex networks. Based on the framework, further research on specific aspects of complex networks economics is required, as depicted in the next chapter.

16.3.4 Implications for Complex Networks Research

The outlined analysis is an application of complex networks theory to practical applications. Since practice and theory have always helped each other to develop, there are some important insights that should be considered:

Ubiquitous Network Properties and Dynamics

A central finding of the outlined research is the ubiquitous importance of network properties and dynamics in economic phenomena, as the respective concepts are highly relevant to a variety of problem classes. Complex networks research provides a systematic overview of relevant features, tools and their explanatory potential. In addition, the outlined investigations revealed some fundamental insights on the general nature of diffusion processes in social networks. The key to complex networks research is to identify the underlying relevant network backbone, i.e., the network structure that drives the dynamics relevant to the investigated research question, before the respective diffusion process is selected and calibrated. This can be as diverse as a total population, an aviation network, or observed occurrences of dollar notes (Hufnagel et al. 2004; Brockmann et al. 2006). But, as first impressions can be misleading, it is important to challenge the choice of the selected network and to reconsider other network types. An interesting example of the new class of probabilistic models is the complex networks study on the diffusion of SARS based on an analysis of the aviation network (Hufnagel et al. 2004). It combines a local stochastic infection model with a stochastic aviation network that exhibits, in the limit of large populations, deterministic properties. Accordingly, it is important to recognize the two stage stochastic-deterministic nature of diffusion processes in social networks. In the first stage, the diffusion frequently follows stochastic patterns as they occur at random places. But once the diffusion is in progress, at a certain stage the process is increasingly determined by deterministic rules. Together both effects exhibit a hybrid semi-deterministic and semi-stochastic process. The model delivers reliable results, and indicates that the forecasts of the geographical spread of

an epidemic is possible if the relevant network is known and if its parameters can be reasonably approximated. Nevertheless, such experiments reveal that after the parametrization of the simulations, sensitivity analyses are required as depicted in the outlined complex networks framework.

Social Network Systems

The analysis emphasizes the importance of recognizing that social networks, such as customer networks, are different from scientific networks and, therefore, require network specific research that accounts for such particularities. Social networks are far more fragile and unpredictable due to psychological aspects. Although the general diffusion mechanics may be similar, or even the same, it is important to note that the processes in customer networks may diverge in different types of networks. The research provides an excellent example, based on which further research is required.

Scaling Properties of Networks

The implications of the findings are twofold. First, in general the dynamics of random networks can be simulated in adoption and diffusion simulations due to their invariance to scaling. Second, a suitable adoption and diffusion simulation of a small-world or scale-free network has to account for the scale of the investigated population, as they are not invariant to scaling.