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Disruptive Innovation as a Network Dilemma: A Conceptual Model

Kaan Ataman
Chapman University

Niklas Myhr
Chapman University

Cristina Nistor
Chapman University

Adoption of innovative products, formats and technologies has long been studied in the management and marketing literature. Organizations that adopt new products and processes in order to stay competitive need to determine which technologies will be the winners rather than passing fads. Extant literature has characterized the innovator's dilemma for adopting new products from several points of view, from decision makers' response to niche customers perspective (Christensen, 1997) to a focus on organizational capabilities (Henderson, 2006), while also characterizing the incumbent's strategic response to disruptive innovation (Christensen et al., 2015). Our paper develops a new conceptual model of innovation adoption in markets with network effects. In particular, we focus on the problem that many current companies face: which (if any) new network will be the winner and how to respond? Our model captures surprising aspects of the disruptive innovation dilemma in networks.

Christensen (1997) introduced a new way of analyzing innovation in markets: innovators may serve a niche of customers who then can overtake an established market. Later on the theory was extended to characterize the disruptive innovations: managers may find it easier to serve current consumers and overlook a niche market (Christensen, 1997), companies may not be able to adopt new technologies due to a lack of organizational capabilities (Henderson, 2006), or may be able to respond by setting up internal units as separate businesses to deal with the innovation (Gilbert et al., 2012). Management literature has also emphasized the need to measure innovative management practices inside companies by developing better metrics (Stoyneva, 2022). More recently the literature has evolved to recognize that managers and firms are part of business ecosystems (Ansari et al., 2016; Yang et al., 2020) and thus a linear process of innovation may not be appropriate, renewing a call for incorporating the study of networks and innovation in networks as an extension of the original innovator's dilemma (Christensen et al., 2018). However, we note that networks are more than just a collection of customers and businesses: networks include customers with behaviors and preferences that should steer managers to change how they approach innovation. This nonlinear process can lead to disruptive innovation response strategies that look contrary to previous theoretical predictions, as described anecdotally by Hagiu and Altman (2017).

The importance of networks to managers has increased over time as customers adopt new technologies. For example, social media, virtual reality, electric vehicles, and AI (artificial intelligence) are major disruptive technologies that are changing the landscape of current industries in the business-to-consumer (B2C) world. For the business-to-business (B2B) landscape, consumers' use of networks has led the marketing industry to take into account the rise of influencer markets estimated to be valued at $21.1 billion in 2023 (Influencer Marketing Hub, 2023) in order to drive engagement (Bentley et al., 2020), awareness and purchases (Chu et al., 2023; Nistor & Selove, 2023). Similarly, consumer preferences for privacy and pricing in online technology markets affect changes in cookie policies in the ad-tech industry (Cooper et al., 2023). These exciting networks have a profound impact on our lives as consumers and also on managers' strategic decisions for incumbent companies faced with innovative disruption.

Christensen (1997) detailed an example of disruptive innovation in the disk-drive industry: new entrants provided attributes that were not traditionally valued by the main consumers (lightweight, small) but that were desired by niche customers. Incumbent companies in the disk-drive industry ignored the new technologies and focused on the needs of their biggest established customers which meant that over time they could not provide the disruptive technologies and lagged in the innovation race. The disk-drive industry is a valuable example for many industries that suffer from disruptive innovation but is limited in its resemblance to network markets where consumers' preferences include the need to be on a network with other customers. For example, social media networks like Threads could be a disruptive innovation for the industry as it offers easy-to-setup accounts, strict community rules

and potential for third party apps, or could be a passing fad (Yang, 2023). If many customers adopt Threads, the parent company Meta will add features and potentially outpace incumbent companies. However, if customers do not adopt Threads but continue to use Twitter, Instagram, Mastodon and similar networks, then the disruption will not happen.

Thus, we see a need to develop a conceptual framework that takes into account consumers' behavioral preferences in network markets and models the best strategic responses managers can use in these markets. We focus on two major behavioral components of network markets: consumers want to adopt a network if other consumers are also adopting it (to take advantage of network effects) and there is uncertainty about consumer preferences for network attributes (consumers may prefer an attribute that is not supplied by the existing industry but is supplied in an innovative way in a network by a new entrant). Based on these two characteristics of consumer behavior, we then draw parallels to managers' strategic decisions to adopt innovative technologies: managers can recognize niche markets in networks and may have uncertainty about which innovative disruptive network will grow. The resulting framework has implications that challenge the current understanding of the disruptive innovations and expand our knowledge of future network market innovations.

Our paper aims to develop a new conceptual model for disruptive innovation in markets that have network effects. We focus on the strategic difficulties that customers' behavioral preferences in networks bring to managerial problems: speed of adoption by customers and need for different attributes for networks complicates the innovator's dilemma, leading managers in established companies to develop strategies to respond to the disruptive innovation. From a practical perspective, our paper suggests ways that managers can analyze network markets in order to adapt to a potentially disruptive innovation or to decide whether an innovation may not be disruptive and should not be adopted.

Disruptions are Impactful in Network Markets

Innovators can bring significant attention in an established industry to new solutions or niche customers who are underserved. Christensen et al. (2018) point out that so far the research into disruptive innovation followed mostly businesses that focused on traditional technology products, without a network component. In a broad sense, any market has a need for consensus in the industry and relationships between channel partners in order for efficiency: research on trust suggests that companies fare better when they trust their partners (McEvily et al., 2017), firms obtain better quality in a business relationship compared to a formal contract (Nistor & Selove, 2020), and may be more likely to survive if they have strong relationships (Fudge Kamal et al., 2022). However, most markets operate in an ecosystem of businesses that rely on each other and are embedded in a network of business partners through their alliances and they can benefit

from sharing information and resources in the network (Fudge Kamal et al., 2021). Disruptive innovation in a business ecosystem has received some attention in previous studies (Hagiu & Wright, 2015) but the results have been limited to small areas where empirical results can be derived to confirm the existing theory on innovator's dilemma (Christensen et al., 2018). As networks become more prominent both in B2C and B2B markets, there is a need to develop a broader understanding of how the network characteristics can affect adoption, demand, and strategic responses from established market leaders.

Figure 1 describes the evolution of understanding for markets and where future research should recalibrate the work on disruptive innovation (Christensen et al., 2018). Pane A describes networks as a particular case of a market that may suffer from disruptive innovation, as described by the original literature on innovator's dilemma in Christensen (1997). Pane B is the authors' current description of markets, as suggested by a growing call in the managerial and strategy literature to analyze markets and business models as part of a larger ecosystem of networks (Christensen et al., 2018; Gnyawali & Madhavan, 2001; Hagiu & Altman, 2017). As such, we suggest that the current broader understanding of strategic decisions for each firm should consider a larger network perspective and we aim to focus on disruptive innovation in this context.

In the work on disruptive innovation, previous literature has emphasized the difficulty of predicting whether an innovation would be influential and ultimately disruptive (Christensen et al., 2001). Moreover, empirical work highlighted that managers struggle to recognize whether an innovation would be valuable in their field. For example, Raynor (2011a, b) shows evidence that more managerial experience could help companies identify disruptive innovation sooner and increase the odds of success. Networks that rely on innovative technology may amplify the difficulty of predicting what the future holds. Customers that are potentially part of the network may be uncertain about their own preferences for network attributes. As customers adopt one particular network over another because of a preference for a particular attribute, an incumbent firm may find there is no easy way to implement an innovation because no network is clearly emerging as a preferred platform.

For example, early social networks like Friendster and Facebook both relied on content created by customers. Eventually, Facebook grew and could establish its stronghold on the market with significant network effects as users tend to stay where their friends are as long as the service works reasonably well practicing so-called satisficing behaviors (Simon, 1955).

However, at the outset, it wasn't at all obvious which platform would emerge as the winner. Consumers didn't necessarily know what they were getting into and were not in a position to make an educated assessment of all the attributes and potential benefits that these networks could offer. To address this complexity, users focused on

Figure 1

Our Understanding of Networks and Innovative Technologies
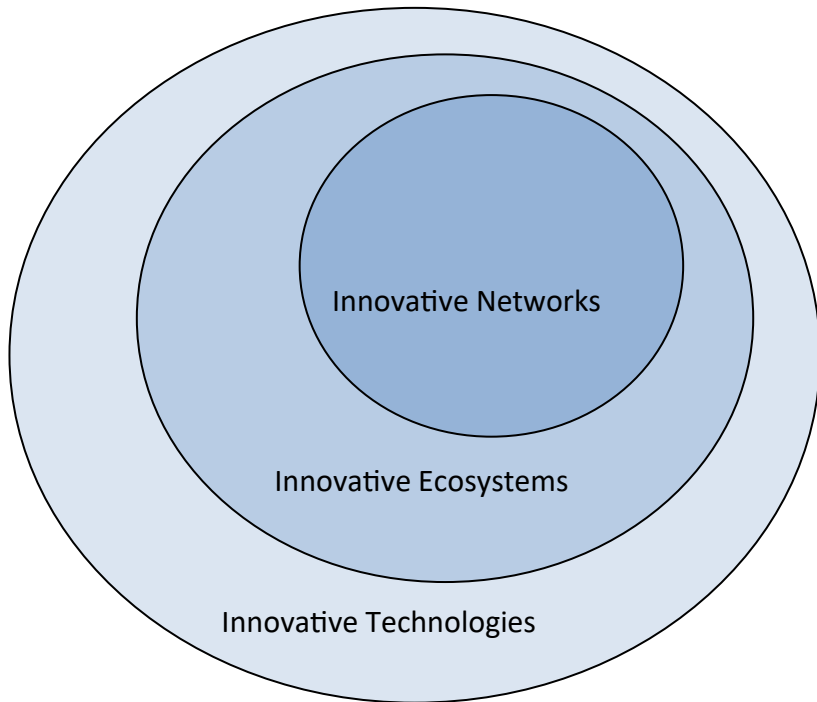
Pane A: 1997
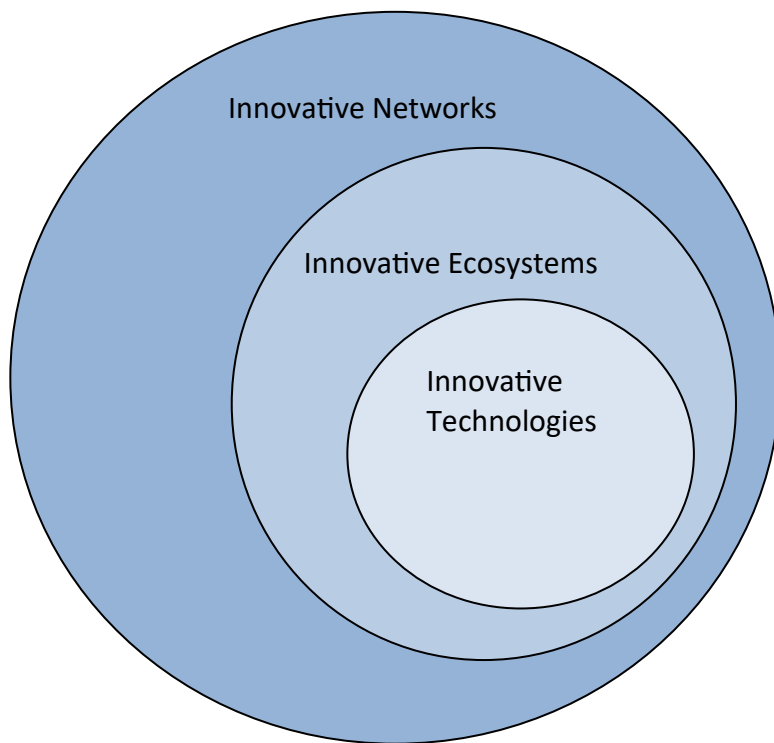
Pane B: 2023

prioritized aspects of the offerings to help inform their initial choices: some early adopters were attracted to Friendster for the ease of joining whereas others chose Facebook lured by its initial elitist appeal based on the more selective eligibility criteria (e.g., only Ivy League schools at first).

Given that a priori is difficult to know which aspect or attribute that will turn out to be significant, even an incumbent company who may be aware of various niche customer preferences across multiple attributes of a service, may still find it difficult to determine which network will ultimately thrive. Thus, we predict that:

P1: As customers are uncertain about their own preferences, managers will find it difficult to predict which disruptive network will ultimately grow and disrupt their market.

However, managers in incumbent companies do not have the luxury of waiting for one particular network to emerge as the winner. Network effects imply that consumers will quickly adopt one network and the second mover is unlikely to also be successful. An incumbent company that waits too long to recognize an innovation in a network setting will be unlikely to sway consumers away from the first-mover company in that network and will thus not be able to anticipate the disruption. One reason that consumers may not shift to a separate network could be high switching costs or a coordination problem. For example, Spotify created a large network of consumers as a first mover in the streaming music industry, disrupting the iTunes download market with Apple as the incumbent (Vroom et al., 2021). Apple had the technological and managerial resources to implement the new format but delayed entry in the streaming market. While the decision may be rational based on profits (Spotify was not profitable for many years after the time of entry in the US market), the delayed entry for Apple meant that the company missed out on the social component of the music streaming industry as most consumers wanted to adopt a network that was likely to have their friends on it. Apple Music thus became a second network market for music streaming, struggling to grow its appeal despite the high brand loyalty the company usually enjoys for its products. Moreover, the delay in adoption for this network market increases the likelihood that new consumers who enter the market later will be more likely to adopt the Spotify platform as well: Generation Z (or Gen Z, born in the mid-to-late 1990s to the early 2010s) consumers are most likely to stream music on Spotify compared to Millennials and Generation X (or Gen X, born from 1965 to 1980) consumers (King, 2021). Gen Z consumers are likely to adopt networks that foster a sense of community and create content for other consumers as well "with Gen Z, there is such a sense of community, especially online. People can just find groups of people, or podcasts, or even brands that have similar interests." (Spotify, 2022) The adoption pattern of new generations of customers is important in other industries that exhibit network effects. For example, Gen Z consumers are more likely to adopt the metaverse and spend money there (Razorfish, 2022) which means

that brands need to decide whether the metaverse will be a disruptive innovation and how quickly to invest in it. Thus, we predict that:

P2: Managers and companies need to respond to new innovations in markets that are networks faster.

We predict that faced with disruptive technologies in networks, managers will need to respond quickly. However, network markets may also have multiple competing entrants (or technologies) which might lead established incumbents to delay adoption or hedge their bets by spreading the investment in several networks. Contrary to findings in previous literature, we predict that the effect of partial adoption may result in the technology not becoming disruptive at all or being delayed in its disruption. Henderson (2006) points to managers anticipating the limitations of organizational competence as a reason for limited capacity to adopt the innovation and respond to the disruption. However, if managers are faced with limited organizational competence but need to respond faster to innovation in networks, they may invest minimally in each network, ensuring that the incumbent stays competitive at the expense of creating competing networks that don't grow too much because network effects limit each from taking over the initial market. One novel example of a disruptive innovation that is failing to grow past a niche customer market is the metaverse. Facebook/Meta is an established incumbent dedicating enough resources to establishing a network for the metaverse. However, it is competing with other metaverses that each have loyal customers like Sandbox, Second Life, Roblox, Fortnite, etc. Thus, companies who want to invest in reaching customers in these metaverses have been at a loss how to allocate their efforts (Pratt, 2022), with each of the metaverses capturing some of the incumbents' efforts to adopt. Moreover, in the ad-tech network, brands that would benefit from the network effects of a large single metaverse find themselves unable to join all networks and may delay adopting the new VR (virtual reality) technology, leading to the disruption not happening at all in the industry (or being delayed compared to a market with a monopolistic entrant). Despite recognizing the potential for success for metaverses, close to 50% of the industry is taking a "wait and see approach" because "For [tech, media and telecom] companies, this poses the classic investment dilemma: where and how much to invest, to avoid being blindsided by a metaverse pioneer, but also to help minimize the chance of plowing funds into projects that become redundant," said Mark Gibson, TMT (tech, media, and telecom) leader for KPMG U.S. (Chiang, 2023). The alternative option of hedging bets is inefficient and expensive but sometimes used by companies: some investors are adopting two potential networks in parallel by backing both Twitter and the new challenger in the form of Meta's new platform Threads (Primack, 2023).

P3: If disruption suffers from competition, the adoption can be slower as managers wait to see the winner and invest in multiple networks.

While the presence of multiple competing networks could increase inefficiencies to adopting innovations, in markets with no competition, the innovator's dilemma could be surprisingly simple to anticipate. Christensen (1997) points out that an innovation that appeals to a niche of consumers will be slow to be recognized and implemented by an established incumbent because the niche may have too few customers and the niche market may grow too slowly. However, in a network setting with no competition among networks, all customers in a niche market would adopt the innovation in the same network and their mass would become quickly observable to an incumbent. Thus, the initial problem of observing the innovation as a disruption for a niche market (Christensen et al., 2018) is more easily solved in a network market where there is no competition among the networks. Facebook is a classic example of a two-sided market that had no competitors initially for its advertising side and quickly disrupted the ad-tech world by introducing social ads (Facebook, 2007). Established companies like Google that relied on search ads quickly became aware of the potential disruption in the advertising market because the ad-tech industry highlighted the salience of the social ads in the Facebook network (Gershberg, 2007). Social ads were not especially successful at first: it was initially difficult for the ad-tech industry to envision a future where social ads would outperform search ads, but the incumbent Google was certainly aware that firms wanted to use social ads to reach consumers (Quitnell & Hempel, 2007). Thus, we can predict that:

P4: Customers in a niche market may be easier to recognize/reach if there are network effects and if there is little competition from other networks.

Christensen (1997) identified the difficulty of managers working in an incumbent firm in recognizing a growing niche that would become a disruption in the industry. Thus, the initial theory on the innovator's dilemma was that incumbents are both too slow to recognize a growing niche market but also have trouble setting up a successful response strategy. Subsequent work however pointed out that some companies were indeed successful in implementing a particular strategy once they recognized the threat: incumbents can set up a separate business unit with freedom to adopt and implement the innovation that allows the company to serve the niche market of customers. Christensen et al. (2018) lists details for these business units that were uncovered by previous research as "anomalies" and built into a theory of strategic response to disruptive innovation once it is recognized as a threat to a current business model. In the context of a disruptive innovation as a network (or market with network effects), the setup of a completely separate internal unit for the disruption innovation is likely to backfire by not taking advantage of the network effects in the consumer market. The solution of setting up an internal business unit to adopt the innovation is not viable in this setting because the new business unit would have to recreate a consumer network as well, which is unlikely to gain traction among consumers who have already adopted the disruptive innovation network by the new entrant. In contrast with previous theory prediction, we suggest that established businesses should acquire the new network and set it up inside the incumbent company. For example, we expect that businesses like Facebook which rely on a large network of customers creating content to share with other consumers can more easily take advantage of an innovative platform like Instagram by allowing it to stay separate while also taking advantage of the resources of the existing incumbent and by capturing the customers who were in the Instagram network already. After being acquired by Facebook, Instagram "would benefit from Facebook's entire operations infrastructure, not just data centers but also people who already knew how to do all the things Instagram would need to learn in the future." (Frier, 2020). The merger is an example of an innovative entrant remaining independent inside a bigger company, which became a model for future mergers in the industry "the structure of the Instagram acquisition — a company purchased not to be integrated — would become an important precedent in technology M&A, especially as giant companies got even more giant, and small companies like Instagram wanted to find some alternative to competing with them or dying. In the coming years, Twitter would buy Vine and Periscope, keeping the apps separate and the founders in charge, at least for a little while. Google would buy Nest, keeping it separate. Amazon would buy Whole Foods, keeping it separate." (Frier, 2020) Thus, we expect that unlike in Christensen (1997), incumbents can actually pursue a strategy of successfully recognizing and responding to innovative entrants but not necessarily by setting up completely insulated new business units (like noted in Christensen et al. (2018)), but rather by keeping the entrant as a separate platform with its own users plugged into the management and resources of the incumbent. Unlike previous research that suggests recreating the new technology inside a separate business unit in the existing company (but which misses out on the existing growth of the network in the consumer market), we posit that this strategy can be successful in network markets as it allows the entrant access to internal resources far superior to what a startup would have while also preserving the network effects of the initial startup in the customer market.

P5: Incumbents in markets with network effects can respond to disruptive innovations by acquiring the disruptor and growing it inside the original company.

One area that both incumbents and entrants struggle is to increase adoption of a network product. Previous research has found that products with a stand-alone benefit may increase the adoption rate in a network as well. For example, Tucker (2008) finds that financial managers are more likely to adopt video conferencing software (a network product) if they can also use it to watch tv (a stand-alone use) and then their co-workers are also more likely to adopt the network product as a result of early adoption in a team. On the cost side, Selove (2013) points out that

in traditional markets with a dynamic investing environment, a large fixed cost can impede retaliation and allow an incumbent to adopt the innovation introduced by a new entrant, thus being able to adapt to the industry disruption. Thus, if the network depends on a non-network or network-adjacent product for the technology to be implemented, the incumbent can prevent the technology from becoming disruptive by not investing in the non-network product. We can infer that in markets with network effects, a large fixed cost to adopting the new product may lead to low investment in the network. For example, the metaverse depends on hardware that is clunky and expensive but is not a network product. Large companies have refrained from investing in the hardware which has constrained the growth of the nascent networks as well (Leswing, 2023).

> P6: Companies with a resource advantage will be more likely to be able to create the network-adjacent product and thus win the innovation race by promoting their preferred network.

Our conceptual model has so far not considered an important part of the consumer experience: brands. Brand associations can be powerful because umbrella branding for a new network product can lead consumers to adopt one particular network over its competitors. This can lead to a clear network emerging as the winner of the disruptive innovation and amass a large enough group of users that companies can recognize the disruptive innovation and also make investments to adopt it. Companies can collaborate with partners in the supply chain to adopt innovative products (Delouya, 2023) or create them (Lauga et al., 2023). For example, electric vehicles (EV) are innovative products that are likely to become disruptive in the car industry. However, the EV market suffers from network effects: the cars need charging stations but there is no incentive to build expensive charging stations unless enough consumers are willing to buy the cars. Tesla, one of the largest EV manufacturers, still has a market share an order of magnitude smaller than the largest gas-powered manufacturers (Kane, 2023). However, Ford and GM, both incumbent companies, have partnered with Tesla to share charging stations for EVs, which will help the EV network grow (Delouya, 2023; Wayland, 2023). The incumbents Ford and GM and innovator Tesla have positive brand associations and are likely to drive adoption of the EV (electric vehicles) market that will benefit all three companies. Meta faces a similar network adoption problem with its disruptive technology for the metaverse: the network effects of the metaverse rely on customers adopting the network in large enough numbers to make it worthwhile for a manufacturer to make low priced and high-quality VR glasses. However, the Meta brand has negative associations for consumers in terms of privacy and there is no industry consensus to collaborate to drive adoption. Moreover, big brands like Apple are willing to create a rival product because they are relying on their own positive brand associations to drive consumer adoption (Richter, 2023).

> P7a: Brands can help to mitigate negative externalities if they have positive associations.

P7b: Incumbent brands with negative associations will have a difficult strategic choice responding to innovative entrants and will suffer from industry disruption (even when they are able to adopt the new technology because consumers will be unlikely to adopt the same network due to the negative brand image).

To summarize our conceptual model, Figure 2 presents a description of the propositions and links our conceptual predictions to consumer behavior in networks, applied to manager's strategic decisions. Our high-level conceptual model propositions P1 and P4 highlight a link between the consumers' network preferences and the uncertainty over these preferences and the managers' difficult strategic decisions over which, if any, innovation should prove to be disruptive and should be adopted. In addition, propositions P2 and P3 posit that consumers' behavior and speedy adoption of networks may influence the speed of adoption on the managers' side for these networks as well. Finally, our conceptual model, through propositions P5, P6, P7a and P7b adds available strategies that managers can take to mitigate the effects of disruptive innovation, depending on the competitive status of the industry and the presence of a non-network component.

Our conceptual model has direct theoretical implications that could be empirically tested in future research. The Table details the potential independent variable (IV) and dependent variable (DV) relationships proposed in P1 through P7, along with potential moderators.

Practical Implications for Managers

Our paper has direct practical implications for managers who are deciding on a response strategy to disruptive innovators. We recognize that current managers are faced with a complicated problem: in network markets consumer preferences and behavior can drive disruptive innovations in ways that are counter-intuitive compared to traditional non-network markets but important to understand.

Networks are increasingly important in the current economy. Traditionally managers have struggled to identify and adopt disruptive innovations in traditional non-network markets. Moreover, as consumers have different preferences for specific network attributes and uncertainty about these preferences, managers may find it even more difficult to predict which innovation will end up disrupting their incumbent status. The managers' intuition and careful analysis of market trends will be needed in markets with network effects because these markets tend to evolve rapidly as consumers join a network. For example, a current buzzword for managers is to try to discover the preferences for the newest generation of Gen Z consumers, as they are the largest group of consumers entering the market, have increasing purchasing power and are trendsetters in networks.

Our work suggests that, depending on the competitive conditions of the market, managers may have a take a calibrated stance: managers in a network market with limited competition would be able to recognize a disruptive innovation sooner than in a traditional market due to consumers quickly adopting the network beyond a niche

status. Once managers identify the potential disruption in their network market, it is imperative to respond to it quickly.

A potential response to disruptive innovation is to take advantage of network effects by acquiring the disruptors and growing them inside the incumbent firm, unlike traditional markets where managers might be tempted to replicate the innovation in a separate unit inside the incumbent company. Moreover, managers may also leverage their incumbent status by offering a network-adjacent or non-network product to incentivize their preferred network to grow. Companies that are leaders in their field and benefit from resource advantages will be able to offer a network-adjacent product more easily.

Finally, we suggest that managers should rely on their brands: they may be able to leverage the existing brand image to grow their incumbent advantage in a network as consumers are willing to adopt new products in networks that carry the same brand name as another trusted product. Brands with negative associations or new brands will thus be at a disadvantage as they will have to convince consumers to adopt the network, while established brands with good associations will have an existing base of loyal customers who can jumpstart the network effects.

Conclusion

Our paper creates a conceptual framework for disruptive innovations in the context of markets with network effects. We suggest several propositions that are counter to the original theory of disruptive innovation and thus respond to the call to develop new understandings that could be empirically tested formally. Previous literature has emphasized the need to understand how networks may differ when they are faced with disruptive innovation (Christensen et al., 2018). Hagiu and Altman (2017) described detailed practices that top companies are using that are surprising compared to the traditional understanding of the innovator's dilemma or disruptive innovation. Our paper responds to the call for a larger view of markets as networks that depend on consumer preferences and behaviors. We propose a conceptual perspective on the counter-intuitive implications for disruptive technologies in network markets that adds to our theoretical understanding of these markets. We use examples from several industries to illustrate how previous research could be expanded to include new network markets. However, we also extend the understanding of previous literature through our new conceptual framework by findings that are counter-intuitive to previous theory of disruptive innovation.

Figure 2

Disruptive Innovation for Network Markets Depends on Consumers Preferences and Behavior
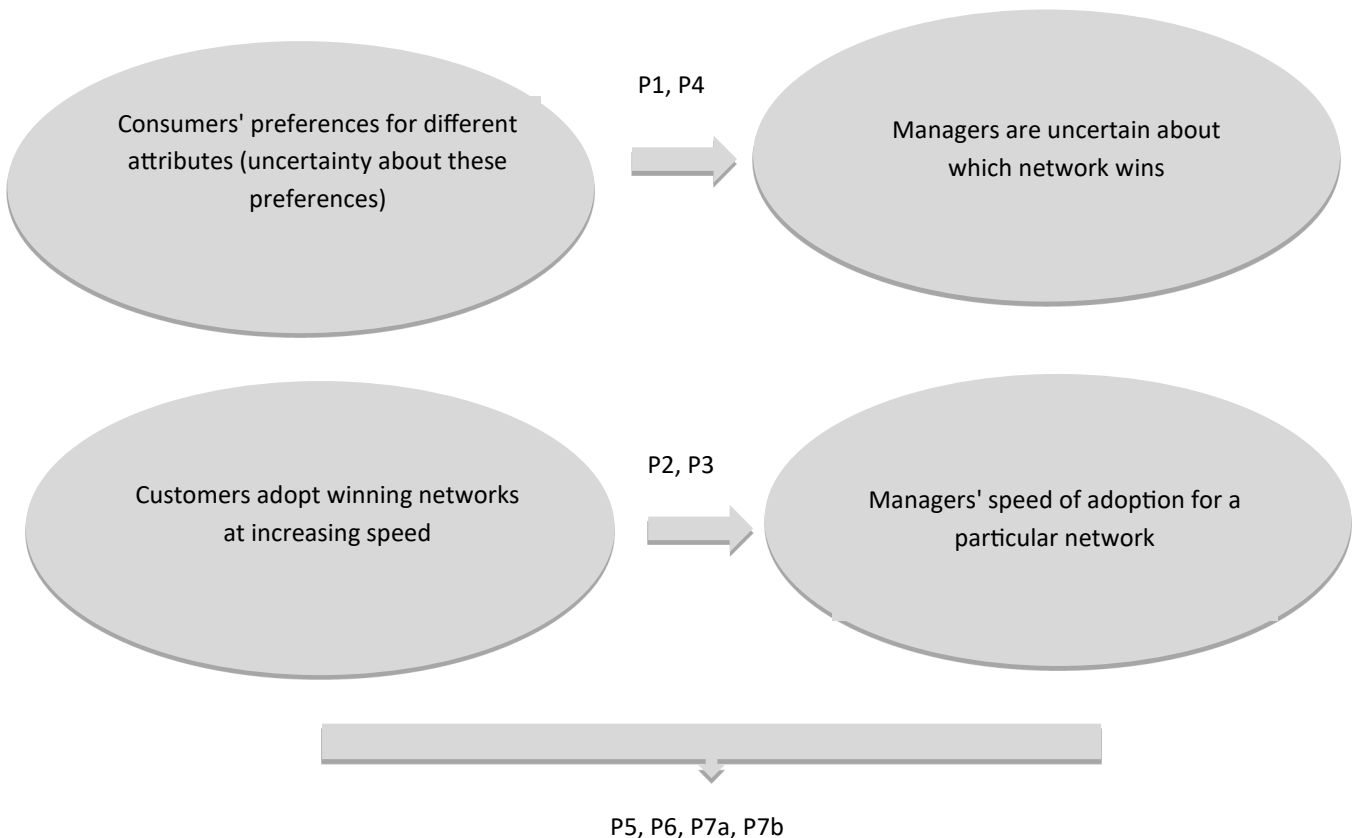
Table

Disruptive Innovation for Network Markets: Theory to Testable Predictions

Proposition	Independent Variable	Dependent Variable	Moderator
P1	degree of customer preference uncertainty	degree of managers' difficulty in predicting disruptive market networks	
P2	managers' response time to new innovations	network adoption speed	
P3	degree of competition in the disruptor market	network adoption speed	managers wait-time to invest
P4	customer perceptions of a niche market	perceived level of network effects *and* perceived level of competition from other networks	
P5	strength of network effects	acquiring/internally growing the disruptor	perceived disruptive innovations
P6	ease of creating a network-adjacent product	promoting preferred network	perceived company resource advantage
P7a	valence of brand associations	magnitude of network externalities	
P7b	perceived brand association	perceived difficulty of responding to innovative entrants *and* perceived degree of industry disruption	

Limitations and Further Research

Our paper lies at the intersection of previous literature on innovator's dilemma, disruptive innovation, and networks. However, our conceptual model has predictions that are counter to previous work in the management and marketing literature and thus will benefit from empirical validation. We hope that future work will test these propositions empirically in several network markets and further our knowledge of innovation in networks.

Our current paper also abstracts away from firm's motivations and corporate responsibility as we focus on firms that want to respond to innovative entrants. However, the management literature has highlighted the importance of analyzing enterprise strategy (Vracheva et al., 2016). Future research could continue this stream of work by looking at the dynamics of disruptive innovation in an enterprise network setting, how the adoption is influenced by the company's general purpose, and how the innovation affects the relationships with stakeholders.

Moreover, we have so far focused on the strategic response decisions that companies could take without modeling internal incentive problems. Thus, further work is needed from a management perspective to incorporate the internal firm factors that influence the response each company should choose. A richer model of resource allocation or organization competencies would complement our conceptual model.

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Kaan Ataman (ataman@chapman.edu)

Niklas Myhr (myhr@chapman.edu)

Cristina Nistor (nistor@chapman.edu)