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Strategy Design in a Digital Ecosystem

The Ecosystem Growth and Collaboration (EGC) Model

There is rising concern among executives to align their strategy to the increasingly digital and connected business environment – what is termed the ‘digital ecosystem’. This article offers a framework – the Ecosystem Growth and Collaboration (EGC) model – to understand and integrate digital ecosystem mechanisms into a corporate strategy. These growth and collaboration mechanisms form the basis to decide where, in which role, and how to play in the digital cosmos.

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Over the past decades, many traditional strategic management, game theory, as well as behavioral approaches were used in order to investigate how companies can achieve long-term competitive advantages by combining various measures in a continually changing environment (Chandler, 1962; Cyert & March, 1963; Nash, 1951; Porter, 1996). In this increasingly digital environment, various empirical laws have been discovered that describe and elucidate the rapid development of technologies that have changed the ways in which companies achieve long-term competitive advantages (Arthur, 1989; Bilby, 1986; Chapuis, 1978; Gilder, 1988; McGuire, 2005; Metcalfe, 1995; Moore, 1975; Reed, 2001).

One approach used to describe the competitive environment and thus shape strategy is the concept of the 'ecosystem'. This concept broadens the firm's view by seeing it as part of a group of interacting firms that depend on each other's activities. Iansiti and Levien emphasize the 'shared fate' in an ecosystem (Iansiti & Levien, 2004, p. 69), highlighting that the performance of individual members is linked to the overall performance of the ecosystem in terms of co-evolution of firm capabilities (Jacobides et al., 2018, p. 2257). One driver of the ecosystem concept is the increasingly digital environment in which ecosystem firms interact.

Under these circumstances, a new strategic approach that considers digital ecosystems and the corresponding empirical laws is required to ensure a company's long-term success.

The authors aim to explain strategy mechanisms in digital ecosystems by investigating the following research questions:

1. What are the major changes due to the digital environment and the relevant laws in the digital economy?
2. What are the changes resulting from a company's integration into a digital ecosystem?
3. What does a new strategy approach look like?

The Digital Economy and Corresponding Empirical Laws

The digital economy can be defined as "[...] the amalgamation of several general-purpose technologies, and the range of economic and social activities carried out by people over the internet and related technologies" (Dahlman et al., 2016, p. 11). Moreover, it can be added from other definitions that, instead of being a part of the overall economy, the digital economy can rather be seen as a major force behind the cur-

rent changes in almost all sectors, with varying impacts (Afonasova et al., 2018, p. 293; Kling & Lamb, 1999, p. 17; Malecki & Moriset, 2007, p. 4; Zimmermann, 2000, p. 729). Some of the factors relevant in this context are network effects, dominance of fixed costs, lock-in effects, positive feedback effects, and increasing returns to scale. These factors can be categorized into three sets of empirical laws as illustrated in figure 1. Instead of interpreting them as laws of nature, they can be seen as empirically substantiated statements that attempt to describe and analyze the current rapid developments.

The first set (❶ in figure 1) comprises various laws that involve increased network options for firms. According to Gilder's law, the bandwidth rate doubles every six months (Gilder, 1988, pp. 49–51). This allows for increased network effects as described by Sarnoff's law (Bilby, 1986), Metcalfe's law (Metcalfe, 1995), and Reed's law (Reed, 2001). Network effects will be stronger as more users get involved – influencing a network's value. However, the decisive factor for an increase in value depends on the underlying type of network. Sarnoff's law, which states that a network's value grows on a linear scale with the number of users, applies to one-to-many networks (Bilby, 1986; Clement & Schreiber, 2016, pp. 68–72). In contrast, many-to-many networks follow Metcalfe's law and Reed's law. Metcalfe's law states that a network's value grows on a quadratic scale with the number of users (n) because the number of unique possible connections in a network can be expressed as $n(n-1)/2$ or, for a large number of users, n^2 (Cle-

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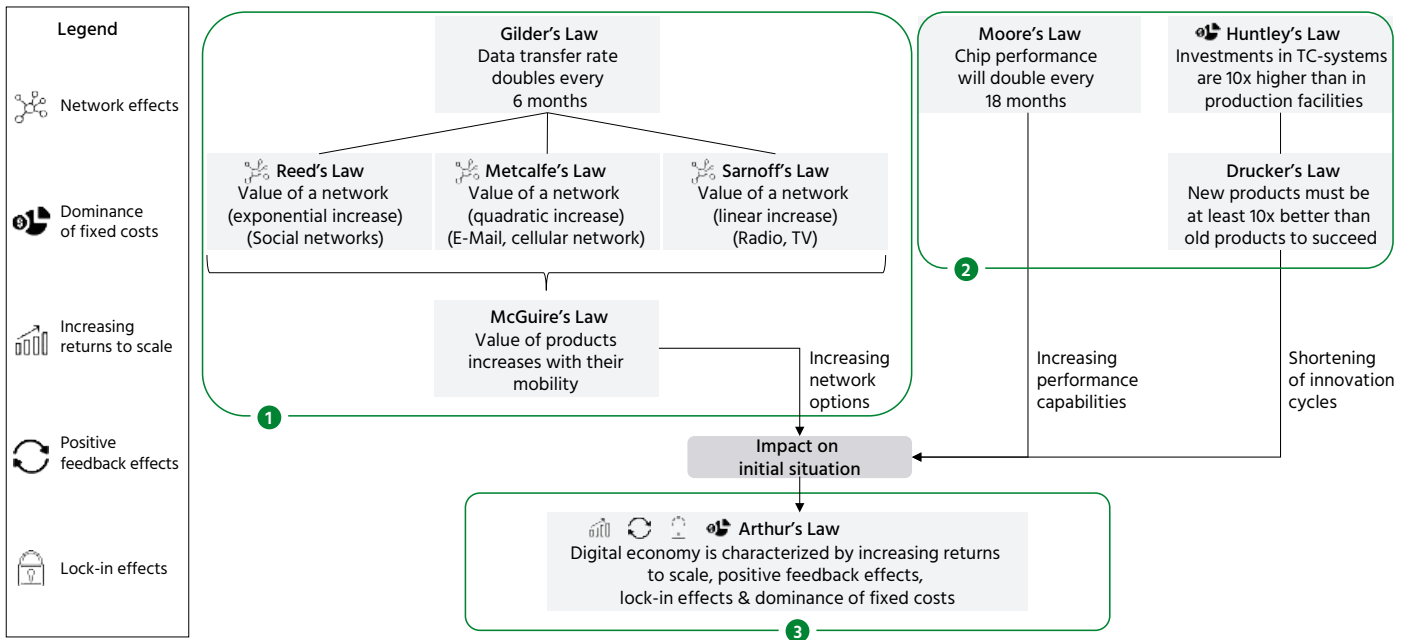
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Fig. 1: Empirical Laws of the Digital Economy



Source: Own illustration.

ment & Schreiber, 2016, p. 66; Metcalfe, 1995, p. 65; Yoo, 2015, pp. 88–94). Reed's law states that the value of a network grows on an exponential scale with the number of users (n), because the number of possible sub-groups of network participants is $2n - n - 1$ or, for a large number of users, $2n$ (Clement & Schreiber, 2016, p. 66; Reed, 2001, pp. 63–68). Although a precise network value cannot be derived because it depends on many different factors, these laws help explain why well-known tech giants have emerged quickly – after reaching a critical mass of users – by taking advantage of direct network effects (Feng & Iansiti, 2019, pp. 118–125). Subsequently, due to digital convergence (Gilder's law) and network scalability (Sarnoff's law, Metcalfe's law, and Reed's law), it is easier for companies to make their offerings mobile. In this context, McGuire's law states that the value of a product or service increases exponentially with mobility. This is due to the fact that mobility is inherently connected to the time a product is available for use (McGuire, 2005).

In the second set (2 in figure 1), the importance of technological performance and innovative solutions is highlighted. Moore's law states that chip performance will double

every 18 months at the same price (Moore, 1975, pp. 114–117). However, to ensure processor performance and data transfer, and to make offerings mobile, a new infrastructure is needed. According to Huntley's law investments in telecommunication technology are ten times higher than in traditional production systems – implying a high dominance of fixed costs. As a result, companies face shorter innovation cycles and have to take higher risks to satisfy ever-changing customer requirements (Chapuis, 1978, pp. 39–42). According to Drucker's law, new products must be at least ten times better than old products to succeed in the marketplace (Drucker, 1954).

All empirical laws described so far affect the overall situation, by increasing network options, increasing performance capabilities and shortening innovation cycles, thus forming the foundations for Arthur's law which is cited in the third set (3 in figure 1). Arthur's law states that the digital economy is characterized by increasing returns to scale, positive feedback effects, and lock-in effects in a production environment dominated by fixed costs (Arthur, 1989, 1996). The concept of returns to scale describes the change in output to the change in input of the same factor.

Increasing returns to scale deviate from most business management concepts that assume decreasing returns to scale (Engelhardt & Magerhans, 2019, pp. 15–16; Mankiw & Taylor, 2016, pp. 199–200). Apart from increasing returns to scale, the digital economy is also characterized by positive feedback effects, which describe a self-reinforcing process in which strong companies will have an additional edge. In contrast, weak enterprises will continue to lose ground. This self-reinforcing process is leveraged by lock-in effects, which means that switching from one provider to a different one is too costly for customers. Consequently, users rather stay with the current provider (Verhoef & Donkers, 2005, pp. 31–34).

Digital Ecosystems as Drivers of Change in Strategy Design

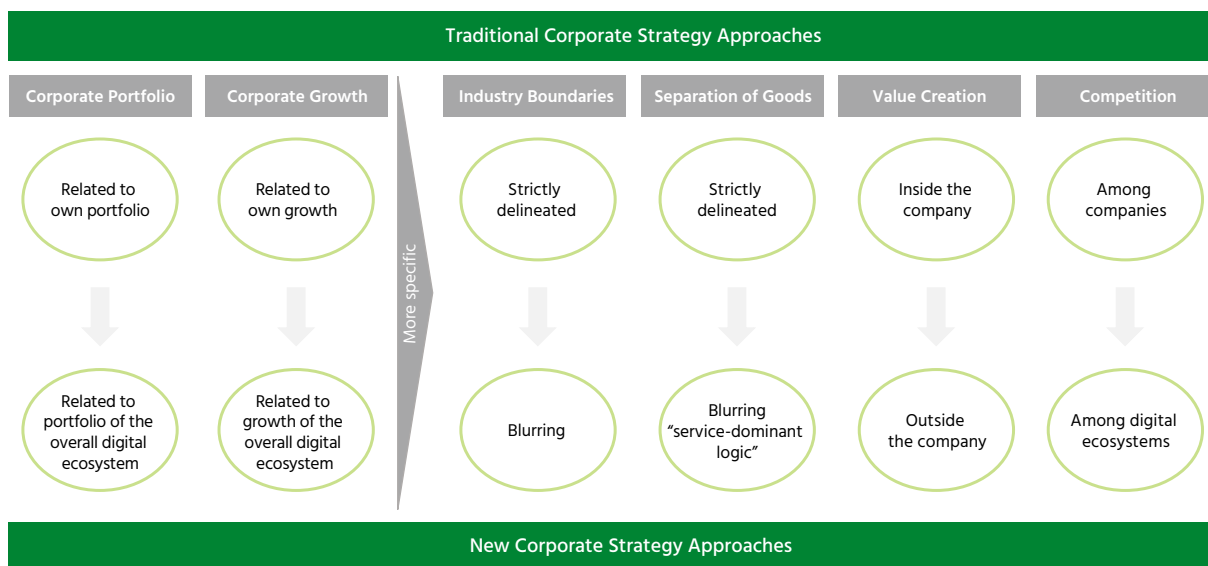
In recent times, there has been an increased interest in the topic of ecosystems. The term ecosystem was first coined by Tansley in the late 1930s to describe a biological community consisting of organisms that compete, collaborate, and interact with each other (Tansley, 1935, pp. 299–300). In the following years, first Moore and subsequently other scholars recognized many parallels between the processes in a

biological ecosystem and the business practices of companies – a finding that led to the term ‘business ecosystem’. Based on various definitions, a business ecosystem can be conceived as an economic community with different actors that have joined forces to foster collaborative value creation (Adner, 2006, p. 98; Iansiti & Levien, 2004, p. 35; Moore, 1996, p. 26; Moore, 2006, p. 31). Over the last years, the

Management Summary

The business world is undergoing a radical shift due to the rise of digital ecosystems. Three major questions arise regarding the corporate strategy within the digital cosmos: where, which role, and how to play? To answer these questions, we first examine the digital economy and some of its empirically deduced laws and second, identify the critical characteristics of a digital ecosystem. Finally, the Ecosystem Growth and Collaboration (EGC) model is presented which condenses the previous analyses and findings into a comprehensive framework.

Fig. 2: Evolution of Corporate Strategies



Source: Own illustration.

traditional business ecosystem has evolved into a digital ecosystem. This can be described as an adaptive, demand-driven, self-organizing and digitally connected community that enables its actors to benefit from shared interests and is powered by competitive digital technologies. The community aims at creating value through collaboration and competition (Boley & Chang, 2007, p. 2; Briscoe & De Wilde, 2010, p. 3; Corallo et al. 2007, p. 2; Dong & Hussain, 2007, p. 2944; Fu, 2006, p. 143; Khalil et al., 2011, p. 66; Razavi et al., 2009, p. 367). Jacobides et al. (2018) provide a literature review and define what makes ecosystems different from other business constellations.

Taken together, the growth of digital ecosystems and the digital economy have led to a situation in which some companies operate by new strategy approaches, as illustrated in figure 2.

In the past, an industry encompassed a certain number of companies that were competing for customers with similar products or services in the same market (Jacobides et al., 2019). However, the improvement and availability of information and communication technology (ICT) according to Moore's law, Gilder's law, and Huntley's law has created a more interconnected world. Consequently, many opportunities have opened up for companies to grow with an aligned scope of product portfolio offerings by improving existing lines of business, expanding into adjoining segments, or exploring unrelated business areas; simultaneously, industry boundaries are blurring and innovation cycles are beco-

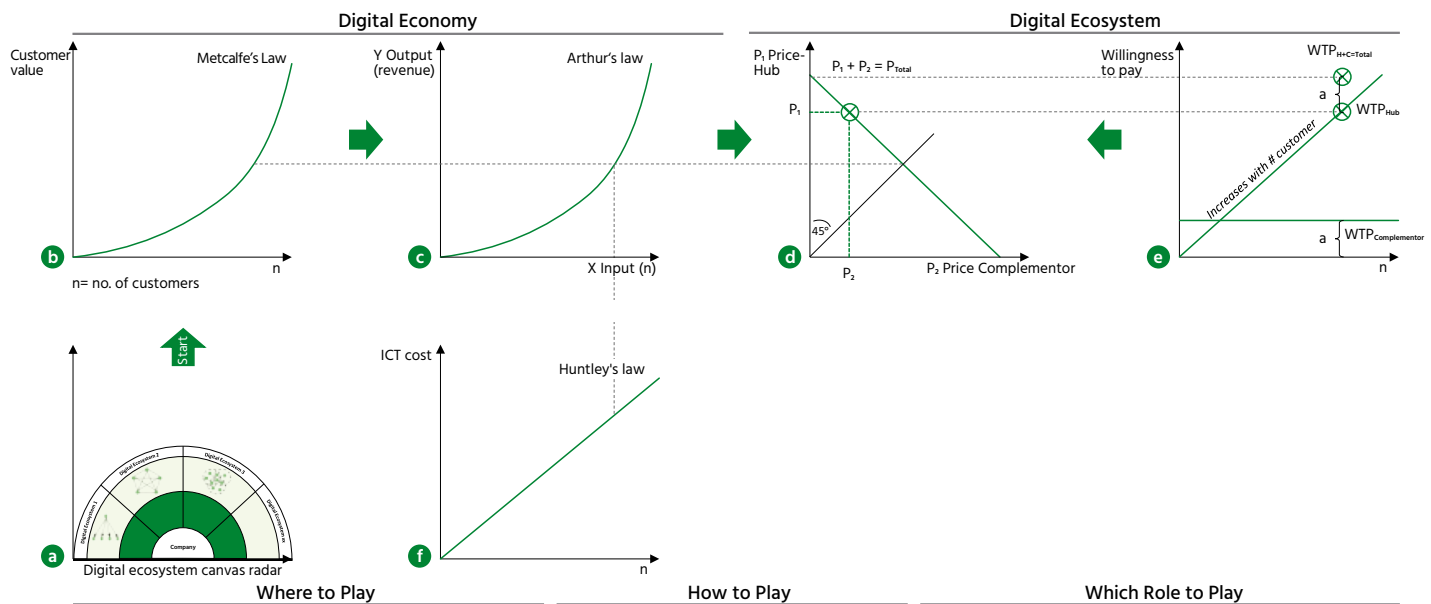
The EGC model describes
the network effects and
value creation as well as
the capture mechanisms
in digital ecosystems.

ming shorter and shorter in line with Drucker's law (Gammack & Hobbs, 2006; Jacobides et al., 2019; Pidun, 2019). The scope of these new offerings has been extended by two possibilities. First, while in the past physical goods and digital goods were strictly separated, today almost all products are digitally enriched ('service-dominant logic'). Second, it is not even necessary anymore to produce products or services internally, because value creation has also changed: in some cases, it does not take place exclusively inside the company anymore but outside the firm, by linking up

with other digital ecosystem complementors via relationships and networks (Birkinshaw, 2019; Jacobides et al., 2019). This reverse model of value creation is characterized by increasing returns to scale, but also by a rise in network effects, positive feedback effects, and lock-in effects according to Sarnoff's, Metcalfe's, Reed's, and Arthur's law – allowing companies to scale up quickly (Arthur, 1996; Bilby, 1986; Metcalfe, 1995; Reed, 2001). Moreover, competition has also shifted. Formerly, competition existed among companies; future competition will be among digital ecosystems in which organizations have collaboratively joined forces to leverage power (Kimura et al., 2019).

Strategy Design in a Digital Ecosystem

The Ecosystem Growth and Collaboration (EGC) model (figure 3) is a strategy model developed by the authors. The EGC model describes the network effects and value creation in the digital economy (left side of figure 3) as well as the capture mechanisms in the context of digital ecosystem collaboration (right side of figure 3). The two critical exogenous – i.e., external – variables in the EGC model are the number of customers (n) and their willingness to pay (WTP). The type of digital ecosystem is used as a 'basic setting' (figure 3a). According to theory and the cited empirical laws, the number of customers is determined by the digital ecosystem type. The various WTP levels are determined by the value contributions of the hub and the complementors as perceived by the customers. Based on these mechanisms, the EGC model examines the relationship between the type of digital ecosystem, number of customers, perceived value, output from a joint digital ecosystem perspective, resulting (blended) price level, and individual prices obtainable by the leader (hub) and the complementors of the digital ecosystem. The latter ones, the obtainable individual prices, are determined by the individual WTP. For reasons of simplification, the digital ecosystem comprises only two players, namely hub and one complementor. The term 'hub' refers to that actor within the digital ecosystem who serves as the architect and platform sponsor and is thus the critical actor. The hub shapes the digital ecosystem and is the central and differentiating element in customer interaction. Amazon, for example, is a typical hub. The complementor provides goods or services (complements) that add value to the platform in the eyes of the consumer. To further discuss the mechanisms of the EGC model, we classified it into three areas: "where to play", "which role to play", and "how to play".

Fig. 3: The Ecosystem Growth and Collaboration (EGC) Model

Source: Own illustration.

Where to Play

First, executives have to determine in which digital ecosystems their company should play ("where to play"). Before choosing one of the different digital ecosystems available, a profound internal and external evaluation is advisable. For this evaluation, the "digital ecosystem canvas radar" can be used (figure 4). Furthermore, it needs to be considered that in most cases companies will not just play in one digital ecosystem but rather in several different ones, as illustrated in figure 4.

The digital ecosystem canvas radar with the various types of digital ecosystems forms the basis of the EGC model (figure 3a). As stated, network effects may follow Sarnoff's, Metcalfe's, or Reed's law. Figure 3b shows the network effects according to Metcalfe's law. The horizontal axis represents the number of customers, the vertical axis the customer value. In figure 3b a concrete manifestation of customer number and value has been chosen. The dashed line shows how this transfers to the next diagram (figure 3c) which presents the increasing economies of scale in accordance with Arthur's law. The number of customers acquired is expressed as an input variable on the horizontal axis and

revenues are shown as an output variable on the vertical axis. Due to the increasing returns to scale, output increases by more than the proportional change in input (in this case, the customer base).

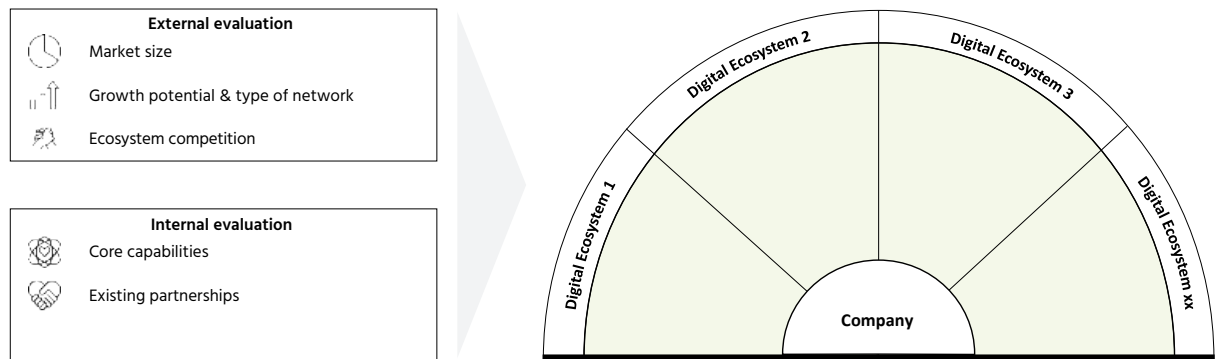
Which Role to Play

Next, executives have to decide on their engagement in the digital ecosystem(s) ("which role to play"). There are two possible roles for organizations – as a hub by establishing their own digital ecosystem(s) or as a complementor by engaging in existing ones.

As a hub, a company creates and runs a digital ecosystem by providing a platform with a sound basis of infrastructure, services, and other tools. By setting up a reference architecture for collaboration, a digital ecosystem hub tries to connect complementors to integrate and co-create diversified products and services, bringing together supply and demand (Jacobides et al., 2019).

As a complementor, a firm joins an existing digital ecosystem by providing different products or services on the platform, thus increasing the overall growth potential. In this way, complementors reap the benefits from the other

Fig. 4: Digital Ecosystem Canvas Radar



Source: Own illustration.

partners' resources and capabilities through the large network. This makes it possible for companies to improve their own business and simultaneously enhance those of others (Jacobides et al., 2019).

In this context two curves, WTP and (blended) price level, are of special interest. Figure 3d shows the number of customers on the horizontal axis, the WTP on the vertical axis. The WTP curve depicts the maximum price at or below which a consumer will buy one unit of a product or service on the digital ecosystem platform. According to the constructive preference view, consumer WTP is a context-sensitive construct; that is, a consumer's WTP for a product depends on the concrete decision context and differs for hubs (WTP_{Hub}) and complementors ($WTP_{Complementor}$). In the case of the hub (WTP_{Hub}), consumers tend to be willing to pay more if the platform has more users. This assumption is consistent with the above-stated network theories, which imply that the perceived value – expressed here as WTP – has a functional interrelationship with the number of users within the network. In contrast, the WTP curve of the complementor ($WTP_{Complementor}$) is an (almost) horizontal line because (almost) no functional connection exists between the WTP for the concrete product or service and the number of customers on the digital ecosystem platform. The respective WTPs of the hub and complementor(s) add up to the total WTP, $WTP_{Hub} + WTP_{Complementor} = WTP_{Total}$, which equals the (blended) price level of the digital ecosystem.

Figure 3e shows the blended and individual price levels. The horizontal and vertical axes in this diagram show the pro-rata individual prices achieved by the hub (P_1) and

the complementor (P_2), respectively. To deduce this, the blended price level that can be achieved in the digital ecosystem as a whole and the individual WTP are brought together. For this purpose, on the one hand, the WTP_{Total} of the diagram in figure 3d is transferred as P_{Total} on the ordinate in figure 3e. On the other hand, the blended price level is displayed graphically by transferring the resulting output level according to Arthur's law in figure 3c to the bisector in the price diagram shown in figure 3d. The point of intersection with this bisector and the point of intersection with the ordinate form a straight line that represents all permissible combinations of the individual prices. On

Main Propositions

1. Traditional strategy approaches are of little value in digital ecosystems, due to game-changing mechanisms such as increasing returns to scale and network effects.
2. The very nature of competition has also dramatically changed. Formerly, competition has been between companies; in future, various digital ecosystems will compete.
3. Growth will not end in an increment in long-term shareholder value of a single firm, rather in an enhancement of the long-term digital ecosystem value.



Fotos: © Adobe Stock

this straight line, $P_1 + P_2 = P_{\text{Total}}$ is therefore formally represented as a linear combination. Based on this, the third step is to quantify the attainable individual prices of the hub and the complementor by transferring the individual WTP from figure 3d. For this purpose, the intersection of the hub's individual WTP with the blended price level line is determined. This intersection – represented by the cross on the blended price level line in figure 3e – shows the individual prices that the hub (P_1) and the complementor (P_2) can achieve in the digital ecosystem. Therefore, this diagram (3e) summarizes the insights of Arthur's law and the split of customers' WTP for the digital ecosystem service offerings. Thus, the collaboration and balance of power

between hub and complementor are visible as an expression of the monetarization that each player can achieve in the digital ecosystem.

How to Play

The final part of the model ("how to play") is about successfully designing and managing the digital ecosystem. Depending on the role, it is essential to understand the value drivers and the cause-and-effect links within the EGC model. Major value drivers are (1) customer perception, experience and behavior, (2) growth and value capture mechanisms within the network, (3) digital ecosystem innovation, (4) partnership and governance, and (5) ICT architecture. The latter includes investment in cutting-edge technological infrastructure, which is capital intensive compared to traditional production systems according to Huntley's law (Chapuis, 1978) (cf. figure 3f).

In order to influence and shape the customer and network value drivers (1 and 2), it is essential to actively develop the type of network (from Sarnoff to Reed or from linear to exponential growth), to acquire a critical mass of users and to utilize network effects (Bilby, 1986; Metcalfe, 1995; Reed, 2001). Attracting, winning, and retaining users will be crucial to the future success of a digital ecosystem.

Conclusion and Outlook

Our EGC model complements existing research by providing a cause-and-effect diagram that takes into account fundamental empirical laws as well as collaboration interdependencies and customer's willingness to pay in digital ecosystems. The EGC model simplifies the ideas behind network effects, returns to scale theories, and price and demand principles. This is reflected in the three areas of "where to play", "which role to play", and "how to play". Our model deepens and extends existing work on collaboration and growth as well as value creation/capture mechanisms in a digital ecosystem setting. Ultimately, firms have to focus on their own contribution to improve the overall value creation of the digital ecosystem, because success will be achieved together – by considering "where to play", "which role to play", and "how to play".

Future research in this area should concentrate on collaboration and value capture ("why to play"), mathematical formulation and development of the EGC model on an analytical level, and finally on the model's empirical foundation.



Lessons Learned

- 1. Where to Play** – Do I understand the digital ecosystem I am integrated in? In the digital ecosystem cosmos, success requires a thorough understanding of network effects and the mechanisms of increasing return. It is crucial to jointly design the digital ecosystem, foster the shift to exponentially growing networks, and manage the customer base's resource-intensive growth. Make sure to grow faster than the competing digital ecosystems – in the end, there can only be one (digital ecosystem).
- 2. Which Role to Play** – Do I understand the way of collaboration in my digital ecosystem? Success or failure is not just determined by the company itself, but rather by the whole digital ecosystem. Former competitors are now hubs or complementors and jointly support the success as a collective. However, the levers for making a digital ecosystem successful are different in each role, as is the margin distribution.
- 3. How to Play** – Do I use the resources to play in the right way? Playing in the arena of digital ecosystems with increasing returns requires several things: expect and accept market instability, improve the ability to lock in customers, boost the customer base, and improve their willingness to pay. Ideally, the value of the offered solution should be directly linked to the number of users.

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