Introduction

The ongoing digital transformation manifests itself in a number of new smart technologies. These include robotics, artificial intelligence, autonomous systems, platforms, and new digital business models. They create new market opportunities. Both supply-side and demand-side factors determine the respective development paths, the type of players involved, but also the form and intensity of innovation activity. In these processes of market or industry development, the new smart technologies mentioned are still at an early stage and their further development is still open. Nevertheless, possible development patterns and their driving factors can be indicated by considering the literature on industrial organisation (IO) and industrial dynamics. And that is precisely the aim of this chapter, with a special focus on the role of entrepreneurs and start-ups, their opportunities for, and obstacles to success.

Overview

The following sections address the role of entrepreneurship against the background of industrial organisation. The impetus of economic change roots in the entrepreneurial behaviour of individual actors. They shape the industry structure and its evolution. Entrepreneurial behaviour, or more general, entrepreneurship constitutes an endogenous element in industrial dynamics. In a reciprocal fashion, entrepreneurial behaviour is also influenced by industry pattern and related characteristics. It is two sides of the same coin. Entrepreneurship and industrial organisation theory should therefore be close friends.

Whereas the focus in the entrepreneurship literature is rather put on understanding the spur and nature of the successful entrepreneur or successful entrepreneurial behaviour, the literature on industrial organisation brings the role of industry structure, actor conduct, and actor performance to the fore.

One of the early predecessors in entrepreneurship research, Joseph Alois Schumpeter, conceives the entrepreneur as the main driver of economic change.1 In his seminal contribution *The

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1 There are many concepts of the entrepreneur. Hébert and Link (1988) identify 12 themes, each of which emphasising a specific aspect such as the entrepreneur as a risk taker, a financer, a decision-maker, or most prominently the entrepreneur as an innovator. Compare also Grebel (2004).
Entrepreneurship, industrial organisation

Theory of Economic Development, Schumpeter (1912/1934) portrays the entrepreneur as a leader who is willing to seize business opportunities and carry out new combinations. In other words, Schumpeter describes the entrepreneur as innovator that destroys existing (industry) structures while creating new ones. In later contributions, Schumpeter (1912/1934 1942) also realised that it is larger firms playing a major role in boosting technical change through innovation.

At the onset of industrial organisation studies (Bain 1956, 1959), the vantage point was to investigate the impact of industry structures on the economic performance of actors. Out of the early structural approaches, the Structure-Conduct-Performance (SCP) approach arose, in which the interplay between the conduct of firms (i.e. profit maximisation) and the industry leads to a specific performance. Looking through the lens of the SCP approach, Schumpeter (1912/1934, 1942) offers an implicit story of industry dynamics with his entrepreneurship concept. The heroic Schumpeter entrepreneur (Schumpeter 1912/1934) who is not satisfied with the economic performance of competitive markets (structure) tries to innovate (conduct) in order to destroy existing industry structures and to achieve monopoly rents (performance) at best.

Both strands of literature, entrepreneurship and industrial organisation, have meanwhile developed a large body of complementary theories and empirical studies, some of which we briefly sketch in this chapter. We start with the classical discussion about the impact of market structure on innovative activities motivated by the Structure-Conduct-Performance approach in the 1970s, followed by tournament and non-tournament models in “New Industrial Economics” – including an empirical perspective – that endogenised the link between entrepreneurship/innovation and market structure in the 1980s. Recognising that innovation is tantamount to saying that entrepreneurship always includes the production of knowledge/technology. The successive section is dedicated to the impact of appropriability conditions within markets and industries on entrepreneurial behaviour. Thereafter, the dynamic perspective of entrepreneurship and industry life cycle theory is addressed, followed by a section on the concept of entrepreneurial ecosystems emphasising the fact that entrepreneurship and thus endogenous change of industry structures is a restless, perpetual economic process. Demand-side-related aspects to industrial dynamics and their relation to entrepreneurship and entrepreneurial opportunities are addressed in the section before the conclusion; in the latter, we suggest some research desiderata.

Market structure, innovation, and entrepreneurship – from Structure-Conduct-Performance to New Industrial Economics

As pointed out, combining one of the most basic research questions in entrepreneurship research – “What drives entrepreneurial/innovative behaviour?” – with the industrial organisation perspective – “What role does market structure play in economic performance?” – the immediate complementary research question is: “What drives entrepreneurial/innovative behaviour, given a certain market structure?” Early studies on innovation activities and entrepreneurship focused on the relationship of structural conditions of industries and innovation-related profit opportunities. Consequently, absolute firm size on the one hand and industry structure and hence relative firm size, on the other, were dominating the discussion at the time: what firm size or market structure, respectively, is more conducive to entrepreneurial activity?

Structure-Conduct-Performance approach

A first systematic treatment of the role of industry structure and economic performance was offered by the Structure-Conduct-Performance approach (SCP) (Bain 1956, 1959). The gist of its argument was that firm behaviour (conduct) and the economic/industrial structure they are
embedded in determine overall economic performance. For simplicity, market structure, be it competitive or monopolistic, or anything in between, was interpreted as the structural dimension of an industry, and the conduct of firms as profit-maximising behaviour.

Evidently, market structure and relative firm size go hand in hand. In general, a monopolist is large, while, under perfect competition, individual firms tend to be negligible in size. By and large, this is tantamount to comparing entrepreneurs (small firms) with large firms, a distinction that has become one of the core topics in economics of innovation.

First and foremost, it was Schumpeter himself pointing at this distinction. In contrast to The Theory of Economic Development (1912) where he identified the entrepreneur as the main driver of innovative and economic change, Schumpeter proposed large firms with deliberate research efforts as deus ex machina in his 1942 book Socialism, Capitalism and Democracy. This distinction entailed a long-lasting discussion on context factors to what extent they favour either small or large firms as main innovators. From an industrial organisation viewpoint, this boils down to the question about the most conducive market structure: monopoly, perfect competition, or oligopoly. Hence, the so-called Neo-Schumpeterian hypotheses were born, claiming that large firms or more monopolistic market structures respectively favour innovation activities. The difference between the two viewpoints is simply absolute versus relative firm size.

In a seminal paper, Arrow (1962) argues by constructing a model with exogenous innovation that firms in a competitive environment (i.e. small firms) should have a higher incentive to innovate than a monopolist has. A competitive small firm, earning zero extra profits before innovation, will earn a monopoly profit afterwards. So would a monopolist, but the monopolist would lose the profit he or she already had before innovation. Thus, the notion of the cannibalisation effect was born with the conclusion that a small, entrepreneurial firm should have a comparatively higher incentive to innovate than an established large firm. Reformulated in terms of market structure, a more competitive market structure should appear to be more conducive to innovation activities than a monopolistic one. Hence, the questions related to Neo-Schumpeterian hypotheses were answered in favour of small firms and competitive market structures.

New Industrial Economics

Arrow’s model suffers from several drawbacks; for example, it conceives innovative behaviour in isolation and treats market structure as exogenous. In the aftermath, new types of models were developed that take a game-theoretic approach, of which some deal with dynamic aspects. This strand of research has become known as the so-called “New Industrial Economics” approach (NIE). It introduced a further impetus to the discussion of innovation and entrepreneurship in an industry context.

Non-tournament models and endogenous market structure

Most prominent and path breaking in this context is the work by Dasgupta and Stiglitz (1982). They design a model in which both R&D investment of firms and market structure are endogenous. They criticise Arrow’s (1962) assumption that innovation would not affect the market structure and innovations were exogenous. The model by Dasgupta-Stiglitz has become a standard modelling element (Levin and Reiss 1984; Klepper 1996), which meanwhile is labelled a non-tournament model.

The basic assumption is that all firms invest in R&D and decide on the quantity of a (homogenous) output in a profit-maximising way. According to the results of the Dasgupta-Stiglitz model, it rather is an oligopolistic market structure with a few firms that is conducive
Entrepreneurship, industrial organisation

to innovation than a competitive market structure, or small entrepreneurial firms. In the vein of Dasgupta-Stiglitz’s model, a firm’s willingness to invest into R&D, proxied by the share of R&D expenditures in sales, the so-called R&D intensity, should be lower for small firms. This, in turn, contrasts the conclusions of Arrow (1962); Dasgupta and Stiglitz (1982) propose the opposite: for firms to strive for innovation, the market structure needs to differ from perfect competition.

Though Dasgupta and Stiglitz formulate their theory as a static model, it suggests an implicit dynamic driven by profit opportunities. New entrepreneurial firms enter the market as long as profit opportunities are positive. With an increasing number of firms entering the market, these opportunities eventually vanish and so does firm entry. In other words, market structure, interpreted as the final number of firms in the market, is endogenous in the model. By construction, the equilibrium number of firms in the market is always greater than one and smaller than infinity, which leads to the conclusion that an oligopolistic market structure is most conducive to innovation.

Tournament models and “the winner takes it all”

In contrast to non-tournament models – where all firms innovate successfully – tournament models, or synonymously, patent races assume that “the winner takes it all”. Some of these models feature innovation as a sequence of innovations. In each innovation round a monopolist is determined, be that an incumbent or an entering (entrepreneurial) firm. Consequently, market or industry development reflect a sequence of monopolies. With respect to the incentive to innovate, as Reinganum (1983, 1984) as well as Harris and Vickers (1985) show, firms or entrepreneurs entering the market have a higher incentive to invest in R&D than incumbent firms do because the latter always run the risk to cannibalise existing profits – entrepreneurs do not. This leads to the equivalent conclusion that a potential entrepreneurial entrant should be more willing to invest in innovation than an established firm does.

Empirics

Looking at the empirical evidence, the validation of the Neo-Schumpeterian hypotheses (see Cohen 2010 for a splendid overview) shows a mixed picture. At the most, a robust result is that in absolute terms large firms spend more on R&D than small ones (entrepreneurs); in relative terms, however, no significant difference is detectable. Only with respect to R&D productivity, measured by the number of patents or innovations per unit of R&D, small firms appear superior.

However, many empirical studies identify an inverted u-shape relationship between market concentration and R&D investment, its explanatory power remains weak. Including further explanatory variables such as technological opportunity and profit appropriation conditions reduce the significance of market concentration as an explanatory variable drastically. Only 1.5–4% of innovativeness can be attributed to market concentration, whereas industry type, demand structure, technological opportunities, and appropriability conditions explain up to 32–50%.

Overall, the evidence for large firms and concentrated markets sustaining and promoting higher innovative activities is weak and hence the validation of the Neo-Schumpeter hypotheses fails. Remaining variables such as technological opportunities, average cost of R&D projects, continuity and predictability of technological development, or learning curve effects appear to have more explanatory power. Further neglected aspects in empirical studies are demand-side effects such as product differentiation, or the intensity of price competition. Moreover, the majority of empirical studies use cross-sectional data, which do not allow any conclusions on causality and the dynamic nature of innovation within industries.
Contextual factors concerning technology, demand, or other economic aspects need not only be considered each distinctively, they also have to be put into the timely context of an industry’s development. As the following sections show, with changing industry conditions, the type of innovation and the incentive for start-ups to enter the market change, too.

Innovation structures, appropriation regimes, and entrepreneurship – industry/technology classifications

In view of the mixed empirical evidence concerning the Neo-Schumpeterian hypotheses and the observation that it is industry- or technology-specific factors rather than market concentration explaining entrepreneurial activities and innovation within a market/industry, a new stream of literature started to develop in the 1980s. The primary objective was to understand industries in terms of their ability to foster and promote certain types of innovation activities (i.e. internal, external, and cooperative R&D; product or process innovation). Thus, the prospects on innovation rents and the role of appropriation conditions came to the fore. In these mostly empirical studies, the focus was put on an inductively generated, broad account of empirical regularities, which eventually led to the so-called OACK approach (opportunities, appropriability conditions, cumulativeness of technological change, and the specific nature of knowledge).

In various studies, Malerba and Orsenigo (1993, 1997) attempted to classify industries into Schumpeter Mark I and Schumpeter Mark II industries, the former reflecting the ideas of Schumpeter (1912), the latter the elaborated concept of Schumpeter (1942). Using patent data to measure innovativeness allows them to do so, where mainly IPC classes represent technologies, sometimes coinciding with industries. Malerba and Orsenigo discover, in what they call Schumpeter Mark I technologies (i.e. technologies in which small firms and innovative start-ups dominate innovative activities), that the concentration of innovators is quite low and innovator rankings regularly change over time. Since new or entering innovators constantly destroy or at least damage the economic value generated by previous innovators, Malerba and Orsenigo conclude that creative destruction is prevalent in these technologies. The story in Schumpeter Mark II technologies looks different. Large firms dominate innovative activities. Innovator concentration is high and, on the contrary, the ranking of innovators remains stable over time. Additionally, the manner of innovation is different. Innovators primarily introduce improvements of previous innovations. For this reason, Malerba and Orsenigo conceive innovation as a process of “creative accumulation” in those technologies. With little surprise, this also has an impact on firm entry and exit. Technologies of the Schumpeter Mark I type experience a high rate of innovative entrepreneurial entry and exit, whereas, in Schumpeter Mark II technologies, entry and exit remain low.

One of the main insights of Malerba and Orsenigo is that there is a significant positive correlation between firm size, innovation concentration, stability in performance rank-orders, on the one hand, and a significant negative correlation of these technology characteristics with the rate of innovative entry, on the other. At least for the technologies in the major industrialised countries, these findings appear to be robust.

The two classes by Malerba and Orsenigo, Schumpeter Mark I and Schumpeter Mark II, suggest that, aside from profit opportunities, the innovative performance of industries also depends on appropriation conditions, the specific characteristics of knowledge creation and its cumulativeness as well as the kind and scope of innovation. These dimensions interact in a specific way and characterise the two classes, Schumpeter Mark I and Schumpeter Mark II. First, the opportunity dimension simply takes account of whether the industry under consideration offers relevant and exploitable innovation opportunities. In case this condition does not hold,
Entrepreneurship, industrial organisation

neither small entrepreneurial firms, nor innovative start-ups, nor established innovators will engage in innovative activities. A second factor, appropriation conditions, which directly refer to the characteristics of knowledge created during the innovation process, determines the actual degree of appropriation. To the extent to which knowledge represents a public good, (potential) competitors will make use of it. Given sufficient absorptive capacities (Cohen and Levinthal 1990; Criscuolo and Narula 2008), they will imitate the innovator’s technology. In case newly created knowledge is generic, codified, well-structured, and self-containing, imitators will be able to exploit the new knowledge. In case knowledge is highly specific, tacit, rather complex, and systemic, its imitation/exploitation comes at cost, which might be unsurmountable for potential imitators, due to the lack of absorptive capacity. The cumulativeness of knowledge is one aspect that will aggravate its exploitability by external actors. It contributes to its systemic instead of independent character as well as to its complex instead of well-structured dimension and partly to its tacit versus codified nature. Hence, cumulativeness and appropriability are more to the benefit of established firms than to entrepreneurial firms or innovative start-ups. The latter might rather be inclined to innovate new products and services, whereas established firms with a large accumulated stock of knowledge tend to engage in process and organisational innovation.

Along this line of reasoning, the two classes, Schumpeter Mark I and Schumpeter Mark II, have become labels for two regimes in innovation activities. The entrepreneurial regime is based on Schumpeter Mark I, characterised by a low degree of appropriability due to the specific type of knowledge, low cumulativeness in new knowledge generation, and a higher inclination for product innovation, which, in addition, will motivate small firms and entrepreneurial start-ups to enter the market. Conversely, the Schumpeter Mark II regime represents a routinised regime in which large firms with a high degree of cumulated knowledge focus on process and organisational innovation, since the cumulativeness of knowledge improves appropriation conditions because small entrepreneurial firms lack absorptive capacities and often the required financial scope. In other words, the path dependence of knowledge creates barriers to entry and provides large incumbent firms with a competitive advantage in innovation.

Entrepreneurship over the industry life cycle

The inconclusiveness of the empirical evidence on the Neo-Schumpeterian hypotheses, whether it is small versus large firms being the primary innovators, revealed that mainly industry-specific factors (i.e. profit opportunities, the specificities in knowledge creation, and appropriation conditions) are factors that explain entrepreneurial behaviour and innovative activities. Moreover, with the classification of innovation regimes and the insight that industry conditions change over time, a large body of literature has developed, called industrial dynamics (e.g. Dosi et al. 1995), which deals with the following basic pattern. Firms usually enter a market or industry as small firms with an innovation, some of which grow large over time by further innovating; some have to exit and this altogether determines the dynamics of an industry.

An interesting elaboration of industrial dynamics is the industry life cycle approach (ILC). Through radical innovations, new markets/industries are born experiencing certain patterns of evolution and thus shape an industry life cycle. This approach offers to track the dynamics of industries from cradle to grave, although the analyses run in principle only until maturity. Evidently, entrepreneurial behaviour, entrepreneurship, and innovative activities play an important role in the narrative of an industry life cycle. However, the kind and quality of these phenomena change along the industry life cycle. First, it is entrepreneurs/innovators who create an industry or set the initial seed for an industry. Secondly, entrepreneurs constantly keep the competitive
pressure up within an industry. Thirdly, entrepreneurs/innovators shape the evolving structure of an industry in all phases of the ILC. Vice versa, it is the ILC pattern and its dynamics that feed back on entrepreneurial behaviour and the type of innovation regime.

**Industry life cycle**

To give an example, the industry life cycle of the German car industry was born in 1886 when Carl Benz invented the first automobile. Benz, and shortly afterwards Daimler, founded new firms to market automobiles. After that, many new firms emerged. Figure 5.1 graphs the development of this emerging industry showing the number of car companies over the years.

The development follows a pattern that comes close to a stereotypical ILC, as indicated by the bold line indicating the number of firms for each year. In a first phase, only a few firms exist in the industry (here until about 1897); then, in a second phase, a rapid take-up follows until a peak is reached (here 1924). A third phase follows, the shake-out phase, which manifests a sharp drop in the number of firms (here ending in 1930). In a last, fourth phase, the number of incumbent firms stabilises and entry-exit turbulences fade.

The second phase shows two sub-phases, a decline in the number of firms between 1908 and 1918 followed by a sharp increase between 1918 and 1924. Hypothesising about the effect of World War I, it seems plausible to assume that business prospects before the economic shock started to deteriorate; after the shock, entrepreneurial opportunities improved rapidly, possibly accelerating firm entry even more as it might have been the case without such shock (Grebel 2004; Grebel et al. 2003). If no shock had occurred, more firms would have entered the industry and the industry life cycle may have taken the shape of the dashed line (stylised ILC 1).

![Figure 5.1 Development of the German automobile industry from 1886 to 1945](image)

*Source:* Based on Cantner et al. (2009)

*Note:* There were two shocks to the ILC: World War I and hyperinflation. Both shocks affected the economy as a whole and the car industry in particular. The hypothesis that World War I inhibited entrepreneurial behaviour in the beginning and boosted it later seems self-evident. Assuming no such shock, the dashed line as hypothetical stylised ILC would have been conceivable. The second shock, hyperinflation, leading to a run into real investment possibly had entrepreneurial entry overshooting. Assuming this shock away, the dotted line marks another conceivable, counterfactual path of the ILC.
Alternatively, the sharp peak can be explained by the effect of the hyperinflation period (1918–1923). The induced run into real investment had firm entry overshoot aggravating the shakeout phase. In this scenario, the industry life cycle of the automobile industry might have taken the path of the dotted line (stylised ILC 2) given no hyperinflation.

The pattern of an ILC results from two underlying dynamics, entry and exit. Figure 5.2 displays the net effect of the two dynamics, which allows to detect several phases in the ILC. The phases are distinguished by whether net entry is positive, negative, or zero. By this criterion we distinguish phases I to VI, characterised as in Figure 5.2.

The bold line represents net entry as the difference between the number of entering and exiting firms. From 1886 to 1896 entry is moderate and exit did not occur, our phase I. From then on until 1907, phase II, the entry dynamics dominate the exit dynamics leading to positive net entry. The reverse holds for phase III, 1908 to 1917, thereafter, in phase IV, net entry is positive again until 1924, followed by a harsh shake-out phase V until 1930 with a strongly negative net entry. From then on, in phase VI, the winnowing of the industry slows down and net entry becomes very small, with slightly more exits than entries.

The type of entry in this development has different sources. It contains newly founded firms but also lateral entry, when established firms of other industries enter the automobile industry. With regard to the exit dynamics, observed exits comprise several ways of leaving the market such as bankruptcy, lateral exits, and mergers and acquisitions.

Overall, the ILC describes the change of an industry’s organisation as well as a change in the type of entrepreneurial behaviour and innovation. Both, entrepreneurial behaviour and the industry structure, follow a mutually influencing pattern of change. Entrepreneurs found firms, create new markets, or enter a market to seize perceived profit opportunities. In the early phase of an ILC, it primarily is innovative start-ups driving the entry dynamics, when creative destruction constantly reshuffles innovator rankings. The shake-out phase winnows successful from unsuccessful innovators before the industry eventually consolidates and established firms start dominating the industry dynamics in an innovation regime labelled creative accumulation. This, however, already anticipates the discussion of entrepreneurial ecosystems in the following section.
Entry dynamics: mechanisms of entry and the endogeneity of entry barriers

Making profits certainly is the main driver of entrepreneurs to enter a market. The potential profit opportunities depend on the degree of novelty and generality of an initial innovation. Radical innovations, as a whole, provide a larger scope for follow-up innovations and entrepreneurial activities than incremental ones. In addition, whether potential entrepreneurs/innovators eventually enter a market/industry also depends on his/her personality, knowledge, expertise, access to various resources (venture or seed capital), or properly trained staff, and beyond and above, also his or her personality and aspiration to newness and risk-taking. The actual decision to entrepreneurial/innovative actions depends on various determinants. Only if this individual threshold is exceeded market entry and a subsequent entrepreneurship-driven evolution of an industry emerges (Grebel 2004; Grebel et al. 2003). These lower bounds represent a kind of entry barrier, a minimum level of knowledge and competencies, a minimum level of venture capital or access to possible contributors to the venture. In the course of industry development, these entry barriers are not fixed but may change over time and tend to become binding.

No innovation and fixed entry barriers

In the model by Klepper and Graddy (1990), such kind of entry barrier is modelled as a fixed monetary amount $e$. Only if this fixed cost of entry can be covered by the first period’s returns, entrepreneurs decide to enter the market. Each potential entrant or entrepreneur $i$ is characterised by firm-specific per unit production cost $c_i$, which is randomly assigned and drawn from a half-open interval with a given lower bound $c^*$. After the random assignment of unit costs $c_i$ in the first period, they remain constant for each firm. Whenever a potential entrant’s per unit profit, measured as the difference between the market clearing price $p$ and unit costs $c_i$, covers entry costs, $p - c_i \geq e$, an entrepreneur decides to enter – potential entrepreneurs with unit costs such that $p - c_i < e$ decide to remain outside the market.

As the industry evolves, new firms enter and established firms expand their total output. Given a conventional market demand function, the market-clearing price $p_t$ constantly declines over time and so do per unit profits $p_t - c_i$ for an incumbent firm and $p_t - c_i - e$ for an entrepreneur that just entered.

For potential entrepreneurs outside an industry, a declining $p_t$ implies declining chances for a firm entry. Given fixed entry cost $e$ the positive margin of market entry shrinks over time; as for a potentially entering firm it must hold that $p_t - e \geq c_i \geq c^*$. Once $p_t$ has reached a certain level so that $p_t < c^* + e$, entrepreneurial entry peters out. For firm performance, measured by $c_i$, this means that entry cohort by entry cohort, the average of the unit cost of the entering firms decrease. Hence, the steadily improving performance of cohorts finally approach $c^*$.

Looking at the contribution of entrepreneurship to the industry dynamics, the following can be summarised. The fundamental mechanism of industry development, aside from firm growth, is entrepreneurship and entrepreneurial entry. The higher the entry barrier to an industry, the less important entrepreneurial entry – in terms of number of entering firm per period and in terms of the number of periods in which entry takes place at all. In the course of an ILC, the

2 In the model of Klepper and Graddy (1990) unit costs in the first period can randomly be changed once but then stay fixed.
Entrepreneurship, industrial organisation

productive performance of entering firms increases, or put differently, in later phases of the industry's development, successful entry requires a better productive performance.

Innovation and endogenous entry barriers

In his 1996 contribution, Klepper extends the previous model by Klepper and Graddy (1990). Klepper (1996) introduces product and process innovation and endogenises the entry barrier. He considers industries as driven by incumbents, entrepreneurial entries, exits (of incumbents), and firm growth. In each period incumbents and entrepreneurs pursue two types of innovation activities, product and process innovation. In addition, incumbents decide about expanding their production capacity. Introducing a new product yields a one-period innovation rent to the innovator. The expected return depends on the innovative expertise \( s_i \) of firm \( i \), which is assumed to be a random number \( s_i \in [0; s^*] \) exogenously assigned to firm \( i \), where \( s^* \) is the upper bound. In the subsequent period, the product innovation becomes an integral part of the standard product. In order for firms to be able to imitate all product innovations of the previous period and integrate them into the standard product, they all have to screen the market that incurs cost \( F \) in every period. \( F \) is assumed to be constant and to exceed the innovation rent of product innovation. This implies that each firm, established or new, needs to produce the standard product and invest in process R&D to reduce unit production cost in order to cover the losses arising from screening the market for imitation due to the assumption that the return to product innovation never covers those costs. Nonetheless, it is the innovation expertise \( s_i \) and the level of optimal product R&D that influence the final firm profit.

The optimal level of process R&D depends, inter alia, on firm size, the expansion of the market size – since the market-clearing price continuously falls and the corresponding firm output \( Q_a \) of the standard product increases. Because of the assumption that incumbents steadily increase their production of the standard product in the course of time, older firms grow large and manage to generate higher unit cost reductions in the standard product than smaller (younger) ones. In principle, the smaller (younger) a firm, the lower the price of the standard product, the less it invests in process R&D to reduce unit production cost \( c \), and the lower the profit out of the standard product.

Putting the focus on our core interest, that is, entrepreneurial entry and exit, the crucial condition is the expected firm profit \( E(\pi_a) = f(s, Q_a, p_i) \) of an incumbent or a new firm \( i \) in period \( t \) that determines firm entry and exit. The pivotal parameters in the model are the innovative expertise \( s_i \) of firms and the moment in time they enter the market. In the course of the ILC, the price \( p_i \) steadily falls and therewith the individual firm margin \( (p_i - c) \) of the standard product.

In each period \( t \), a minimum level of innovative expertise \( \bar{s}_a \) in \([0; s^*]\) is required to ensure expected profit to be non-negative, \( E(\pi_a) = f(s, Q_a, p_i) \geq 0 \). This holds when the expected profit is at least as high as to cover the market screening cost minus the innovation rent from a new product plus the profit from the standard product. The minimum level \( \bar{s}_a \) is specific for every entry cohort in period \( t \). Only potential entrepreneurs of a certain cohort that meet or better exceed \( \bar{s}_a \) have the expertise and knowledge to generate a product innovation with a high enough probability for a non-negative expected total profit. Only if this is satisfied, entrepreneurs decide to enter the industry.

3 By model construction, optimal product R&D, the resulting product innovation rent, and the screening cost are identical and constant for all firms, both incumbents and entrants.
As the industry develops, the minimum level of expertise \( \tilde{s}_i \) required for entry increases from cohort to cohort. Due to a steadily declining market-clearing price for the standard product \( p_t \), the prospective gains from process R&D shrink. The declining price lowers the return a firm can reap from process innovation and constrains the scope to cover expected losses when product-oriented R&D activities fail. Hence, for potential entrepreneurs of different cohorts with an equivalent \( s \), the expected profit \( E(\pi) = f(\tilde{s}_i, Q_t, p_t) > E(\pi_\text{R&D}) = f(\tilde{s}_i, Q_{\text{R&D}}, p_{\text{R&D}}) \) with \( Q_{\text{R&D}} \approx Q_{\text{R&D}} \) and \( p_t > p_{\text{R&D}} \) \( (n \geq 1) \). The higher the entrepreneur's innovative expertise \( \tilde{s}_i \), the higher her expected profits. The later firms enter the market, the higher the minimum level \( \tilde{s}_i \) required to enter. Eventually, firm entry comes to a halt, when \( \tilde{s}_i \) has reached the upper bound \( s^* \).

This is how Klepper (1996) endogenises the entry barrier: it is arising from the need to cover expected losses in product innovation plus imitation activities, develop endogenously and get tighter over time. Regarding the number of entries, whether they go up or down over time depends on the random assignment of \( s \) to the potential entrants. However, the average quality level of entrants measured by innovation competence \( s \) increases from cohort to cohort. Eventually, at a certain point \( T \) in the industry development the required competence level \( \tilde{s}_i \) gets higher than \( s^* \), the upper bound. Then, entry dynamics come to an end.

Summarising, industry dynamics in terms of entrepreneurship is characterised by the following entry dynamics. Over time, the quality of newly founded entrepreneurial firms, as indicated by their innovative expertise, increases. Although the rate of entry may fluctuate, the average expertise of entering firms increases along the industry life cycle. Entry eventually fades out when the entry barrier has reached the upper bound \( s^* \) and potential entrants are no longer able to meet the minimal innovation expertise required for a non-negative expected profit.

**Exit dynamics: entrepreneurial entry and survival**

Not all entrepreneurs entering a market survive. If expected profits, when staying in the market, are negative, firms will exit the market. In Klepper and Graddy (1990) the negative profit arises from the difference between the firm-specific (constant) level of unit cost in production and the market-clearing price, which gradually declines over time as the number of firms in the market and the total industry production increases. In each period, incumbents stay only in the market if \( p_t - c_t \geq 0 \), otherwise they exit. The exit dynamics stop when the price has declined sufficiently so that \( p_t = c^* \). When comparing the average unit cost of firms in exit cohorts, we see a steady decline in the average of unit cost between consecutive exit cohorts. This means that, over time, more and more better performing incumbents are forced to exit.

In the Klepper (1996) model, as for the entry dynamics, the required minimum innovative expertise also drives the exit decision. The fact that the expected return to product innovation never fully covers the imitation cost \( F \), it must be the return from process innovation and from selling the standard product to compensate for that loss in order to have positive expected total profits. Age also is a relevant factor that increases the chance of positive expected profits. The younger (smaller) a firm, the lower is the expected profit from process R&D. This profit might be too small to compensate for expected losses arising from product innovation plus imitation. For the latter it again holds true that the expected loss is the smaller, the higher the innovation competence \( s \) of a firm.

There again exists a minimum required competence \( \tilde{s}_i \) at which the expected loss out of product innovation plus imitation is low enough to get just compensated for by the profits out of process R&D. For a small (young) firm \( \tilde{s}_i \) is relatively large and may even be higher than \( s^* \), the maximum possible innovation competence. For larger (older) firms, however, \( \tilde{s}_i \) will be relatively low.
Along with industry development, the minimum innovative competence \( s_0 \) required to stay in an industry increases over time. The reason for that is a gradually falling market clearing price for the standard product. Forces behind this are process innovations that decrease production costs and the increase in total production in the industry due to entry and due to expansion of established firms. With a declining market price, the per unit profit out of the standard product declines and with it the degree by which a loss out of product innovation plus imitation can be covered. For that larger firms have more financial means than smaller ones. Consequently, for two firms in period \( t \) that are equal in innovation expertise \( s \), the one which is smaller (younger) will have a higher minimum required innovation competence \( s_0 \) and thus is more likely to exit. For two firms that are of equal size in period \( t \), both face the same \( s_0 \) and the one with the lower \( s_i \) is more likely to exit. Hence, in terms of comparing profits, it holds true that

\[
E(\pi_u) = f(s_i, Q_u, p_t) > E(\pi_a) = f(s_j, Q_a, p_t)
\]

with either \( Q_u > Q_a \) and \( s_i = s_j \), or \( Q_u = Q_a \) and \( s_i > s_j \), or proper combinations of the two.

In view of these relationships, a clear-cut time pattern of exit dynamics cannot be derived. Certainly, over time, younger and thus smaller firms are more likely to exit than older and larger firms as incumbents have the advantage of a higher profit out of the standard product. However, these dynamics interfere with the dynamics of entering entrepreneurs that steadily exhibit better terms of innovation competence, often even better than incumbents. This may lead to situations in which larger firms are forced to exit before smaller firms.

**Empirics**

In this section, we discuss some empirical results on the aforementioned entry and exit dynamics of entrepreneurial firms during the industry life cycle. The studies we draw on refer to the German automobile industry from 1986 to 1945, as introduced earlier.\(^4\)

For the purpose of this chapter, we consider the number of entering firms including their innovation expertise on the one hand and, on the other, the number of exiting firms including their respective innovation expertise. For innovation expertise we take two alternative indicators; first a dummy variable indicating patenting of a firm and secondly a firm patenting dummy combined with its duration in the industry. Firms that enter without a patent are considered imitators.

We demarcate certain phases during the time span 1886 to 1945 (see Figure 5.2). An early phase with a moderate rate of entry is 1886–1896; a first phase of high entry is 1897–1907; 1908–1917 shows a negative net entry rate; for 1918–1924 a sharp increase in entry is observed; 1925–1930 follows with an industry shake-out; a slightly negative or rather zero net entry rate follows in 1931–1945.

**Entry dynamics**

From 1886 to 1945 the total number of entering firms is 351 of which 333 exited the industry again. Of those entering, 128 held patents, of those exiting 113. The average duration in the industry is about 7 years with a maximum of 60 and a minimum of 1 year. Some of the exits occurred shortly after entry. We run an alternative analysis on those entries that lived for 5 years.

\(^4\) The data and the way they were collected is described in Cantner et al. (2006, 2009, 2011) and Dressler (2006).
and more. That leaves us with 147 entering and 129 exiting firms, which held 85 and 70 patents, respectively.

As to entry dynamics, the proposition is that the entry barrier in terms of product innovation expertise is increasing over time so that fewer and fewer firms are able to meet it. A proper test for this would be a comparison of entering and non-entering firms in their innovation expertise. However, data on potential entrants that did not enter are unavailable. As a kind of auxiliary analysis, we simply track innovation driven entries over time. We look at all entries and additionally on those that lived at least for 5 years.

Table 5.1 delivers the result of our analysis. First, looking at the full-time span from 1886 to 1945, for firms with and without innovation expertise there is early on an increase followed by a drop in the number of entries – which follows a life cycle pattern. Secondly, in terms of the share in innovation-based entries in all entries, for the full sample, this share starts with 75% in 1886–1896, then drops gradually to 23% in phase 1931–1945. For the sample of entry surviving at least 5 years, the drop is less severe: from 86% in 1886–1896 it falls to 43% in 1931–1945. In terms of innovative entry, fewer and fewer firms are observed in absolute as well as in relative terms. Conversely, imitation, for which firms without patents may strive for, seems to become comparatively easier over time.

Thirdly, in order to qualify patenting, we use a further measure, the average survival time of patenting versus non-patenting entries – where higher survival indicates higher innovative quality. Looking at the subsample of survivors of at least 5 years, patenting firms start in 1886–1896 with an average duration of about 28 years. This is about four times higher than an average non-patenting firm. The duration drops in the next sub-periods to 17 years and even 4 years (in World War I times). From 1925 on, it rises up to 21 years in 1931–1945, which is about five times as much as an average non-patenting firm. Hence, except for the starting sub-period and during wartime, the quality of patenting entries increases absolutely as well as in comparison to non-patenting (imitating) firms. An interpretation of this result is that the entry barrier, in terms of a minimum innovation expertise, increased over time. In this sense, the core result of our discussion of entrepreneurial entry dynamics over the industry life cycle finds some empirical support.
Exit dynamics

As to the exit dynamics, we start with an analysis equivalent to the entry dynamics in order to find an indication for an increasing minimum innovation expertise. Table 5.2 reports our results.

First, for the whole sample as well as for the subsample of firm survival of at least 5 years, exit activities start low, reach a peak, and then decline. This holds for both firms with and without patenting. For the whole sample, twice as many non-patenting firms exit as patenting firms; for the reduced sample, it is rather balanced. Secondly, in terms of the share of exiting firms that patent in all exits, for both samples, this ratio increases over time. This is due to non-patenting firms exiting more in earlier phases and only when the required minimal innovation expertise increased high enough, more and more patenting firms are forced to exit. Thirdly, as to the average survival time of exiting firms, patenting dropouts compared to non-patenting ones live shorter on average – in all phases before 1931–1945. Average survival is increasing from 3.5 years in 1897–1907 to about 18 years in 1931–1945. This indicates that in earlier phases of the ILC recent entries and hence smaller (younger) firms are forced to exit; in later phases, this shifts larger (older) companies.

Table 5.2 Exit – patenting versus non-patenting

<table>
<thead>
<tr>
<th>Period</th>
<th>All firms</th>
<th></th>
<th>Firms with survival of at least 5 years</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>exits</td>
<td>patenting exits</td>
<td>patenting exits in all exits</td>
<td>exits</td>
</tr>
<tr>
<td>1886–1896</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1897–1907</td>
<td>43</td>
<td>17</td>
<td>0.40</td>
<td>15</td>
</tr>
<tr>
<td>1908–1917</td>
<td>68</td>
<td>18</td>
<td>0.26</td>
<td>39</td>
</tr>
<tr>
<td>1918–1924</td>
<td>42</td>
<td>9</td>
<td>0.21</td>
<td>4</td>
</tr>
<tr>
<td>1925–1930</td>
<td>140</td>
<td>50</td>
<td>0.36</td>
<td>52</td>
</tr>
<tr>
<td>1931–1945</td>
<td>39</td>
<td>19</td>
<td>0.49</td>
<td>19</td>
</tr>
<tr>
<td>sums</td>
<td>333</td>
<td>113</td>
<td>129</td>
<td>70</td>
</tr>
</tbody>
</table>

Additional results on ILC and entrepreneurs

Besides these descriptive results on required innovation expertise to stay in the industry, survival analyses deliver insights on the type of entrepreneurial firms that are more likely to survive (longer) in an industry. The following results are of interest (see Cantner et al. 2006, 2009, 2011): first, entrepreneurial firms that entered an industry early/earlier and survived for some time (i.e. larger and thus older firms), are less likely to exit. Consequently, entrepreneurs entering later have a harder time surviving. Secondly, entrepreneurial firms that entered an industry with an innovation are less likely to exit than those entrepreneurs that entered without innovation. Moreover, those that entered earlier and with an innovation are less likely to exit than entrepreneurs that entered later without innovation. Interestingly, being late can be compensated by being innovative, given a start-up meets the minimum innovation expertise. Thirdly, entrepreneurial start-ups that entered with more experience they have accumulated elsewhere and which contributes to their innovation expertise are less likely to exit than those without that kind of expertise.
The results presented in this subsection largely offer evidence on the interaction of entrepreneurial action and context. In view of this chapter, the conditions for entrepreneurial entry and firm exit change endogenously; entry and exit rates shape the pattern of industry dynamics that in turn feed back on entry and exit conditions. Obviously, the fit of the theoretical model(s) and the empirical evidence needs to be improved on both sides. There is potential for further progress.

Entrepreneurship and the dynamics of entrepreneurial ecosystems

Entrepreneurship and new firms take a substantial impact on industries along their life cycle. However, entrepreneurship plays its main role in early phases of the industry life cycle. By the degree to which industries mature, this impact vanishes. In the final phase of the industry life cycle, when the market structure stabilises, entrepreneurial activities are of no relevance anymore concerning the concurrent main technology.

However, a conceptual lacuna opens up here, the question about what comes after an industry has matured and what kind of further or different developments may follow. For the latter, new firms may be the constituting factor. For instance, in a mature industry characterised by an established core technology, further improvements of this technology become more difficult to achieve. This makes innovation activities more and more expensive. Instead of trying to improve the state-of-the-art technology any further, the attempt to aim at radical innovation may appear more promising to sustain profits. This radical change may take place via substituting the former key technology with a new one. For that type of change, new firms are more likely to be the promoters. Established firms, often having huge production capacities and a high stock of human capital related to the old technology, are less likely to succeed in exploiting such economic opportunities. Hence, with the maturity of an industry and an increasingly costly-to-improve key technology, the context conditions call for new entrepreneurial activities – new directions for innovation, new key technologies, and hence new technological and economic opportunities.

Here, the concept of entrepreneurial ecosystems comes into play. It serves as a framework to explain entrepreneurial activities within regions and industrial sectors. Cantner et al. (2020) who show how innovation activities shift between entrepreneurs, intrapreneurs, or incumbents in an industry or a region, have suggested a dynamic version of this approach. Entrepreneurs are predominantly active in start-ups in the sense of the ILC approach. The latter fits rather well into the ILC setting because in principle they are the established firms that run innovation projects, corporate or internal ones.

In an entrepreneurial ecosystem, the relation between the two types of actors can be considered as follows: in an early phase, phase 1, entrepreneurs and their innovation activities dominate the pattern of development – phase 2, the growth phase, in Cantner et al. (2020). In phase 3 – the stabilisation and maturity phase – intrapreneurs pursue more and more innovation activities such as scaling up former start-ups or acquiring small firms with their innovations. Dominance by intrapreneurs is achieved in phase 4 – the phase of decline. Entrepreneurial activities decline to lead to a downturn of the entrepreneurial ecosystem. So far, the similarity to an ILC model is obvious: the model of a dynamic entrepreneurial ecosystem resembles this mechanism of shifting innovation activities from entrepreneurs towards intrapreneurs as time goes on.

In addition, entrepreneurial ecosystems conceptualise the shift of innovation activities away from intrapreneurs back to entrepreneurs. It is this shifting, back and forth, of innovation activities between entrepreneurs and intrapreneurs that is at the core of a dynamic entrepreneurial ecosystem approach. To accomplish this, phase 1 – the birth phase of an entrepreneurial
ecosystem – is connected to phase 5, the reemergence phase. In phase 5, incumbent firms offer a pool of not commercialised ideas for entrepreneurs. By the degree to which these entrepreneurs use these opportunities, which are often quite different from the fundamentals of current prevailing technologies, a new cycle of an entrepreneurial ecosystem takes off and another phase 1 is initiated.

Hence, on this conceptual basis, the role of entrepreneurship is not only to get a new technology established – just as in the ILC approach – but also to take the lead in radical change. Established firms are quite reluctant to redirect their daily business. They rather try to avoid cannibalisation effects and, due to lock-in effects, they often lack the proper expertise. New entrepreneurial firms are flexible enough, not too much imprinted by the past in order to go into new directions and pursue radically new technologies. This is what the dynamic version of the entrepreneurial ecosystem approach substantiates. In this sense, it describes a continuous reloading of an entrepreneurial ecosystem cycle. Notwithstanding this, an empirical corroboration of concept is still pending – but on the agenda.

**Demand-side aspects on entrepreneurial entry**

The analysis in the previous sections focuses on the supply-side analysis of innovation decisions in general and on start-up decisions by entrepreneurs in particular. The demand side was considered here either via the assumptions of a given fixed demand function or exogenously growing demand. In this section, we will neglect the less specific consideration of the demand side and take a closer look at its importance for innovative entrepreneurs.

A connection between market size – and thus demand – and innovation was first established by Adam Smith (Smith 1776). As market size increases, the possibilities for the division of labour increase, and the resulting, more efficient use of labour is due, among other things, to “the invention of a great number of machines, which facilitate and shorten labour, and enable one man to do the work of many” (Smith 1776, chapter 3). This explicit link between market size and innovation has rarely been discussed further.

A notable exception is the work of the sociologist of invention Gilfillan (1935a, 1935b), who not only echoed Adam Smith’s idea but also proposed an additional role for the demand side in the innovation process. First, he suggested that the pace of technology should be faster in industries where the number of potential adopters, and thus the incentive for firms to innovate, is higher. Second, he suggested that demand not only creates incentives, but also alerts to new needs that must be met by the supply side. And both factors, when viewed in this way, create increased opportunities for entrepreneurs and innovative start-ups. However, this relationship requires at least two qualifications.

First, in a dynamic context with growing demand, this correlation holds only true whenever the growth of demand is higher than the growth of established companies. This relationship can be explained by the development of the number of companies in the German automobile industry, as shown in Figure 5.1. This development takes place in a context in which the demand for automobiles grows continuously from year to year. In years with an increasing number of companies, the incumbents grow less than demand; in years with a decreasing number of companies, demand growth is lower than incumbent growth. A major reason for strong growth of firms is returns to scale (i.e. static and especially dynamic returns to scale). The latter can be found in Klepper’s (1996) model that we presented previously, where dynamic returns to scale occur in process innovations. Seen this way, the exploitation of new opportunities, opened up by an increasing demand, can be inhibited by a too small scale of companies. Therefore, it will be incumbents rather than entrepreneurial entrants that take advantage of these opportunities.
Second, in addition to dynamic returns to scale on the supply side, demand-side dynamic returns to scale can break up the positive relation between demand-side growth and entrepreneurial entry. Dynamic returns to scale on the demand side, also called network effects, are based on the phenomenon that the utility a user or adopter of a technology can enjoy depends on the number of other users or adopters of this technology (see e.g. Arthur 1989). The development of an industry where such effects are at work shows a trend toward a reduction in the variety of alternative technological approaches that eventually may lead to a dominant technological design. Such a reduction, in turn, diminishes the economic opportunities for entrepreneurs and hence entry rates.

In view of these findings and relationships, also the demand side has ambiguous effects on innovative entrepreneurial entry into an industry. Higher demand potentially opens up more opportunities for entrepreneurs to enter an industry with an innovation. This may be counteracted by demand side–based network effects as well as with dynamic economies of scale on the supply side.

**Conclusion**

*Entrepreneurship and industrial organisation*

This chapter combines two strands of literature, entrepreneurship and industrial organisation, and it shows that both are inextricably intertwined. Entrepreneurial behaviour and entrepreneurship give impetus to economic change as put forward by the work of Joseph A. Schumpeter. It creates new industries and shapes their economic evolution. The structural approach found in the industrial organisation literature theorises about the consequential economic behaviour idiosyncratic industry structures induce, such as asking whether it is a monopoly structure that offers higher incentives to perform innovative activities than perfectly competitive markets. The Structure–Conduct–Performance approach provides mixed propositions. Arrow claimed that perfect markets have a higher incentive to innovate than monopolies. The literature on the New Industrial Economics sees oligopoly markets as main drivers of innovation.

Likewise, empirical evidence does not solve the puzzle satisfactorily, either. Whether large or small firms are the main innovators, as Schumpeter reasoned, there is no significant difference in R&D efforts according to firm size. It rather is industry-specific characteristics such as technology, knowledge, or absorptive capacity that entrepreneurs/firms need to be endowed with in order to explain industrial dynamics. Industry life cycle theory, taking up this dynamic perspective, vividly documents that entrepreneurial behaviour, entrepreneurship, innovation as much as technological, economic, and behavioural change are time- and context-dependent as well as reciprocal dynamic phenomena asking for an integral approach. This necessarily needs to include demand-side factors as these may on the one hand push entrepreneurship and show features that reduce entrepreneurial opportunities, on the other.

The theoretical approaches as well as the empirical studies addressed in this chapter underline the important role of entrepreneurship and entrepreneurs. They seek and seize new technological opportunities for innovative activities. As long as profits can be reaped, entrepreneurs will stay active; they do not stop activities before profit opportunities are exploited or entry barriers are too high. Then, entrepreneurial dynamics slow down. In the entrepreneurial ecosystem approach, this slowing down is seen as a shift of innovation activities from entrepreneurs towards intrapreneurs (as located in established firms). The story usually ends, here. However, economists should be able to say more about what comes after. Entrepreneurs not only exploit given opportunities but sometimes they are the ones that create new ones. This process is much less understood since
the pattern of radical change and radical innovation are not well understood. To look deeper into entrepreneurial behaviour that goes against the odds or the mainstream and to relate that to radical structural change and even the birth of new industries is an avenue to follow in future research. In our current situation with radical changes in many industries and technologies, with transformative tendencies and with the emergence of new actors on a broad scale, the object of analysis is clear: modelling and empiricism are awaiting to be pursued and aligned further.

Relevance for digital transformation

Referring back to the introduction, the literature-based discussion of the relation between entrepreneurship and industrial organisation earlier is meant to inform about potential developments in prominent new digital technologies and their respective industries and markets. Aspects of small versus big firms, followers versus leaders, appropriability conditions, the whole range of life cycle pattern and dynamics as well as demand-side factors are to be expected to play their role herein too, although not necessarily with equal importance. Especially the role of scale and network effects appear to be of far more and higher importance in digital technologies than in “traditional industries”. The combination of supply-side dynamic scale economies – mainly due to rather negligible marginal costs of additional users – and demand-side network externalities may be a reason for a faster decline of economic opportunities for additional and new entrepreneurs and their innovative ideas. Entry costs rise in a relatively short time and prevent even good, new ideas from falling on fertile ground.

In addition, digital technologies have functions such as easy matching of demand and supply and they operate in contexts that were not considered in industrial dynamics literature. Platforms, for instance, are such a new form of a market in virtual space which are particularly relevant for new, digital business models. On the one hand, platforms significantly strengthen the market performance of platform members, as both sides of the market reinforce each other’s attractiveness, due to easier accessibility and contractibility. For outsiders, such a constellation tends to reduce the economic opportunities. These, be they entrepreneurs or established companies, find it increasingly difficult to compete with an evolving platform and to innovate. Setting up a new, competitive platform instead will become less probable over time. On the other hand, a platform itself can be particularly attractive for entrepreneurs to become members and pursue innovation activities on it. Here the benefits of a platform arise from the fact that entrepreneurs can reach the demand faster and more efficiently. Research in this respect concerning industry patterns and dynamics is still pending.

References


