TI 2016-072/VII
Tinbergen Institute Discussion Paper


# The Schumpeterian Entrepreneur: A Review of the Empirical Evidence on the Antecedents, Behavior, and Consequences of Innovative Entrepreneurship

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# The Schumpeterian entrepreneur: A review of the empirical evidence on the antecedents, behavior, and consequences of innovative entrepreneurship

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**Published in *Industry and Innovation***

**http://dx.doi.org/10.1080/13662716.2016.1216397**

**Abstract**

Innovative entrepreneurship is considered an important pillar for economic development and has sparked a lively discussion in academia and practice alike. Oftentimes, however, the debate is not sufficiently grounded on solid empirical evidence. The academic literature is growing but very scattered and is separated into several disciplines. We provide a summary that takes stock of the academic knowledge about innovative entrepreneurship and summarizes the evidence from 102 empirical studies published in the primary economics and management journals on the antecedents, behavior, and consequences of innovative entrepreneurship. Based on this state-of-the-art literature review, directions for future research are discussed.

**Keywords**: innovative entrepreneurship, Schumpeter, literature review, economic development

**JEL Classification**: L26, L53, M13, O31, O33

**Acknowledgements**: We thank Tim van der Weert and Bernd Balle for excellent research assistance, Karl Wennberg as well as Christoph Grimpe for careful reviews of earlier versions, and Philipp Koellinger for pointing us to important papers on innovative entrepreneurship that were not brought up using our search criteria. We thank the Maersk Mc-Kinney Møller Chair and the Danish DEA Thinktank for their support.

## 1. Introduction

Entrepreneurship and the entrepreneur have been studied extensively in economics and management research in recent decades. In society, entrepreneurship has become an activity associated with high esteem, and entrepreneurs are praised for their contributions to society. For instance, one often reads or hears about entrepreneurs' impact on job creation, healthy competition, economic growth, promotion of an "inclusive" society by creating chances for people who have difficulties finding jobs and, last but not least, innovation.

These potential benefits to society have sparked not only academic, but also political interest in the matter, leading many players in the political arena to develop policies to promote entrepreneurship. Most governments in developed countries spend significant amounts of money to stimulate entrepreneurship (Shane, 2009; Acs et al., 2016). Policies to promote entrepreneurship typically address one of the following: Education to prepare people for an entrepreneurial career, access to finance, business transfer facilities, decreasing the fear of punishment for failure, or alleviating overly burdensome administrative processes. Moreover, many national and European efforts aim at increasing innovation and innovative entrepreneurship (European Commission, 2015).

Entrepreneurship's role as a defining influence in the development of these policy measures is viewed as unambiguously positive. But, how does the scholarly debate, based on empirical fact-finding, differ from the uncritical approach to entrepreneurship that circulates throughout policy circles? Empirical research on job gains (and losses) attributed to entrepreneurship has been seriously investigated since around 1980, when Birch (1979) found empirical support demonstrating that small firms have a disproportional contribution to net job creation (Birch, 1979; Birch, 1987; Davidsson et. al., 1998; Henrekson and Johansson, 2010; Neumark et al., 2011; Haltiwanger et al., 2013). Since then, research has focused on the effects of entrepreneurship on

innovation, economic growth, and welfare, in addition to its effect on job creation (Van Praag and Versloot, 2007). The heretofore unambiguously positive effects of small firms on job creation, however, have been recently called somewhat into question: research shows that it is mainly young firms, rather than small firms, that are responsible for job creation (Haltiwanger et al., 2013) and that the quality of jobs created is sometimes poor (Coad et al., 2014).

Determining the effects of entrepreneurship on macroeconomic outcomes is technically challenging. In reality, entrepreneurship may not only affect innovation, but innovation may, in turn, affect entrepreneurship outcomes and access to critical resources. Economic growth and entrepreneurship are also interrelated, as are innovation and economic outcomes. For example, Wennekers et al. (2005) find a positive correlation between entrepreneurial activity and innovative capacity in developed countries. This suggests that by increasing the level of entrepreneurial activity, developed countries can improve their ability to "produce a stream of commercially relevant innovations" (p. 297), or the other way around. Moreover, greater innovativeness can lead to higher productivity in a region through, for instance, process innovations and knowledge spillovers (Holtz-Eakin and Kao, 2003; Henderson and Weiler, 2009; Acs et al., 2009; 2013). Entrepreneurship's effect on economic growth is often indirect (Aghion and Howitt, 1992; Carree and Thurik, 2008) and the variables involved are not sufficiently understood or conclusively discovered. Many studies find a positive correlation between entrepreneurial activity and economic growth, whereas the complex causal relationship between entrepreneurship and economic growth is not sufficiently acknowledged (Wennekers and Thurik, 1999). Henderson and Weiler (2009) go so far as to summarize entrepreneurship as the "link between ideas and economic growth" (p. 24).

As a result of this uncertainty, researchers have started to acknowledge that establishing effects of entrepreneurship and innovation on each other and on (other) economic outcomes is not easy. Positive correlations are not necessarily evidence of a positive causal effect of entrepreneurship.

Moreover, a debate on how the role and importance of entrepreneurship for society depends on the *definition* of entrepreneurship has begun, and has received increasing research attention (Henrekson and Sanandaji, 2014; Acs et al., 2016). By and large, researchers are now realizing that the desired benefits from entrepreneurship are mostly generated by a small number of innovative, high-growth ventures, whereas the vast majority of new ventures only experiencing moderate growth in terms of employment and turnover, if they survive at all. Indeed, the share of high-growth enterprises represents only two to six percent of the enterprise population for most countries, with a particularly low share for most European countries (OECD, 2015). Most entrepreneurs don't employ personnel, are home-based, and earn low incomes (Shane, 2009).

Astonishingly, the correlation between a country's proportion of self-employed and GDP per capita is negative (Henrekson and Sanandaji, 2014). Only when employing stricter measures of (more successful) entrepreneurship, like incorporated entrepreneurs (Levine and Rubinstein, 2013), innovative and high growth entrepreneurs (Shane, 2009), or venture capital (VC) backed (e.g., Lerner, 1994) or even billionaire entrepreneurs (Henrekson and Sanandaji, 2014), does this negative correlation turn positive. Moreover, only after including these additional groups does the "occupation of entrepreneurship" become appealing to individuals in terms of its financial returns (Hamilton, 2000). For these reasons, and also based on a number of evaluation studies on the (non-)effectiveness of public policy to promote entrepreneurship (e.g., Baumgartner and Caliendo, 2008; Koesters, 2010; Koski and Pajarinen, 2013; Rannikko and Autio, 2016), the recent academic debate on public policy to promote entrepreneurship has become very critical, and almost cynical (Shane, 2009; Acs et al., 2016). Some of the most effective policy interventions do not even appear like entrepreneurship policy. Fairlie et al. (2011, 2016), for example, show that removing a distortion in the entrepreneurship decision (the coupling of health insurance with paid employment) can have sizable effects on entrepreneurship entry.

Evidence of what distinguishes the majority of new enterprises from those few innovative enterprises that create the aforementioned benefits for society is still scarce (van Praag and Versloot, 2007). Oftentimes, the benefits of entrepreneurship to society are linked to so-called 'Schumpeterian entrepreneurs' – referring to Schumpeter's early theory on 'creative destruction' (Schumpeter, 1934). In his understanding, vibrant economies are characterized by a constant birth and death of firms. This process is initiated by entrepreneurs who turn new ideas into marketable products and services (Acs et al., 2009; Henderson and Weiler, 2009; Block et al., 2013). These innovative entrepreneurs can be distinguished by their ability and willingness to search for and create new economic opportunities (Wennekers and Thurik, 1999). A clear understanding of this aspect of Schumpeterian entrepreneurship, including how innovative entrepreneurs can be spotted is missing. This appears to be the case, despite the fact that it is highly relevant to both policy and research.

Our study addresses this gap through a state-of-the-art literature review of empirical contributions published in the primary economics and management journals that cover topics linking entrepreneurship and innovation. We try to organize recent academic debates on the role of innovation in entrepreneurship, and vice versa, based on a carefully selected set of quantitative empirical analyses in the fields of economics and management. The research question addressed is: *what are the antecedents, behavior, strategy, outcomes, and consequences of innovative entrepreneurs or innovative entrepreneurship?*

Besides its academic value, our study might also be relevant for politics and entrepreneurship practice. From a political standpoint, a better understanding of the innovative high-growth entrepreneur – the "Schumpeterian entrepreneur" – can lead to more targeted efforts in promoting high-potential entrepreneurs, since "simply encouraging more people to become entrepreneurs is not necessarily the best policy for enhancing economic growth" (Shane, 2009; Arvanitis and

Stucki, 2012; Acs et. al., 2016). Much in the same way, it can be of value to practitioners such as VCs or business incubators in their efforts to scout, finance, and promote high-potential innovative start-ups.

In the following, we begin by discussing the conceptual model used to organize the literature review (Section 2). Section 3 discusses the data collection and the sample. Section 4 presents the core of the review. Section 5 provides conclusions and avenues for further research on innovative entrepreneurship.

## 2. Conceptual model of innovative entrepreneurship

In this section, we describe a simple conceptual model that we have developed to facilitate an understanding of innovative entrepreneurship and to organize our literature review. The model describes the antecedents, behavior, outcomes, and consequences of innovative entrepreneurship or innovative entrepreneurs. The model is a simple one and is not meant as a stand-alone contribution itself, but shall rather help the reader (and us) to categorize and organize the empirical studies that we discovered.

### 2.1 Antecedents of innovative entrepreneurship

Like all forms of entrepreneurship, innovative entrepreneurship originates from a nexus of individuals and opportunities (Shane, 2003). Innovative entrepreneurship is more likely to occur with some sources of opportunities than with others: opportunities that are knowledge-based, technology-, or research-driven are strong antecedents of innovative entrepreneurship (Acs et al., 2009). Innovative entrepreneurship is more likely to occur if entrepreneurs possess some socio-economic and personality characteristics such as academic education and technical background (Shane, 2000; Koellinger, 2008). Next to opportunities and the entrepreneur's individual

characteristics, the environmental context and the available or accessible resources from stakeholders, alliances, and networks also influence the gestation of innovative entrepreneurship (Eisenhardt and Schoonhoven, 1996; Elfring and Hulsink, 2003). Industrial clusters, for example, facilitate knowledge transfer and knowledge spillovers, which can lead to innovative entrepreneurship. Due to its exploratory character and the high level of novelty involved, innovative entrepreneurship may require large financial and highly specialized human resources. Restricted access to these resources can serve as a crucial barrier to innovative entrepreneurship.

### 2.2 Behavior and strategy of innovative entrepreneurs

Innovative entrepreneurs often operate in emerging markets or challenge existing firms in established markets. This makes them likely to show different types of (competitive) behavior or strategy than other entrepreneurs or other types of start-ups (Samuelsson and Davidsson, 2009). Moreover, to overcome liabilities of newness and compensate for a lack of complementary assets needed to successfully commercialize innovations, innovative entrepreneurs may decide to cooperate with incumbent firms (Gans et al., 2002; Gans and Stern, 2003) or seek to be acquired by incumbents (Henkel et al., 2015). The reverse is also true: incumbent firms, even when highly innovative, need to cooperate with or acquire innovative start-ups in order to survive in a dynamic marketplace (Dushnitsky and Lenox, 2005). Incumbent firms are often good at incremental and sustainable innovations, but face problems with radical or disruptive innovations or new business models (the "innovator's dilemma") (Henderson, 1993; Christensen, 1997). The cooperation between innovative start-ups and incumbent firms can be institutionalized in the form of corporate venture capital (CVC) or corporate acceleration programs.

### 2.3 Innovation outcomes and consequences of innovative entrepreneurship

Either alone or together with incumbent firms, innovative entrepreneurs achieve innovation outcomes such as inventions, patents, novel products, or new business models. These innovation outcomes can have substantial and various consequences at the individual, firm, industry, region, or even the country level. As noted in the introduction, innovative entrepreneurship can be a source of individual and regional wealth generation as well as societal progress (Schumpeter, 1942; Aghion and Howitt, 1992).

### 2.4 Feedback loop between innovation outcomes and the resources needed for innovative entrepreneurship

Start-ups that are successful in creating innovative products or processes may find it easier to attract the resources needed for innovative entrepreneurship. Patents, prototypes, or first innovative products are signals that help start-ups to overcome the information asymmetries that exist between them and resource providers such as venture capital firms (Hottenrott et al., 2016).

*- Please insert Figure 1 about here -*

## 3. Data and sample

To address our research question, we construct a sample of recent empirical and quantitative studies published in top economics or management journals that deal with the topic of innovation in the entrepreneurial process in general, and Schumpeterian entrepreneurship more specifically. The approach we use is similar to the approaches used in previous state-of-the-art literature review articles in the fields of entrepreneurship and innovation (e.g., Van Praag and Versloot, 2007; Dahlander and Gann, 2010).

Initially, we identify high-quality journals that (potentially) deal with the topic of Schumpeterian entrepreneurs in the fields of economics, entrepreneurship, management, and innovation. As a basis for the quality and topic classification of journals, we use the ERIM (*Erasmus Research Institute of Management*) Journals List (EJL) in the latest version of 2016 (ERIM, 2016). The EJL ranks the "best" journals in the field of management as either P* (highest category) or P (second highest category). We subsequently identify all journals potentially dealing with the topics of entrepreneurship and innovation in the population of P*/P journals. Because entrepreneurship and innovation are not only studied by management scholars, but also by economists, and as our research question involves an economic component, we add several top economic journals (American Economic Review, Economic Journal, Journal of Economic Behavior & Organization; Journal of Economics & Management Strategy; Journal of Political Economy, RAND Journal of Economics, The Review of Economics and Statistics, Quarterly Journal of Economics). Last but not least, we include the journal "Industry and Innovation" because of its fit due to its specialization on the intersection between entrepreneurship and innovation. The total list of journals considered for the literature review encompasses 26 journals (see Table 1). Books, book chapters, and working papers are not included in this literature review.

Upon compiling our list of 26 journals, we perform a keyword-based search using the journals' websites and various databases (e.g., EBSCOhost, Sciencedirect, SpringerLink). We keep the sample as unrestricted as possible and identify all articles that include a variant of the term "entrepreneur" and "innovation" in the study's title and/or abstract. In line with previous literature reviews, we intend to provide a review of state-of-the-art research (Van Praag and Versloot, 2007), so we restrict the sample to publications between 2000 and 2015. The broad search led to an initial sample of 395 studies (see Table 1). The journal with the highest contribution to the initial sample

is Research Policy (63 studies), followed by the Journal of Business Venturing (54 studies), and Small Business Economics (50 studies).

In the next step we remove entries from the initial sample that are of little use for our literature review. Comments, book reviews, conceptual and qualitative research articles that clearly lack a quantitative-empirical fundament are removed. This procedure reduces the sample to 176 studies (see Table 1) that we downloaded and read.

As expected, it turned out that the broad keyword-based search had identified various studies that deal with entrepreneurship and innovation to some extent (and mentioned both terms in the title and/or abstract), but do not relate to our research question at all (for example more than 20 studies on corporate entrepreneurship). We manually excluded these studies, based on the evaluation of three independent coders (mostly the authors themselves). If the coding activities had not resulted in a unanimous conclusion, a study was put up for discussion among the author group. The discussion usually led to the adoption of the majority view of the coders. The resulting sample consists of 82 studies. The journal contributing the highest number of studies to this sample is Small Business Economics (18 studies), followed by Research Policy (14 studies), and the Journal of Business Venturing (13 studies).

These three deductive stages of data collection for the literature review resulted in the definition of categories, subcategories, and a sample of studies in each category. However, our search, so far, could easily lead to an unjustified exclusion of studies by imposing that both "innovation" and "entrepreneur" are included in the title and/or abstract of a study. For instance, studies on inventor entrepreneurship might not include the word innovation but are likely to cover the topic. Therefore, we undertook three more steps to complete the sample. We used an inductive stage looking for relevant studies (in the selected journals and year issues) per category or sub-category. We also consulted existing literature reviews and meta analyses on topics related to our

research question (e.g., Djokovic and Souitaris, 2008; Rosenbusch et al., 2011; Agarwal and Shah, 2014). Finally, we asked experienced research scholars on innovative entrepreneurship to suggest further important empirical studies that we had missed using our search criteria. These three extra search steps identified an additional 20 empirical studies (see Table 2, which also shows the studies per category). Our final sample thus includes 102 empirical studies.

*–Please insert Table 1 and Table 2 about here–*

## 4. The core of the literature review

In this section, we describe and summarize the findings in the literature according to the categories introduced in Section 2 (see Figure 1 and Table 2). Subsection 4.1 discusses antecedents of innovative entrepreneurship and how start-up innovation output helps to obtain the resources needed for innovative entrepreneurship (the feedback loop described in Subsection 2.4), subsection 4.2 discusses research on the behavior and strategy of innovative entrepreneurs. Subsections 4.3 and 4.4 deal with the (direct) outcome and (indirect) consequences of innovative entrepreneurship, respectively. Each of the Subsections 4.2 to 4.4 ends with a brief conclusion about fruitful avenues of further research (framed in a box). In Subsection 4.1, these conclusions are provided directly after Subsections 4.1.1 to 4.1.4. Section 4.5 discusses the limitations of our literature review.

### 4.1 Antecedents of innovative entrepreneurship

Our conceptual model (Section 2) introduced various antecedents of innovative entrepreneurship put forth in the theoretical and empirical literature and that we use for organizing our discussion. The exploration and exploitation of opportunities help to shape innovative entrepreneurship. As such, this section starts with a discussion of the sources and areas where opportunities for

innovative entrepreneurship emerge. Moreover, the characteristics of the individual entrepreneur might shape innovative entrepreneurship, as may the entrepreneur's environment. These are discussed in Subsections 4.1.2 and 4.1.3, respectively. In the last category of antecedents we discuss innovation as a signal to obtain resources needed for innovative entrepreneurship (4.1.4). This section corresponds to the feedback loop between start-up innovation outcomes and the capability of a start-up to obtain the resources needed for innovative entrepreneurship (Section 2.4).

### 4.1.1 Sources and areas where opportunities for innovative entrepreneurship emerge

A key topic in the field of entrepreneurship is the question of where entrepreneurial opportunities come from and *who* identifies and exploits them (Shane and Venkataraman, 2000). The individual-opportunity nexus argument (Shane, 2003) suggests that individuals' knowledge and experience shape the process of opportunity identification and exploitation. Investigating the opportunities pursued by a sample of high-tech firms, De Jong and Marsili (2015) show that pure Schumpeterian type opportunities are rare, and that only a few young and small ventures exploit such opportunities. This finding is in line with our main argument presented in the introduction that only a minority of entrepreneurs can truly be called innovative.

In the following, we discuss the sources and areas where opportunities for innovative entrepreneurship are identified and exploited. In this regard, we focus on the role of inventors, innovative and demanding users, employees, and academics for innovative entrepreneurship. These are specific groups of individuals that have more frequent contact with knowledge- and research-based opportunities and are thus also more likely to engage in innovative entrepreneurship.

*Inventors:* "Inventor entrepreneurship" refers to individuals who develop new technologies or products independent of established companies and who start new companies to commercialize

these technologies or products (Markman et al., 2002). What characterizes this group? What types of inventors commercialize their developed technologies and products through start-ups? How do they differ from other inventors who commercialize via other means, such as selling their Intellectual Property Rights (IPR) to incumbent firms or by leaving it in the firm they work for as an employee?

Markman et al. (2002) show that higher levels of self-efficacy are associated with a higher probability of starting new businesses, vis-à-vis alternative channels of commercialization. Similarly, Astebro and Thompson (2011) find that a more diverse professional work history is positively correlated with business ownership for inventors. In other words, being a jack-of-all-trades (rather than a specialist) affects an inventor's entrepreneurial behavior.

*Innovative and demanding users:* Similar to inventors, *innovative and demanding users* are an important source of innovative ideas for firms (von Hippel, 1988; Autio et al., 2013; Agarwal and Shah, 2014). However, instead of providing their ideas and feedback to incumbents, users may become entrepreneurs themselves by producing and commercializing products or services that they originally created for their own use (Shah and Tripsas, 2007; Adams et al., 2013). This phenomenon of "user entrepreneurship" is a new topic of study. Adams et al. (2013) address the relevance of user entrepreneurship in the semiconductor industry and show that the magnitude of innovation (as measured via patents) by user firms is relatively high. Adams et al. (2013) also search for the distinguishing features of user firms, which turn out highly heterogeneous in terms of size and diversification, but actively engage in R&D collaboration and co-patenting. Also, their spin-offs survive longer than other companies' spin-offs. While the paper underlines the importance of user entrepreneurship in certain industries, this research stream is still relatively new

and several questions remain unanswered: For example, it is unclear whether user entrepreneurship is as relevant in other industries.

*Employees:* A third group of individuals that often engage in innovative entrepreneurship are former employees who quit their employer to establish a new start-up. This is a common phenomenon in specific industries, such as the semiconductor industry, where many companies can be traced back to one parent company (Klepper, 2001). A distinct characteristic of these employee spin-offs is that they are often closely related to the firms they originate from in terms of their innovative orientation (Klepper, 2001; Andersson et al., 2012). Particularly, knowledge inherited from the parent company is one of the most important characteristics and levers of competitive advantage that founders bring to their new start-ups (e.g., routines, resources, and customers). Since knowledge and R&D strategies are assumed to be closely related, Andersson et al. (2012) test how the incumbent's R&D strategies influence the probability of novel employee spin-offs and their quality (in terms of firm survival). Using a Swedish sample of matched employers-employee data covering 350,000 individuals in 2,200 incumbent and 3,000 start-up companies, their findings suggest that spin-offs from R&D intensive parent companies are less numerous (lower quantity), but survive longer (higher quality).

*Academics:* Papers on academic entrepreneurship investigate start-ups coming from universities or research institutes that are founded to exploit knowledge that was initially developed in academic institutions (Fini et al., 2011). Until recently, universities' main tasks were to provide education and perform (basic) research (Rosenberg and Nelson, 1994). In recent years, there has been a worldwide shift towards including a third activity: technology transfer from universities to industry (Etzkowitz and Leydesdorff, 2000). Spin-offs are an important vehicle for universities to engage

in technology transfer (Shane, 2004; Djokovic and Souitaris, 2008). Supported by various governmental initiatives (e.g., Shane, 2004; Fini et al., 2011), universities around the world have adapted their policies, leading to a stark increase in university technology transfer, particularly in the form of spin-offs, over the past 30 years (Astebro et al., 2013). University spin-offs are assumed to create jobs, contribute to a nation's or a region's economic and innovative development, and advance scientific knowledge (Walter et al., 2006; Djokovic and Souitaris, 2008; Fini et al., 2011). Studies in this group are rather heterogeneous. For example, using a sample of 149 university spin-offs, Walter et al. (2006) find that a spin-off's performance is positively associated with its network capability. Toole and Czarnitzki (2007) more closely analyze the role of a governmental subsidy program in fostering academic entrepreneurship in the US. The authors show that the subsidy program assessed was regularly used as a commercialization channel by academic scientists. Furthermore, the resulting firms performed significantly better than other firms in terms of subsequent venture capital funding and patenting. Using a sample of 187 biopharmaceutical firms started by 275 academic entrepreneurs in the US, Kolympiris et al. (2015) show that the location choice of academic entrepreneurs is influenced by both personal (e.g., age) and external factors (e.g., proximity to knowledge assets and VC firms). Investigating 478 academics who left Swedish universities to become full-time entrepreneurs, Astebro et al. (2013) show that the private returns of academic entrepreneurs are low: earnings do not dramatically change, while the income risk is three times higher in entrepreneurship. Focusing on how individual factors shape UK academics' decisions to found new companies, Clarysse et al. (2011) find that an academic's opportunity recognition capacity and his/her prior entrepreneurial experience are the most important predictors of academic entrepreneurship, and are more important than, for example, the academic's social environment or several organizational factors. Abreu and Grinevich (2013) also find that prior entrepreneurial experience is vital. They show that females are less likely to create spin-offs than

males, as are individuals with education in social sciences or humanities; conversely, individuals with education in biological or engineering sciences are more likely to create spin-offs.

Box 1: Conclusion of Section 4.1.1

We conclude that innovative entrepreneurship opportunities are particularly likely to be identified and exploited among inventors, (innovative and demanding) users, employees, and academics. Few studies have analyzed the determinants of the likelihood of entrepreneurship among individual agents within each of these groups of innovative actors. At this stage, this research is too preliminary to conclude whether the characteristics that distinguish entrepreneurs within these groups are different or similar to characteristics of entrepreneurs in general. Moreover, whether or not innovative entrepreneurs from these four "high opportunity" categories are more or less likely to be successful in creating private and social benefits is also a topic of study about which the results have not yet proven conclusive, at least not for all of the discussed categories.

### 4.1.2 Characteristics of the individual entrepreneur in innovative entrepreneurship

Entrepreneurship research posits that socio-demographic, occupational, and psychological characteristics of the entrepreneur influence the process of opportunity identification and exploitation (Shane and Venkataraman, 2000). This section deals with these characteristics. A fundamental question within entrepreneurship research is the distinction between imitative and innovative entrepreneurs and identification of the distinguishing characteristics of innovative entrepreneurs (Cliff et al., 2006; Dyer et al., 2008; Koellinger, 2008). Most studies in this section address this question and show that an entrepreneur's individual characteristics (e.g., experiences, beliefs, capabilities, and other socio-demographic characteristics) are important determinants of the innovativeness of an entrepreneurial endeavor.

Focusing on socio-demographics, De Tienne and Chandler (2007) study gender differences in innovation outcomes of entrepreneurial start-ups and find none. Mueller (2014) finds no differences regarding innovation performance between immigrant and native entrepreneurs based on a sample of entrepreneurs in Germany. Using a sample of more than 9,000 nascent entrepreneurs from the 2002–2004 adult population surveys of the Global Entrepreneurship Monitor, Koellinger (2008) shows that innovative entrepreneurs differ from other entrepreneurs by educational attainment, unemployment status, and self-confidence. Other studies focus on prior the entrepreneur's prior experiences (e.g., Cliff et al., 2006; Ucbasaran et al., 2009; Gruber et al., 2013; Simmons et al., 2014). For example, Ucbasaran et al. (2009) show that entrepreneurs with more prior business ownership experience identify and exploit more innovative opportunities with greater wealth creation potential, while business failure experience is not associated with the innovativeness of exploited opportunities. Gruber et al., (2013) use a sample of 496 technology ventures to show that more diverse founding teams with regard to industry experience and external knowledge sourcing relationships identify more varied market opportunities. The founders' technological expertise matters for the variety of opportunities identified, but not for the number of opportunities identified. Further studies focus on how the entrepreneur's network or networking abilities influence innovative outcomes (e.g., Ruef, 2002; Bahlmann, 2014; Schott and Sedaghat, 2014). Ruef (2002) shows that the ability of entrepreneurs to obtain non-redundant information from their social networks positively influences innovative outcomes. Similarly, Schott and Sedaghat (2014) show that networking benefits innovation, particularly networking in the public sphere. However, these studies don't take into account that entrepreneurs who are likely to invest in networking are also the ones who are likely to engage in innovative entrepreneurship, such that the network should not necessarily be the *cause* of the entrepreneur's innovativeness.

Using data from high-tech firms located in a large Chinese Science park, Liu et al. (2010) show that firms founded by returnee entrepreneurs (defined as scientists and engineers returning to their native country to start a venture) are more innovative than local SMEs. Using the same dataset, Filatotchev et al. (2011) show that returnee entrepreneurs positively influence firm level innovation in other high-tech, non-returnee firms located in the same cluster, and thereby establish a positive knowledge spillover effect.

Finally, few studies deal with the topic of founder imprinting, suggesting that the early choices entrepreneurs make can have long-lasting impacts on an organization. For example, Hsu and Lim (2014) show that organizational innovation outcomes are influenced by the founders' initial mode of knowledge brokering (i.e., the combination of knowledge exploration and exploitation) long after the founder has made these decisions. Block (2012) shows that founders have a strong influence on innovation even after an IPO. Using a panel data set of 154 technology firms listed on the US stock market, the author finds that firms where the founders have kept ownership have higher R&D intensity and R&D productivity compared to other firms.

Box 2: Conclusion of Section 4.1.2

| |
|---|
| We conclude that the search for individual characteristics associated with a higher likelihood of innovative (as opposed to imitative) entrepreneurship has taken off quite actively in recent years. The literature on this topic is comparable to the literature that searches for the determinants of successful entrepreneurship (in terms of business growth, profits, etc.). It would be interesting to compare the determinants of innovativeness with those of (other) measures of business success. More basically, the correlation between measures of business success in general and innovativeness in particular would be an interesting direction for future research and would bring together two separate strands of research. |

### 4.1.3 The environment of innovative entrepreneurship

The environment is a key determinant for both innovation and entrepreneurship. No wonder then, that it is studied as a potential influence on innovative entrepreneurship. We distinguish two categories: First, a topic of study in the literature has been the effect of *clusters* of firms and knowledge creators. How does the physical proximity of other firms or universities affect innovative entrepreneurship? What is the effect of the knowledge spillovers that often go together with these clusters on innovative entrepreneurship? Second, *innovation policies*, mostly at the country level, can be seen as an environmental determinant for individual innovative entrepreneurs.

(*Regional) Clusters and innovative entrepreneurship and knowledge spillover entrepreneurship*: The regional environment and regional clusters have an influence on the innovation activities of start-ups. Using a dataset of German regions, Audretsch et al. (2012b) show that regional competitiveness and university spillovers have a positive effect on start-up innovation. Distinguishing firm innovativeness across cluster types, Eisingerich et al. (2012) find that clusters characterized by start-ups differ strongly from clusters characterized by large, mature firms. University-industry collaboration only has a positive effect on firm innovativeness when occurring in clusters dominated by start-ups. Using data from 154 SMEs in the Valencia region of Spain, Molina-Morales and Martínez-Fernández (2009) find that the positive effect of social capital in clusters on innovation decreases beyond a certain point. Too much social capital can hinder innovation within clusters, due to so-called over-embeddedness (Uzzi, 1996), which describes when firms are locked into their current networks. This reduces openness and restricts firms' abilities to create new ties with outside firms, causing them to miss out on distant knowledge (i.e. outside their cluster) that is needed for innovation.

Another research stream investigates how regional innovation and regional entrepreneurship interact with each other. Using a sample of Spanish regions, González-Pernía et al. (2012) find that regional development is highest in innovative regions with high levels of entrepreneurship. Thus, on a regional level, entrepreneurship and innovation are complements that reinforce each other to strengthen regional competiveness. This finding is in line with the knowledge spillover theory of entrepreneurship (Acs et al., 2009, 2013), which argues that knowledge spillovers from innovative activities create entrepreneurial opportunities for start-ups. Start-ups are needed to exploit the opportunities arising from knowledge spillovers and serve as a driving force for turning knowledge and R&D into innovation and value creation (Michelacci, 2003). In a recent paper, Modrego et al. (2015) show that regional innovation output depends on both the stock of researchers and the number of new firms, thereby reconfirming the basic assumptions of the knowledge spillover theory of entrepreneurship. Using European country-level data, Block et al. (2013) estimate the moderation effect of entrepreneurship on the relationship between knowledge and innovation; they find that high rates of entrepreneurship increase the chances that knowledge turns into innovative products. In a slightly different way, Audretsch et al. (2008) use data from German regions to postulate a mediation effect of entrepreneurship on the relation between innovation and regional development.

Knowledge spillovers and arbitrage opportunities can also differ by industry. Anokhin and Wincent (2014), using a sample of 26 industries and defining arbitrage opportunity as "room for optimizing under a given means–ends framework", find that industries with high arbitrage opportunities are characterized by high entry rates. This positive effect, however, becomes weaker in industries with strong appropriability conditions, particularly industries where patents, secrecy, and lead time are effective tools to protect innovation rents and avoid (unintended) knowledge spillovers.

*Innovation policy and its effect on innovative entrepreneurship*: In the last decades, Western countries have spent increasing amounts of public resources on (innovation) policies to support entrepreneurship under the assumption that these policies have a positive effect on entrepreneurial activity (Stenholm et al., 2013). For example, Fritsch and Mueller (2007) show that the main factors explaining regional variation in business development are regional variation in innovation and an entrepreneurial climate. Various studies have empirically tested whether these government programs to stimulate innovative entrepreneurship are effective.

Cumming (2007) studies the impact of innovation policies more directly. He analyzes the effect and the performance of the Australian Innovation Investment Fund program. From his sample of 280 Australian venture capital and private equity funds and their investments in 845 entrepreneurial firms, he concludes that this policy fosters the financing and development of start-ups. Cumming and Fischer (2012) study the effect of a Canadian governmental program to provide business advisory services and coaching to early stage firms that are growth and innovation oriented. They use various econometric methods to address the self-selection of start-ups that use the provided services. The findings indicate that the (number of hours of) advisory services have a positive impact on the sales growth and likelihood of (angel) financing, but the evidence is ambiguous for innovation outcomes (applying for or obtaining a patent), and the formation of alliances. Elston and Audretsch (2011) collect data from 182 surveys and two economics-based field experiments to examine the role of personal capital in the entry decision for US high-technology entrepreneurs. They conclude that such start-ups are dependent on access to capital in both the initial and early stages of development: governmental funding is shown to increase the number of potential and nascent high-technology entrepreneurs. Kim et al. (2012) investigate the effect of the triple helix system and habitat factors on the birth and death rates of U.S. firms at the

state level; they conclude that government R&D will generate a synergistic effect that indirectly influences regional firm birth rates. Woolley and Rottner (2008) support this concept in their study on the effect of the emergence of nanotechnology policy initiatives and related firm formation in the United States. Their findings suggest that regions that are most attractive to entrepreneurs not only stimulate innovation and provide resources, but also encourage and legitimize commercial development.

Box 3: Conclusion of Section 4.1.3

Research clearly shows a strong interaction between entrepreneurship, innovation, and growth. Regional environments and clusters have an influence on the innovation activities of start-ups. University-industry collaboration has a positive effect on firm innovativeness in clusters, particularly for those clusters dominated by start-ups. Various studies show that regional development benefits from both entrepreneurship and innovation: they fulfill complementary roles. Evidence supports the knowledge spillover theory of entrepreneurship: knowledge spillovers from innovative activities create entrepreneurial opportunities. In turn, start-ups are needed to exploit these opportunities that arise from knowledge spillovers; furthermore, start-ups are a driving force for turning knowledge into innovation and value creation.

The ways in which policy makers can help create stronger "knowledge triangles" to stimulate entrepreneurship, innovation, and economic development are not so evident. Research into this requires sophisticated impact evaluations. These evaluations need to be carried out for many programs, and often require that programs be setup in ways that enable the use of field experiments to evaluate their impact. So far, studies in this category suggest that innovation policies may affect entrepreneurship, but that policies stimulating innovation are more difficult to design in effective ways. However, because this conclusion is based on only a few studies, some of which don't even allow for causal conclusions, is rather speculative. More research is certainly needed in this important domain, particularly as it is highly policy-relevant. The effect of taxes and entry regulations on innovative entrepreneurship is another important area for future research. So far, we only know about the effects on entrepreneurship, per se. No distinction is made between innovative and non-innovative entrepreneurship.

### 4.1.4 Innovation as a signal to obtain resources needed for innovative entrepreneurship

Innovative entrepreneurship is often demanding and sometimes requires very specialized and rare resources to take off and to be successful. This category includes studies that deal with the role of start-up innovation for obtaining resources needed for innovative entrepreneurship, particularly

how innovation is used as a signal to obtain financial and human resources[1] (the feedback loop described in Section 2.4).

*Start-up innovation and access to financial resources*: Innovative start-ups can use their innovation output and their innovative capabilities as a signal to attract resources from VC firms, business angels, and other providers of start-up finance. In particular, patents and other IP rights are a valuable resource in this regard. Various papers show that patents, prototypes, trademarks, and combinations thereof increase the likelihood and amount of VC funding (Lerner, 1994; Baum and Silverman, 2004; Mann and Sager, 2007; Audretsch et al., 2012a; Conti et al., 2013; Hsu and Ziedonis, 2013; Block et al., 2014; Haeussler et al., 2014). Using a sample of 535 financing rounds of 173 VC-financed biotechnology firms, Lerner (1994) shows that the breadth of patent protection positively affects firm valuation. Based on data from British and German VC-backed biotechnology firms, Haeussler et al. (2014) find that VCs not only value the patent application per se, they also consider the entire patent examination process. Citations and opposition procedures have an information value that influences the likelihood of VC financing. The study from Audretsch et al. (2012a) goes in a similar direction. Using data of more than 900 new ventures in the US, they demonstrate that VCs and business angels only provide equity financing if prototypes are also available next to patent applications. Thus, the value of a patent application as an appropriability signal is higher when coupled with a signal of feasibility. In addition to patents, trademarks are important to innovative startups (e.g., Block et al., 2015). For example, Block et al. (2014) investigate the VC valuations of 2,341 VC financed early-stage start-ups in 4,816 funding

[1] Importantly, this review only includes studies that deal with innovation-related aspects as an instrument of obtaining resources. Summarizing all studies that deal with any of the various criteria needed for innovative start-ups to obtain resources such as team, product, business model, or industry characteristics is beyond the scope of this paper.

rounds. They find that those start-ups with a higher number of trademarks and broader trademarks receive higher VC valuations. Thus, innovation capabilities have to be seen in combination with marketing capabilities when innovative firms seek to attract financial resources from VC providers.

Conti et al. (2013) use a sample of technology incubator start-ups to empirically examine the use of patents and founder, friends, and family (FFF) as signals for venture capital and business angel investment. The authors find that venture capitalists see patents as a quality signal: Patents are valued more highly than FFF money, while business angels value FFF money higher than patents. Additionally, the effect of patents on venture capitalists is larger than the effect of FFF money on business angels. Assessing the financing activities of 370 venture-backed semiconductor start-ups, Hsu and Ziedonis (2013) also show that patents lead to improved access and terms of trade on the market for entrepreneurial financing.

A recent study by Parhankangas and Ehrlich (2014) shows that stressing innovation too much can be counterproductive. Using a sample of 595 young firms seeking funding from business angels, they find an inverted U-shaped relationship between the degree to which innovation is stressed in an investment proposal and the likelihood that a business angel invites the firm to give a presentation and that it provides financing. Innovation means risk and uncertainty and stressing innovation too much makes the investment proposal look overly risky and incalculable from the perspective of a financial capital provider.

The relationship between VC and start-up innovation, however, also works in the other direction. VC is not only attracted by innovation, but also spurs start-up innovation. Using industry-level data and exploiting a 1979 policy shift that spurred VC fundraising in the US, Kortum and Lerner (2000) find that increases in venture capital activity in an industry are associated with significantly higher patenting rates. At the firm level, various empirical studies show that VC providers not only select innovative firms but also push these firms towards innovation and

commercialization of their products (Colombo and Grilli, 2010; Samila and Sorenson, 2010). Bertoni et al. (2011) explicitly disentangle this selection and treatment effect of VC financing on start-up innovation. Using a 10-year longitudinal data set of 538 Italian new technology ventures and controlling for the endogeneity of VC investments, they find that VC investments positively influence firm growth, particularly employment growth.

Closely related, Elston and Audretsch (2010) investigate the role of risk attitudes and wealth on financing choices for entrepreneurs and show that both wealth and risk attitudes may play an important role in the financing choice of entrepreneurs. In particular, the authors show that lower levels of wealth increase the probability of grants and also reduce the probability of using loan financing. Furthermore, their results show that higher levels of risk aversion, but not higher levels of wealth, increase the probability of financing start-ups with earnings from a second (part-time) wage job.

*Start-up innovation and access to human resources:* Innovative start-ups need motivated and highly competent employees. However, as their products and business models are uncertain and failure is likely, they often find it difficult to attract the right talents. Using a sample of German start-ups, Backes-Gellner and Werner (2007) find that innovative start-ups who use signaling via the founder's (university) education degree increase their chances to find qualified personnel.

Box 4: Conclusion of Section 4.1.4

We can draw unambiguous conclusions about the relationship between venture capital (VC) and innovation. Innovative outputs, such as patents, prototypes, and trademarks, are valuable signals to (VC) investors and have positive effects on the firm's valuation. VC's do not only select innovative firms, they also spur the innovative behavior of the firms they finance. Thus, there is a two-way interaction between innovation and VC. Future research might inform us better about which types of innovation are most valued and what exactly the positive effect of VC financing on innovative entrepreneurship entails. Is it just the money that is important, or is it also the guidance that VC's offer through the active (non executive) board role they often play in VC backed start-ups? Future research could also focus more on later stage start-ups and the relationship between innovation and VC financing. So far, most studies investigate early-stage start-ups. Finally, there is limited evidence of human capital's positive role as a signal for innovative start-ups to increase the likelihood of being able to employ qualified personnel.

### 4.2 Behavior and strategy of innovative entrepreneurs

In this subsection, we first summarize research into firm and entrepreneur characteristics that are associated with the behavior and strategy of innovative start-ups. We are particularly interested in firm characteristics that are determined by the entrepreneur's choices and behavior, such as organizational form. We then summarize research into innovative entrepreneurs' exit behavior its consequences. Finally, under the header 'corporate venture capital', we discuss research on this particular form of cooperation between start-ups and incumbents.

*Innovation behavior of start-ups:* The various studies on the innovation behavior of start-ups are similar in terms of their research approaches, while differing mostly in their scope. Most studies investigate the determinants of innovation and the sharing or using of innovative capabilities, either at the industry or the firm level. The importance of firm characteristics for innovation is one of the

key results from these studies: firm size, location, organizational form and an entrepreneurial attitude are associated with a firm's innovativeness (Sundbo et al., 2007; Robson et al, 2009). Knowledge management is also associated with innovative behavior (Sundbo et al., 2007; Palacios, 2009). At the individual level, business ownership experience is associated with a higher likelihood of innovative behavior, as is portfolio entrepreneurship (Robson et al., 2012). Other individual characteristics, such as the education level of the entrepreneur, are also positively related to the extent of innovation (Robson et al., 2009). Robson et al. (2012) thus argue that when developing policies to stimulate innovative behavior amongst start-up entrepreneurs, it is important to get assistance from more experienced or portfolio entrepreneurs.

Samuelsson and Davidsson (2009) focus on investigating differences in the venture creation process for innovative versus imitative ventures. Studying new venture creation is important because of high level decisions made at the time of founding that influence the ventures' actions and success long into the future. Overall, the authors find that the venture creation process differs between innovative and imitative ventures. For example, because innovative ventures are associated with greater uncertainty, more gestation behaviors are undertaken. Also, general human capital, as indicated by education level, as well as specific human capital, as represented by previous venture creation experience, are relatively more important for making progress with innovative venture ideas. Moreover, building social capital is important for making progress with both types of ventures.

Kotha et al. (2011) use data from 128 biotechnology firms to analyze the innovation output of young and old technology firms after branching into a new technological niche. They find that older firms show a higher quantity of innovation output (measured by the number of patent applications), whereas younger firms produce innovations of higher impact (measured by the number of forward citations). This finding is in line with Henderson (1993), who utilizes data from

the photolithographic alignment equipment industry to show that established firms invest more than entrants in incremental innovation, and are less productive than entrants with their research efforts when seeking to exploit radical innovation.

Link and Ruhm (2011) investigate the tendency of innovative start-ups to reveal their knowledge in the form of publications or by filing patents. They find that the background of the entrepreneur plays an important role. Entrepreneurs with an academic background are more likely to publish their intellectual capital in the form of a publication, whereas entrepreneurs with a business background are more likely to patent their intellectual capital. Simcoe et al. (2009) investigate the IP strategies of firms that participate in standard setting organizations (SSOs). Their results show that small entrepreneurs litigate their IP more than large incumbents after it has been incorporated into a standard. Thus, the authors show that that small entrepreneurs and large incumbents have different IP strategies.

Marcati et al. (2008) relate an entrepreneur's intention to adopt innovations (in small and medium sized enterprises) to the entrepreneur's innovative attitude. In turn, the entrepreneur's innovative attitude is related to the personality characteristics measured by the validated "Big Five" (the five factor model of personality). They conclude that an entrepreneur's innovativeness is significantly related to their basic personality traits, and further, that entrepreneurs with a more innovative attitude pursue more innovations within their companies.

*Exit behavior of innovative ventures and its consequences:* Innovative ventures show different growth and exit paths than other ventures. Exit by trade sale, M&A, and IPO are important exit options for innovative new ventures (Giot and Schwienbacher, 2007; Wennberg et al., 2010; Arora and Nandkumar, 2011; Henkel et al., 2015). The founder(s) plays an important role in the exit decision and strategy. DeTienne et al. (2015) distinguish between three modes of exit for the

entrepreneur: financial harvest (IPO or acquisition), stewardship (family succession, employee buyout, and sale to an individual), and voluntary cessation (liquidation and discontinuance). Using a cross-sectional dataset of 189 firms, they show that the perceived innovativeness of the entrepreneurial opportunity increases the likelihood of financial harvest and decreases the likelihood of voluntary cessation. Using a large sample of Dutch manufacturing firms, Cefis and Marsili (2011) show that innovative new ventures in low-tech industries have a low probability of exit by closure. This effect was not found in high-tech industries. Thus, being an innovator seems to be a sufficient condition for survival in low-tech industries, while it is a necessary but not sufficient condition in innovative industries. With regard to exiting by M&A, Cefis and Marsili (2011) find that young innovative firms in particular are preferred targets for acquisition, and the odds of exiting by M&A are significantly higher than in other firms.

Sarkar et al. (2006) use a sample of more than 3,000 firms in 33 industries over 80 years to investigate how the *innovative environment* influences firm survival. They find that entrants have higher chances of survival in an environment characterized by a high number of product innovations and innovation opportunities. This beneficial effect of the innovative environment is found to be even higher for small versus large entrants. Thus, the innovative environment seems to mitigate scale disadvantages for small entrants.

Aggarwal and Hsu (2014) approach the same question from the opposite angle. They investigate the effect of entrepreneurial exit on innovation. Using a panel data set of VC-backed biotechnology firms, they find that innovation quality (measure by patent counts and forward patent citations) is highest with private ownership and lowest with an exit by IPO. Exit by acquisition is intermediate between the other two exit options. The authors explain their result through information confidentiality, which is highest with private ownership and lowest with public ownership. Similarly, Hoetker and Agarwal (2007) investigate whether there is an ongoing

diffusion of knowledge even after a firm exits an industry. Focusing on firm exits from the disk drive industry, the authors find that exit impairs the ability of other firms to draw on the knowledge generated by the exiting firm. However, this effect diminishes over time and does not prevent all future uses of a firm's technology. Thus, firms that exit an industry provide spillover benefits to others.

*Corporate venture capital:* Incumbents or large firms use corporate venture capital as an external innovation strategy to learn and benefit from the innovation output of start-ups (Sykes, 1990). Using a 20-year panel of public firms, Dushnitsky and Lenox (2005) show that large firms' corporate venture capital investments increase subsequent patenting output, both in terms of quantity and quality. However, they also show that this positive effect of corporate venture capital is weaker in industries with weak intellectual property regimes. Moreover, they find that the contribution from investments in corporate venture capital to patenting depends on the firm's own knowledge investments. Firms with low absorptive capacity benefit less from corporate venture capital investments than firms with high absorptive capacity. Using panel data from the telecommunications industry, Wadhwa and Kotha (2006) investigate the role of active involvement by corporate venture capital investors in the knowledge creation process. Knowledge creation is measured by subsequent patent applications by firms investing in corporate venture capital. Wadhwa and Kotha (2006) show subtle relationships between the number of corporate venture capital investments and the rate of knowledge creation as being dependent on investor involvement. Da Gbadji et al. (2015) investigate the regional environment's role in the decision of large firms to run a corporate venture capital program. Using cross-sectional data from Fortune 500 companies, they find that firms are more likely to run a corporate venture capital program in a regional environment where the market for early-stage investment is well developed and innovation-related

resources are available. Costly bankruptcy regulations, in turn, constitute a barrier and decrease the likelihood of corporate venture capital investments by large firms.

Box 5: Conclusion of Section 4.2

To conclude this subsection, firm characteristics that are importantly determined by the entrepreneur's choices and behavior, such as firm size, organizational form, entrepreneurial attitude, and knowledge management are associated with a firm's innovativeness. At the individual level, business ownership experience is associated with a higher likelihood of innovative behavior, as is portfolio entrepreneurship. Personality characteristics of the entrepreneur explain their innovative attitude and endeavor. It is therefore argued that it is important to get assistance from more experienced or portfolio entrepreneurs when developing policies to stimulate innovative behavior amongst start-up entrepreneurs, so as to guide their strategic and behavioral choices.

Innovative ventures show different growth and exit paths than other ventures. Exit by trade sale, M&A, and IPO are important exit options for innovative new ventures. The founder plays an important role in the exit decision and strategy. Not only does a firm's individual innovativeness affect its survival and exit routes, but the *innovative environment* also (positively) influences firm survival, especially for small firms. Research has also discussed the opposite relationship: entrepreneurial exit decisions affect innovation. Finally, corporate venture capital from incumbent firms can be an important boost to a start-up's innovation behavior, and is dependent, among other things, on the start-up's own knowledge investments and absorptive capacity. Surprisingly, we did not find papers on other forms of cooperation between start-ups and incumbent firms (joint ventures, alliances, etc.), which is clearly a fruitful area for further research.

### 4.3 Innovation outcomes

In this subsection, we discuss the innovation output of start-ups, first at the micro- and then at the macro-level.

*Innovation output of start-ups:* Many studies have analyzed the innovation output of entrepreneurial firms and its antecedents. The studies in this category are pretty heterogeneous. One literature stream compares the innovation output of start-ups and small and young firms with the innovation output of incumbents and large firms. This literature has a long tradition in economics, dating back to Schumpeter and the discussion of whether innovation comes from young and small ("Schumpeter Mark I", Schumpeter, 1934), or large and established firms (Schumpeter Mark II, Schumpeter, 1942). Gittelman (2006) uses patent data from the US and French biotechnology industry and finds that patents from young and entrepreneurial firms receive more citations than patents from large, established firms. Lee and Chen (2009) conduct an event study on the stock market reaction following hundreds of new product announcements and show that the effect is more positive for smaller firms. This suggests that investors believe new product announcements from smaller firms are more likely to result in breakthrough products. Similarly, Dunlap-Hinkler et al. (2010) focus on the relationship between firm size and age and the development and exploration of breakthrough innovations. They find no effect of age and a positive effect of firm size, contrary to the previous empirical support for the notion that smaller and younger firms tend to be more innovative than larger firms, for example, because smaller firms have less inertia and are less rigid, and because they don't typically have breakthrough-hampering organizational routines. Related to this, Heirman and Clarysse (2007) analyze the launch of a research-based start-up's first product, an important event in a company's lifecycle. Their results show that different starting conditions have a huge impact on innovation speed. For example,

higher team tenure and greater founders' experience leads to faster product launch, while a higher amount of initial financing and alliances with other firms do not significantly affect innovation speed. Finally, Vaona and Pianta (2008) identify systematic strategic differences between SME's and large firms in the effective introduction of new products. For example, while small firms often use patents that then lead to new products, large firms more heavily rely on acquisitions and market expansion strategies.

Another literature stream within this category demonstrates the importance of *networks* for innovation in entrepreneurial firms (e.g., Tan et al., 2013; Cox Pahnke et al., 2015). This idea is based on the argument that networks and other business relationships enable entrepreneurial firms to overcome resource constraints and the corresponding liabilities of newness and smallness (Cox Pahnke et al., 2015). For example, Sullivan and Marvel (2011) examine how an entrepreneur's acquisition of different types of knowledge and reliance on their network for knowledge relate to innovativeness; they show that the acquisition of technology knowledge positively influences innovativeness. This effect is further enhanced when relying on the entrepreneur's network. Closely related, there is literature focusing on the role of *external financing* for innovativeness (e.g., Cox Pahnke et al., 2015; Collewaert and Sapienza, 2016). External financing, such as VC or business angel financing, is a particularly relevant ingredient for innovation and innovativeness (e.g., Cefis and Marsili, 2005) - see also Section 4.1.4 above.

A third literature stream assesses how *characteristics of the entrepreneur* behind the venture impact innovation outcomes (e.g., Chatterji, 2009; Gumusluoglu and Ilsev, 2009; Kang et al., 2015). This is important because prior research has shown that small firms rely mainly on their CEO's knowledge to innovate. For example, it has been suggested that leadership is among the most important factors affecting innovation (Cummings and O'Connell, 1978). This might be due to leaders' effects on organizational characteristics such as culture, strategy, structure, reward

systems, or resources (Woodman et al., 1993), or through a direct effect of their behavior on employees' creativity (Oldham and Cummings, 1996). For entrepreneurial firms, it has been shown that transformational leadership positively influences organizational innovation (Gumusluoglu and Ilsev, 2009). Caliendo et al. (2015) compare German unemployed individuals who were offered a subsidy to become self-employed (which is a widespread active labor market policy strategy) to regular business founders. Using a survey-based dataset of more than 4,500 start-ups and focusing on a time frame of 19 months after founding, they show that while the subsidized businesses have higher survival rates, they lag behind regular entrepreneurs in terms of income, business growth, and implemented innovations. Neubert et al. (in press) assess the impact of informal institutions (e.g., norms, values, and beliefs) for microcredit entrepreneurs in subsistence economies (e.g., Kenya and Indonesia); they demonstrate the influence of informal institutions on individuals' ability to recognize opportunities and their propensity to innovate. Another important individual attribute is creativity (e.g., Ahlin et al., 2014; Sarooghi et al., 2015). In a meta-analysis on the effect of creativity on innovation outcomes, Sarooghi et al. (2015) find a strong positive relationship between creativity and innovation. Furthermore, the authors find that this effect is stronger for large firms, process innovations, and low-tech industries relative to small firms, product innovations, and high-tech industries. Related to this literature, other entrepreneur characteristics are analyzed with regard to their impact on innovations. For example, Weterings and Koster (2007) show that a founder's experiences, the relationship with a founder's previous employer, and spatial proximity to the previous workplace all affect the innovative performance of small software firms in the Netherlands. Andries and Czarnitzki (2014) show that not only CEO's and managers', but also *non-managerial employees'* ideas contribute to innovation performance. Baron et al. (2011) investigate a sample of 157 US entrepreneurs and show that an entrepreneur's dispositional

characteristics (i.e., interest, excitement, enthusiasm) can positively affect firm performance in terms of product innovations, up to a certain point.

*The effects of entrepreneurship on innovation at the macro level:* Next to studies that investigate the innovation output of individual firms, an established literature investigates the effects of entrepreneurship on innovation at the industry, regional, or country level. One of the first empirical studies on this issue is from Acs and Audretsch (1988), who find that innovation is lower in highly concentrated and unionized industries dominated by large firms compared to industries dominated by small and young firms. They also find that the industry-level determinants of innovation, such as R&D and the availability of skilled labor, are different for industries dominated by large versus small firms. This finding is in line with an evolutionary view of industries (Nelson and Winter, 1982; Klepper, 1996), which argues that industries follow a life-cycle: In the early phases of an industry, where uncertainty is high and entry barriers are low, young and small firms are the major innovators, whereas in later phases of an industry, when technology matures and industry dynamics slow down, large and established firms become the most important innovative players. Dolfsma and Van der Panne (2008) as well as Dolfsma and Van der Velde (2014) find support for the findings of Acs and Audretsch (1988). Using new product announcements as a measure of innovation, Dolfsma and Van der Velde (2014) find that industries dominated by small and young firms are more innovative than industries dominated by large firms, supporting Schumpeter Mark I. However, when accounting for industry competition levels, the positive effect of the share of young firms on industry innovation disappears, only the innovation-enhancing effect relating to the share of small firms survives. The authors conclude that small firms are not like young firms, and that only the former show a positive relationship with industry-level innovation. Generally, the discussion of whether Schumpeter Mark I (innovation comes from young and small firms) or

Schumpeter Mark II (innovation comes from established and large firms) is true suffers from endogeneity concerns regarding the relationship between firm size, market concentration, and innovation (Pohlmeier, 1992). It is also important to control for appropriability conditions and regimes (Teece, 1986), which is often not consistently done in all empirical studies on this issue.

Another literature stream deals with the effect of an entrepreneurial culture on country or regional innovation. Beugelsdijk (2007) finds a positive relationship between regional entrepreneurial culture and regional innovativeness, using data from the European Values Survey (EVS) (54 European regions). In a subsequent step, the author finds that regional innovativeness mediates the effect of regional entrepreneurial culture on regional growth. Thus, regional innovation is the channel through which regional entrepreneurship affects regional growth, stressing the importance of innovative entrepreneurship for regional development.

Box 6: Conclusion of Section 4.3

Various streams of literature feed the collection of micro-level studies. The first, having a tradition in economics and going back to Schumpeter, compares the innovation output of start-ups and small and young firms with the innovation output of incumbents and large firms: the first group produces more high quality or breakthrough innovations whereas the latter group scores more highly on quantity, while the speed of innovation is determined by starting conditions (team tenure and experience, for instance). The second stream of research demonstrates the importance of *networks* for innovation in entrepreneurial firms and the importance of various sorts of *external financing* (such as VC or business angel financing) for innovativeness. A third literature stream assesses how *characteristics of the entrepreneur* or CEO impact innovation outcomes. For example, leadership styles affect innovation outcomes, as do informal institutions in firms (e.g., norms, values, and beliefs) and creativity, especially in large firms when it comes to process innovations and in low-tech industries. Moreover, a founder's experiences, the relationship with the founder's previous employer, and spatial proximity to the previous workplace, in addition to *non-managerial employees'* ideas, all affect a firm's innovative performance.

At the macro-level, various regional factors are found to affect innovation output, which is lower in highly concentrated and unionized industries that are dominated by large firms. Moreover, in the early phases of an industry, where uncertainty is high and entry barriers are low, young and small firms are the major innovators, whereas in the later phases, large and established firms become the most important innovation players. Generally, the discussion of whether Schumpeter Mark I or Schumpeter Mark II is true suffers from endogeneity concerns regarding the relationship between firm size, market concentration, and innovation, as well as a lack of control for appropriability conditions and regimes. Another literature stream deals with the effect of entrepreneurial culture on country or regional innovation. Regional innovation is the channel through which regional entrepreneurship has an effect on regional growth, stressing the importance of innovative entrepreneurship for regional development. Future research in this area could investigate the effects of innovative entrepreneurship on other macro-level outcomes such as business cycles, productivity measures, or export share. Koellinger and Thurik (2012) provide a promising start in this direction by investigating the relationship between entrepreneurship and business cycles. So far, most studies use either innovation outcomes or growth measures as dependent variables.

### 4.4 Consequences of innovation

In this last subsection of the core of our review, we discuss papers that analyze how innovation influences the performance of start-ups.

*The effects of innovation on start-up performance:* Papers in this category analyze how innovation influences start-up performance. Rosenbusch et al. (2011) conduct a meta-analysis on the relationship between innovation and performance in SMEs. Summarizing the results of 42 empirical primary studies on 21,270 firms, they find that innovation has a positive association with performance for SMEs and that its strength is positively influenced by a number of factors: an overall innovation orientation rather than a focus on creating innovation process outcomes (e.g., patents, innovative products, or services); younger firms rather than more established firms; and a tendency to develop internal innovation projects, which provide more benefits than projects undertaken in collaboration with external partners. Finally, regarding country environment, it is found that innovation has the strongest association with SME performance in collectivistic, Asian cultures.

Multiple studies investigate the effect of innovation on firm survival (e.g., Boyer and Blazy, 2014; Tsvetkova et al., 2014; Howell, 2015; Hyylinen et al., 2015), which has also been briefly discussed in the subsection on innovation and firm exit. On the one hand, it is argued that innovativeness fosters survival-enhancing attributes (e.g., market power and cost efficiency) and capabilities (e.g., absorptive capacity). On the other hand, an innovative start-up faces (and bears the associated risks of) liabilities of newness and smallness that exceed those of its non-innovative counterparts. The prevailing view in the empirical literature appears to be that there is a positive association between firms' innovativeness and their subsequent survival (Audretsch, 1995;

Arrighetti and Vivarelli, 1999; Helmers and Rogers, 2010; Wagner and Cockburn, 2010). Nevertheless, there is emerging empirical evidence suggesting that these results may be context-dependent, and may not necessarily be applicable to younger firms (Boyer and Blazy, 2014; Hyytinen et al., 2015). Thus, this issue remains an open question.

Conducting a survey of 201 small business owners in Kenya who participated in a microcredit program, Bradley et al. (2012) find that innovation is an important moderating variable for the effect of social, business, and individual capital on firm performance. For example, the authors show that human capital (e.g., business expertise) leads to higher firm performance than different forms of financial or social capital in the presence of innovation. Furthermore, the authors distinguish between differentiation-related innovation (i.e., newness in relation to competition) and novelty-related innovation (i.e., newness in relation to customer's needs) and find that differentiation-related innovations improve firm performance to a larger extent.

Box 7: Conclusion of Section 4.4

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|---|
| To conclude, research in this domain deals with the effects of innovation on start-up performance. Overall, innovation is found to have a positive effect on business performance, as demonstrated in various studies. Another indicator of performance that is frequently investigated is firm survival, which is also found to be positively affected by firms' innovativeness. Future research in this domain could focus not only on performance as an outcome variable but focus on other outcomes such as the number and quality of jobs created. |

### 4.5 Limitations of the literature review

Our literature review on innovative entrepreneurship is not without limitations. Various criteria of our selection procedure can be criticized. However, it was necessary to introduce these restrictions in order to handle the multitude of papers and to present them in a coherent framework. For example, the list of journals considered focuses primarily on top journals in both management and economics. Important, second-tier field journals such as Technovation, R&D Management, Journal of Technology Transfer, Economics of Innovation and New Technology were not considered. Other restrictions include our initial focus on papers published between 2000 and 2015, and that we do not consider working papers. The latter restriction can be seen as a quality criterion. The former restriction, however, might have led us to overlook important contributions that appeared before the year 2000. This argument is valid, but somewhat reduced in impact, as the second phase of our literature search includes additional studies that were mentioned to us during conversations with experienced scholars in the field of innovative entrepreneurship. Another restriction in our initial search process is that we only include articles with variants of "innovation" and "entrepreneurship" in their title or abstract. That might have led us to overlook important contributions on innovative entrepreneurship that use other keywords such as "invention". Again, the conversation with experienced scholars and the inclusion of important studies as a result of this conversation weakens the effect of this limitation. Finally, we would like to stress again that our literature review is on *innovative* entrepreneurship. Thus, studies on related topics such as knowledge-intensive start-ups or high-growth are only included if the sample studied in the paper and the main findings are about innovative start-ups.

## 5. Discussion and avenues for further research

Our discussion is composed of two main parts. In the first part (Section 5.1), we provide some general observations on the literature about entrepreneurship and innovation. In the second part

(Section 5.2), we discuss promising avenues for further research based on current trends in technology, entrepreneurship and society.

### 5.1 Observations about the current literature and implications for further research

In Section 4 of our paper, we highlight some general observations about the literature on innovative entrepreneurship and point to some fruitful avenues for further research. Our goal in this section is to show the big picture; we do not intend to repeat the conclusions from the different literature streams on innovative entrepreneurship that are summarized in Boxes 1 through 7 in Section 4, which is the core of our literature review.

*Empirical evidence from only a few countries*: Most research on innovative entrepreneurship is from industrialized and highly developed countries. Very few studies in our literature review use a non-European or non-US sample. It may stem from the fact that our review is restricted to the top management and economics journals, which are still very much dominated by US and European universities, or from the fact that data are more readily available and accessible in these countries. However, this focus paints a biased picture of innovative entrepreneurship. In recent years, the BRIC countries have become more important, experiencing strong growth rates and societal changes. Currently, our knowledge about the role of innovative entrepreneurship in emerging markets is limited.

*Difficult to establish causal effects*: Most quantitative studies in our literature review are cross-sectional and do not have an experimental design. This makes it difficult to establish causal effects and, as a consequence, to base policy on the research findings (Angrist and Pischke, 2015). The economic literature on entrepreneurship and innovation lags behind other fields in economics such

as labor economics, economics of education, and development economics, where causal designs such as instrumental variable approaches or experimental designs are common. Future research in entrepreneurship and innovation needs to incorporate designs that allow for the measurement of causal effects. However, this requires more effort from policy-makers who must provide reliable and harmonized quantitative data or introduce policy measures in ways that allow experimental measurements.

*Very few studies on innovative entrepreneurship in top economics journals*: Our literature review shows that only a few empirical studies on innovative entrepreneurship are published in the very top economics journals (American Economic Review, Quarterly Journal of Economics, etc.). This is different for the field of management, where the number of top publications on innovative entrepreneurship is somewhat higher. The underrepresentation of innovative entrepreneurship as a research phenomenon is surprising, given that important economists like Schumpeter have laid the foundation for research on innovative entrepreneurship and the economic relevance of innovative entrepreneurship for societal development. We explain this finding with the difficulty of showing causal effects and the dominance of the management discipline in research on innovative entrepreneurship.

*Literature is scattered across disciplines:* Our literature review shows that the literature on innovative entrepreneurship is somewhat scattered across the innovation and entrepreneurship disciplines, and not much cross-referencing occurs. Future research is warranted that integrates the various contributions. Particularly helpful would be quantitative meta-analyses on narrow, clearly defined, but highly relevant sub-aspects of innovative entrepreneurship (e.g. Rosenbusch et al., 2011). Such meta-analyses would help to break up the scattered nature of the literature on

innovative entrepreneurship and systematically summarize empirical evidence on important topics related to innovative entrepreneurship. Our broad, state-of-the-art literature review summarizing the main literature streams on innovative entrepreneurship is not intended to satisfy this goal.

### 5.2 New trends and challenges in entrepreneurship, technology, and society and implications for further research

Having derived some fruitful avenues for further research from the existing literature and its shortcomings, we would now like to discuss some avenues for further research based on recent trends in entrepreneurship and innovation (research), which we believe can have substantial effects on the antecedents, nature, and consequences of innovative entrepreneurship.

*From closed to open or hybrid innovation processes*: Over the last years or decades, many firms have seen a change in their innovation process, from a rather closed to a more open process (Van de Vrande et al., 2009; Dahlander and Gann, 2010). Recent developments in this regard are crowdsourcing (Bayus, 2013), innovation contests, corporate venture capital, corporate incubators, and accelerators. While our literature review has captured some of these movements, such as corporate venture capital or user innovation, we believe that there is substantial room for further research in this regard. For example, how does crowdsourcing, as a tool for idea generation or problem solving, change the cooperation between incumbents and innovative start-ups? How can innovative start-ups build successful business models around the new forms of cooperation between incumbents and start-ups?

*New forms to finance innovative ventures*: Innovation and entrepreneurship finance has seen significant changes over the last years. New ways to finance entrepreneurial ventures have emerged

at the crossroads between private and public equity. As examples, consider crowdfunding in its various forms (e.g., Vulkan et al., 2016), government venture capital (Grilli and Murtinu, 2014), start-up accelerators, university-based seed funds, and IP-backed financial instruments. These new ways of financing can complement or substitute traditional ways of entrepreneurial finance such as business angel, VC, or bank-based ways of financing (e.g., Drover et al., 2015). Innovative entrepreneurship is very much affected by these new ways of financing and future research in this direction seems promising. Some exemplary research questions in this direction include the following: How do new ways of financing help innovative start-ups to attract resources? How do they influence their innovation and financial performance? To what degree does it become easier for innovative start-ups to enter markets dominated by large incumbent forms?

*Entrepreneurship education:* Entrepreneurship education and its link to innovative entrepreneurship is another fruitful area of future research. Past research on entrepreneurship education and its effects has focused on entrepreneurship per se (e.g., Rosendahl Huber et al., 2014; Walter and Block, 2016), but did not treat innovative entrepreneurship as a separate category. However, as our literature review shows, innovative entrepreneurship is different from other forms of entrepreneurship, it involves different actors (user entrepreneurs, inventors, academic entrepreneurs, employees) and requires different skills. We think that it also requires a different type of education in order to motivate innovative entrepreneurs (which often encounter high opportunity costs) and to teach them the relevant skills to succeed with their innovative ventures. Exemplary research questions include the following: How can individuals such as innovative users, inventors, academics, or employees be motivated to take the risk of starting an innovative start-up? Which skills are needed to succeed as a successful entrepreneur in an innovative start-up? Which

forms of teaching (e.g., regular lectures, guest lectures by entrepreneurs, case studies, business simulations) are most effective in building these skills?

*New technologies and business models*: In recent years, new technologies such as 3 D printing, additive manufacturing, and the widespread availability of (fast) Internet access enabling the Internet of Things (IoT) have changed or will change the technological environment in which firms operate. New types of business models such as platform-based or app-based business models have emerged, leading to the creation of innovative and highly disruptive start-ups like Spotify, Skype, Airbnb, Uber, etc., which have challenged the business models of established firms. Innovation is no longer only about the product or the process, but now includes the entire business model. Business model innovation is often successfully implemented by start-ups, while incumbent firms experience problems with disruptive innovations that end up cannibalizing their existing business models. These new technological trends and the resulting business model innovations represent an interesting area of research for the innovative entrepreneurship literature. Exemplary research questions include the following: How do new technologies such as 3 D printing and IoT change the ability of start-ups to disrupt industries and markets? How does the cooperation between start-ups and incumbent firms change as a result of the diffusion of disruptive technologies? Which skills and personality traits of founders are most effective in leading start-ups that challenge existing business models?

*Societal changes and challenges*: The relationship between innovative entrepreneurship and societal changes is underexplored and involves many fruitful areas for further research. How do societal trends such as urbanization, increased importance of work-life balance for younger generations, greater participation by women in the labor market, and a movement towards part time

or hybrid entrepreneurship (Folta et al., 2010) influence the resources available for innovative entrepreneurship and its consequence for society? Innovative entrepreneurship can also help to overcome important societal challenges and problems such as an aging population in Western countries or environmental problems in emerging markets like China. On the other hand, innovative entrepreneurship and the digitization and automation that typically go along with an influx of high-tech start-ups can also lead to job destruction and rising inequality due to skill-biased technological change (Acemoglu, 1998; Oesch, 2013). Future research about the interplay between innovative entrepreneurship and the solution (or creation) of important societal problems is warranted. Exemplary research questions include the following: How can innovative entrepreneurship be used, motivated, regulated, or financed in order to overcome the grand challenges that society faces? Which governmental policy is most effective in this regard? What is the relationship between for-profit and social entrepreneurship when it comes to providing innovative solutions for societal problems?

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## Tables

**Table 1**
Overview of journals and articles included in the initial sample.

| Journal | Initial sample | After excl. non-quantitative studies | After excl. studies with a low fit | After including studies that were brought to us by experts |
|---|---|---|---|---|
| American Economic Review | 4 | 4 | 0 | 1 |
| Academy of Management Journal | 5 | 5 | 2 | 2 |
| Academy of Management Review | 4 | 0 | 0 | 0 |
| Administrative Science Quarterly | 4 | 1 | 0 | 0 |
| Economic Journal | 0 | 0 | 0 | 1 |
| European Economic Review | 0 | 0 | 0 | 0 |
| Entrepreneurship Theory and Practice | 36 | 16 | 6 | 6 |
| Industry and Innovation | 13 | 4 | 2 | 2 |
| Industrial and Corporate Change | 31 | 4 | 2 | 2 |
| Journal of Business Venturing | 54 | 38 | 13 | 17 |
| Journal of Economic Behavior & Organization | 4 | 2 | 2 | 2 |
| Journal of Economics & Management Strategy | 2 | 1 | 1 | 2 |
| Journal of Evolutionary Economics | 25 | 9 | 5 | 5 |
| Journal of Management Studies | 16 | 5 | 3 | 3 |
| Journal of Management | 7 | 2 | 0 | 0 |
| Journal of Political Economy | 1 | 0 | 0 | 0 |
| Journal of Product Innovation Management | 30 | 16 | 4 | 3 |
| Management Science | 8 | 4 | 1 | 1 |
| Organization Science | 10 | 5 | 2 | 2 |
| Quarterly Journal of Economics | 0 | 0 | 0 | 0 |
| RAND Journal of Economics | 0 | 0 | 0 | 3 |
| Research Policy | 63 | 24 | 14 | 20 |
| Review of Economics and Statistics | 1 | 0 | 0 | 0 |
| Small Business Economics | 50 | 25 | 18 | 21 |
| Strategic Entrepreneurship Journal | 18 | 5 | 4 | 4 |
| Strategic Management Journal | 9 | 6 | 4 | 5 |
| **Total** | **395** | **176** | **82** | **102** |

**Table 2**
Categories and empirical studies within each category

| Concept | Category | Description | Final sample |
|---|---|---|---|
| *4.1 Antecedents of innovative entrepreneurship* | Sources and areas where opportunities for innovative entrepreneurship emerge | Investigates the sources and areas where opportunities for innovative entrepreneurship emerge (i.e., inventors, innovative and demanding users, employees, and academics) | 11 |
| | Characteristics of the individual entrepreneur in innovative entrepreneurship | Investigates how innovation orientation on an individual influences how entrepreneurship evolves. | 15 |
| | The environment of innovative entrepreneurship | Investigates how geographic proximity, clusters, and innovation policies influence innovative entrepreneurship. | 16 |
| | Innovation as a signal to obtain resources needed for innovative entrepreneurship | Investigates how VC financing and access to human capital influence start-up innovation. | 13 |
| *4.2 Behavior of innovative entrepreneurs* | Innovation behavior of start-ups | Investigates the behavior of innovative entrepreneurs | 10 |
| | Exit behavior of innovative ventures and its consequences | Investigates the exit behavior of innovative firms and its consequences | 4 |
| | Corporate venture capital | Deals with corporate venture capital investments by large firms in start-ups as a source of innovation for large firms | 3 |
| *4.3 Innovation outcomes* | Innovation output of start-ups | Investigates the innovation output of start-ups and its antecedents | 20 |
| | The effects of entrepreneurship on innovation at the macro level | Investigates the effects of entrepreneurship on innovation on an industry, regional, or country level | 4 |
| *4.4 Consequences of innovation* | The effects of innovation on start-up performance | Analyze how innovation influences start-up performance | 6 |
| | | **Total** | **102** |

**Figures**

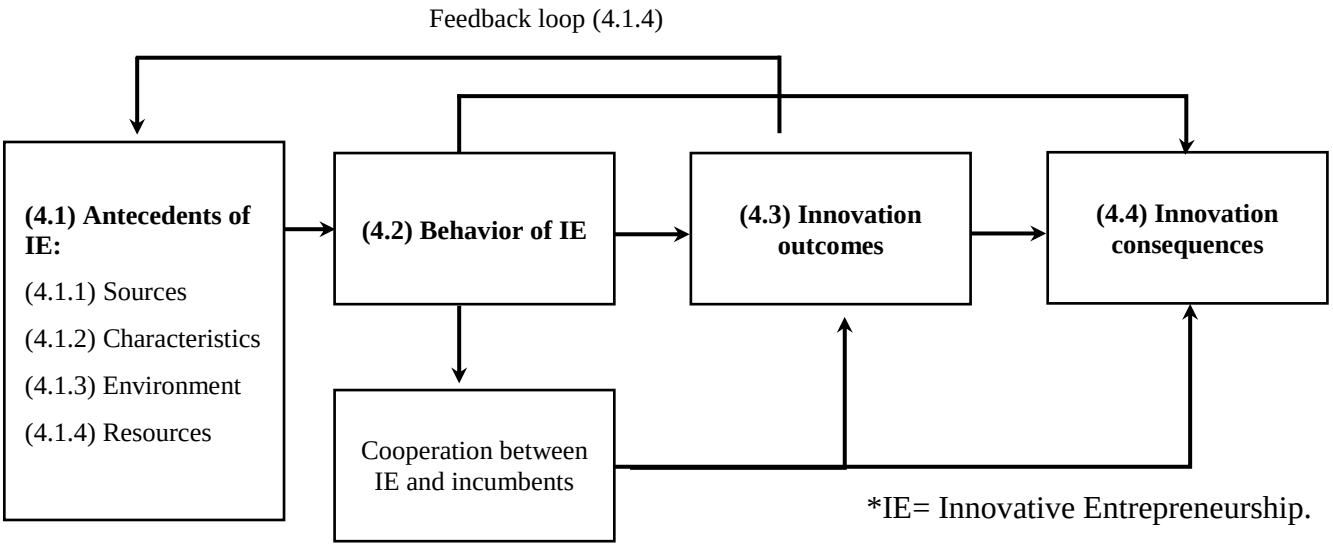


**Figure 1:** Conceptual Model.